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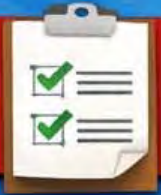


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ICSE CLASS X EXAMINATION PAPER 2026

CHEMISTRY

SCIENCE PAPER - 2

Time: 2 Hours

Max. Marks: 80

General Instructions:

1. Answer to this Paper must be written on the paper provided separately.
2. You will not be allowed to write during first 15 minutes.
3. This time is to be spent in reading the question paper.
4. The time given at the head of this Paper is the time allowed for writing the answers.
5. Section A is compulsory. Attempt any four questions from Section B.
6. The intended marks for questions or parts of questions are given in brackets [].

SECTION-A

(Attempt all questions from this Section.)

QUESTION 1.

Choose the correct answers to the questions from the given options.

(Do not copy the questions, write the correct answers only.)

- (i) A non-metal which reacts with concentrated sulphuric acid to form two gases which turn lime water milky is _____.
(a) Sulphur (b) Carbon
(c) Oxygen (d) Nitrogen

Ans :

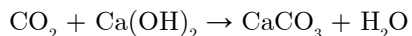
(b) Carbon

Carbon reacts with hot concentrated sulphuric acid and gets oxidised to carbon dioxide while sulphuric acid is reduced to sulphur dioxide. Therefore two gases are produced: carbon dioxide (CO_2) and sulphur dioxide (SO_2). Carbon dioxide turns lime water milky due to the formation of calcium carbonate.

Reaction of carbon with concentrated sulphuric acid:



Carbon dioxide reacts with lime water:



Calcium carbonate (CaCO_3) forms a white precipitate which makes the lime water appear milky.

- (ii) Which of the following element pairs will form an ionic bond?

Pair

P	Elements of Group 1 and Group 2
Q	Elements of Group 14 and Group 16
R	Elements of Group 2 and Group 17
S	Elements of Group 15 and Group 18

- (a) P (b) Q
(c) R (d) S

Ans :

(c) R

Ionic bonds are formed when one atom transfers electrons to another atom. This usually occurs between a metal and a non-metal. Elements of Group 2 are metals and elements of Group 17 are non-metals (halogens). Group 2 elements lose two electrons easily while Group 17 elements gain one electron. This transfer of electrons leads to the formation of ionic compounds such as MgCl_2 and CaCl_2 . Therefore the pair consisting of Group 2 and Group 17 elements will form an ionic bond.

- (iii) The electronic configuration of an element is 2, 8, 2. The hydroxide of this element can produce _____ hydroxyl ions per molecule.

- (a) 3 (b) 2
(c) 1 (d) 0

Ans :

(b) 2

The electronic configuration 2, 8, 2 corresponds to atomic number 12, which is magnesium. Magnesium belongs to Group 2 and forms the hydroxide $\text{Mg}(\text{OH})_2$. When magnesium hydroxide

(viii) An atom of X forms an ion according to the equation $X \rightarrow X^{2+}$. The atomic number of the atom X is:

- (a) 16 (b) 10
(c) 12 (d) 14

Ans :

(c) 12

The formation of X^{2+} means the atom loses two electrons to form a positive ion. Elements that commonly form 2^+ ions belong to Group 2 of the periodic table. Magnesium forms Mg^{2+} by losing two electrons. Magnesium has the electronic configuration 2, 8, 2 and its atomic number is 12. Therefore the atomic number of X is 12.

(ix) Salts can be prepared by the action of dilute acid on:

1. bases
2. carbonates
3. metals
4. sulphites

The method which cannot be used for the preparation of copper salts is:

- (a) 1 (b) 2
(c) 3 (d) 4

Ans :

(c) 3

Copper is below hydrogen in the reactivity series and does not react with dilute acids such as hydrochloric acid or sulphuric acid. Therefore copper cannot produce salts by reacting with dilute acids. However copper salts can be prepared by reacting acids with copper oxide or copper hydroxide (bases), copper carbonate and copper sulphite. Hence the method involving metals cannot be used.

(x) The compound that has the highest melting point amongst the following is:

- (a) Methane
(b) Sodium chloride
(c) Ammonia
(d) Ethanol

Ans :

(b) Sodium chloride

Sodium chloride is an ionic compound with a strong electrostatic attraction between sodium ions and chloride ions in a crystal lattice. A large amount of energy is required to break these ionic bonds, so it has a very high melting point. Methane, ammonia and ethanol are covalent

compounds with weaker intermolecular forces, therefore they have much lower melting points compared to sodium chloride.

(xi) **Assertion (A)** : Dilute sulphuric acid is a stronger electrolyte than concentrated sulphuric acid.

Reason (R) : Dilute sulphuric acid has a higher concentration of mobile ions.

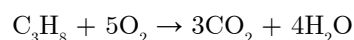
- (a) (A) is true but (R) is false
(b) (A) is false but (R) is true
(c) Both (A) and (R) are true and (R) is the correct explanation of (A)
(d) Both (A) and (R) are true, but (R) is not the correct explanation of (A)

Ans :

(c) Both (A) and (R) are true and (R) is the correct explanation of (A).

Electrolytic conduction depends on the presence of mobile ions in solution. When sulphuric acid is diluted with water, it ionizes more completely producing a larger number of hydrogen ions and sulphate ions. These ions are free to move and conduct electricity. Concentrated sulphuric acid has fewer free ions because ionization is less in the absence of sufficient water. Therefore dilute sulphuric acid behaves as a stronger electrolyte.

(xii) What volume of carbon dioxide is produced at STP when 5 litres of propane is burnt completely according to the equation given below?



- (a) 10 litres (b) 15 litres
(c) 20 litres (d) 25 litres

Ans :

(b) 15 litres

According to Gay-Lussac's law of combining volumes, the volumes of gases in a reaction are in the same ratio as the coefficients in the balanced equation when measured at the same temperature and pressure.

From the given chemical equation,

1 volume of propane produces 3 volumes of carbon dioxide. Therefore 5 volumes of propane will produce $5 \times 3 = 15$ volumes of carbon dioxide. Hence the volume of carbon dioxide produced is 15 litres.

(xiii) An unsaturated hydrocarbon with three atoms of carbon and six atoms of hydrogen is:

- (a) propyne (b) propane
(c) propene (d) propanol

Ans :

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(c) propene

Unsaturated hydrocarbons contain double or triple bonds. Alkenes follow the general formula C_nH_{2n} . When $n = 3$, the formula becomes C_3H_6 . The hydrocarbon with formula C_3H_6 is propene, which contains a carbon-carbon double bond and is therefore unsaturated. Propane is saturated, propyne has the formula C_3H_4 and propanol is an alcohol, not a hydrocarbon.

- (xiv) **Assertion (A) :** In the electrolysis of acidified water, the volume of hydrogen liberated is twice the volume of oxygen formed.

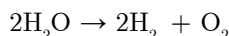
Reason (R) : Water has hydrogen and oxygen in the ratio of 1 : 2 by volume.

- (a) (A) is true but (R) is false
 (b) (A) is false but (R) is true
 (c) Both (A) and (R) are true and (R) is the correct explanation of (A)
 (d) Both (A) and (R) are true, but (R) is not the correct explanation of (A)

Ans :

- (a) (A) is true but (R) is false

During the electrolysis of acidified water, water decomposes into hydrogen and oxygen gases according to the reaction



From the equation, two volumes of hydrogen gas are produced for every one volume of oxygen gas. Therefore the volume of hydrogen collected is twice the volume of oxygen. However the reason given is incorrect because water contains hydrogen and oxygen in the ratio of 2 : 1 by volume, not 1 : 2.

- (xv) In the electrolysis of molten aluminium oxide for extraction of aluminium, the following reactions take place:

- $Al^{3+} + 3e^- \rightarrow Al$
- $2O^{2-} \rightarrow O_2 + 4e^-$
- $C + O_2 \rightarrow CO_2$
- $Al_2O_3 \rightleftharpoons 2Al^{3+} + 3O^{2-}$

The reaction that takes place at the negative electrode is:

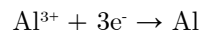
- (a) 1 (b) 2
 (c) 3 (d) 4

Ans :

- (a) 1

The negative electrode in electrolysis is the cathode. At the cathode, reduction takes place,

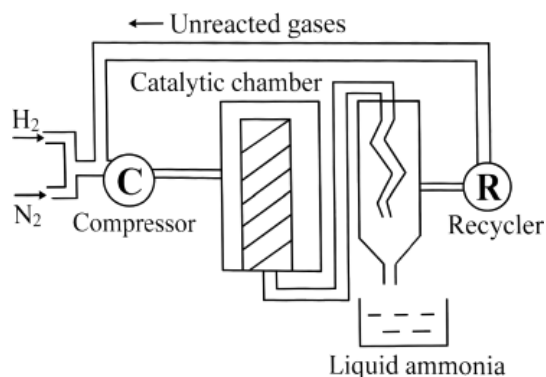
meaning gain of electrons. Aluminium ions gain electrons and are reduced to aluminium metal according to the reaction



Therefore reaction 1 occurs at the negative electrode.

QUESTION 2.

- (i) Given below is the industrial process for the manufacture of ammonia gas. Study the schematic diagram to answer the following questions.



- (a) Name the process.
 (b) Which catalyst is used in the above process?
 (c) In the above diagrammatic setup, how is ammonia gas separated from the unreacted gases to obtain liquid ammonia?
 (d) Which two properties of ammonia gas can be demonstrated by the Fountain Experiment?

Ans :

- (a) Haber process.
 (b) Finely divided iron catalyst.
 (c) The gases coming from the catalytic chamber are cooled under high pressure. Ammonia condenses to form liquid ammonia while the unreacted nitrogen and hydrogen remain as gases and are recycled back into the system.
 (d) Ammonia is highly soluble in water and ammonia is alkaline in nature.

- (ii) Identify the following terms/compounds:

- (a) A compound which reacts with water to give acetylene gas.
 (b) The gas evolved when sodium propanoate is heated with soda lime.
 (c) A reddish-brown precipitate formed when ferric chloride solution reacts with an alkali.
 (d) A pair of electrons present in an atom which is not shared with any other atom during bond formation.

- (e) The relative molecular mass of a substance expressed in grams.

Ans :

- (a) Calcium carbide
(b) Ethane
(c) Ferric hydroxide
(d) Lone pair of electrons
(e) Gram molecular mass

- (iii) Match Column A with Column B.

	Column A		Column B
(a)	$\text{CuO} + \text{C} \rightarrow \text{Cu} + \text{CO}$	1.	Oxidation
(b)	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	2.	Ionization
(c)	$\text{PbBr}_2 \rightarrow \text{Pb}^{2+} + 2\text{Br}^-$	3.	Reduction
(d)	$2\text{O}^{2-} - 2\text{e}^- \rightarrow \text{O}_2$	4.	Redox
(e)	$\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$	5.	Electrolytic dissociation

Ans :

- (a) - 4
(b) - 3
(c) - 5
(d) - 1
(e) - 2

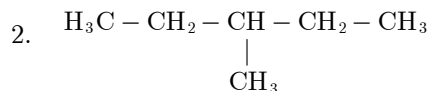
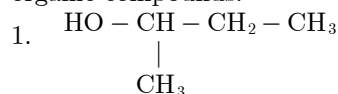
- (iv) Complete the following sentences by choosing the correct option from the brackets.

- (a) The oxide that dissolves in caustic potash (KOH) is _____. [ZnO/CuO]
(b) The reaction that takes place at the anode during the electrolysis of molten lead bromide is _____.
[$2\text{Br}^- - 2\text{e}^- \rightarrow 2\text{Br}/2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2$]
(c) The volume occupied by 8 grams of oxygen gas at STP is _____ litres. [5.6/8.96]
[Atomic weight of O = 16]
(d) _____ does not give hydrogen gas when it reacts with cold and very dilute nitric acid. [Cu/Mn]
(e) _____ is a polar covalent compound. [HCl/CCl₄]

Ans :

- (a) ZnO
(b) $2\text{Br}^- - 2\text{e}^- \rightarrow \text{Br}_2$
(c) 5.6 litres
(d) Cu
(e) HCl

- (v) (a) Give the IUPAC name for the following organic compounds.



- (b) Draw the structural diagram for each of the following organic compounds.

1. butanal
2. pent-2-yne
3. The isomer of n-butane

Ans :

- (a) 1. Butan-2-ol
2. 3-methylpentane
(b) 1. $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CHO}$
2. $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$
3. $\text{CH}_3 - \text{CH}(\text{CH}_3) - \text{CH}_3$
(2-methylpropane/isobutane)

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SECTION-B

(Attempt any four questions from this section)

QUESTION 3.

- (i) Alex was given a solution of an unknown salt Y for analysis. He performed the following tests and recorded his observations.

- To a part of the solution Y, he added silver nitrate solution and obtained a white precipitate which was soluble in ammonium hydroxide solution.
- To the remaining solution he added a few drops of sodium hydroxide solution and obtained a pale blue precipitate.

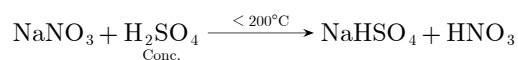
Based on the observations made by Alex, identify:

- (a) the anion
(b) the cation present in salt Y

Ans :

- (a) Chloride ion (Cl^-)
(b) Copper(II) ion (Cu^{2+})

- (ii) Study the reaction given below and answer the questions that follow :



- (a) Give one reason for maintaining the temperature below 200°C .

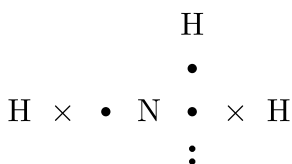
- (b) Why is concentrated sulphuric acid used in the above reaction?

Ans :

- (a) If the temperature exceeds 200°C , nitric acid decomposes into nitrogen dioxide, oxygen and water.
- (b) Concentrated sulphuric acid is a non-volatile acid and displaces nitric acid from sodium nitrate.
- (iii) Element A belongs to group 15 and period 2 of the Periodic Table.
- (a) Identify the element A.
- (b) Write the formula of the compound formed when element A combines with hydrogen.
- (c) Draw the dot ($\bullet$) and cross ($\times$) structure of the compound formed in (b) above.

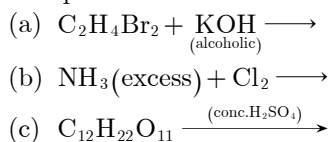
Ans :

- (a) Nitrogen
- (b) NH_3
- (c)

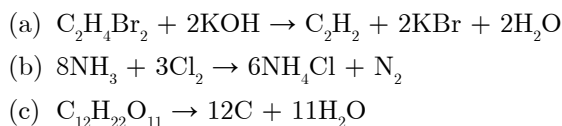


Nitrogen shares three pairs of electrons with three hydrogen atoms and one lone pair remains on nitrogen.

- (iv) Complete and balance the following equations:



Ans :



QUESTION 4.

- (i) Differentiate between the following pairs based on the criteria given in the bracket.
- (a) Acetic acid and Sulphuric acid (number of replaceable hydrogen ion per molecule)
- (b) Electrolyte and Metallic conductor (the particles conducting electricity)

Ans :

- (a) 1. Acetic acid has one replaceable hydrogen ion per molecule (monobasic acid).
2. Sulphuric acid has two replaceable hydrogen ions per molecule (dibasic acid).
- (b) 1. In an electrolyte, electricity is conducted by ions.
2. In a metallic conductor, electricity is conducted by free electrons.

- (ii) Equal volumes of ammonia gas and chlorine gas are kept in two different containers under the same conditions of temperature and pressure. Find the number of molecules contained in chlorine gas when the mass of ammonia is 34 g. [Atomic weight : Cl = 35.5, H = 1, N = 14]

Ans :

Atomic weight of Nitrogen (N) = 14
 Atomic weight of Hydrogen (H) = 1
 Molecular weight of $\text{NH}_3 = 14 + (3 \times 1) = 17 \text{ g/mol}$
 Using the given mass of ammonia (34 g):
 Number of moles of NH_3

$$\begin{aligned}
 &= \frac{\text{Given Mass}}{\text{Molecular Weight}} \\
 &= \frac{34 \text{ g}}{17 \text{ g/mol}} = 2 \text{ moles}
 \end{aligned}$$

Number of molecules contained in chlorine gas

$$\begin{aligned}
 \text{Number of molecules} &= \text{moles} \times N_A \\
 &= 2 \times 6.022 \times 10^{23} \\
 &= 1.204 \times 10^{24} \text{ molecules}
 \end{aligned}$$

- (iii) Elements P, Q and R are in the same period of the modern periodic table.

- P readily loses its one valence electron to form a stable ion.
- Q shares its electrons in bonding but does not form ions easily.
- R has high electronegativity.

Answer the following questions based on the above information :

- (a) Which element would be most difficult to reduce among P, Q and R?
- (b) Which element is expected to have the smallest atomic radius among P, Q and R?
- (c) Arrange P, Q and R in order of decreasing ionization potential.

Ans :

- (a) R
- (b) R
- (c) $R > Q > P$

(iv) Given below are some chemicals:

Lead nitrate, Copper, Hydrochloric acid,
Lead oxide, Iron, Sodium carbonate,
Copper carbonate, Chlorine.

Using suitable chemicals from the box given above, write balanced chemical equations for the preparation of the following salts.

- Lead (II) carbonate
- Copper (II) chloride
- Iron (II) chloride

Ans :

- $\text{Pb}(\text{NO}_3)_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{PbCO}_3 + 2\text{NaNO}_3$
- $\text{CuCO}_3 + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$
- $\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$

QUESTION 5.

- An unsaturated hydrocarbon having two carbon atoms was made to react with two moles of hydrogen gas in the presence of a catalyst to give a saturated hydrocarbon.
 - The type of reaction that occurred is _____ (addition/substitution).
 - Name a suitable catalyst which is used in the reaction.
 - Write a balanced chemical equation for the above reaction.

Ans :

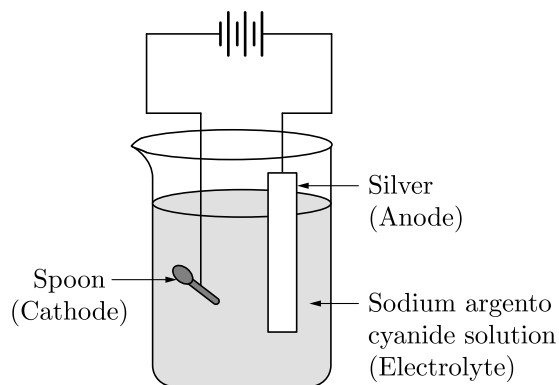
- Addition
- Nickel
- $\text{C}_2\text{H}_2 + 2\text{H}_2 \rightarrow \text{C}_2\text{H}_6$

- During the manufacture of sulphuric acid, a chemist collected the gas formed after catalytic oxidation of sulphur dioxide.
 - Name the gas collected.
 - Which acid is formed when the gas collected by the chemist is dissolved directly in water?
 - Why should we not dissolve this gas directly in water?

Ans :

- Sulphur trioxide
- Sulphuric acid
- The reaction is highly exothermic and forms a dense mist of sulphuric acid which is difficult to condense.

- The diagram given below shows the electroplating of a spoon with silver. With reference to the diagram, answer the following questions :



- Write an equation for the reaction that occurs at the cathode.
- Silver nitrate solution is not preferred as an electrolyte in the above process. Give a reason.
- Why is alternating current not used in the process?
- What is the observation at the anode?

Ans :

- $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$
- Silver nitrate deposits silver very rapidly giving a rough and uneven coating.
- Alternating current reverses the direction of current so deposition of metal cannot occur.
- The silver anode gradually dissolves and decreases in mass.

QUESTION 6.

- Give reasons why:
 - Hydrochloric acid cannot form an acid salt.
 - Electronegativity increases across a period.

Ans :

- Hydrochloric acid is a monobasic acid and contains only one replaceable hydrogen ion. Acid salts are formed only from polybasic acids that have more than one replaceable hydrogen ion. Therefore hydrochloric acid cannot form an acid salt.
- Across a period the nuclear charge increases while the number of shells remains the same. This increases the attraction between the nucleus and the bonding electrons, therefore electronegativity increases.

- State whether the following statements are True or False:
 - Organic compounds having different molecular formula but same structural formula are called isomers.

- (b) A salt is a compound formed by partial or complete replacement of the hydrogen ion of an acid by a metal or electro positive ion.

Ans :

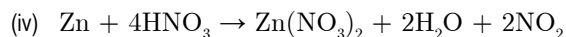
- (a) False
(b) True

- (iii) Anil is a laboratory assistant in a college. He prepared nitric acid but stored it in a transparent container exposed to sunlight. After a few days, brown fumes were observed in the container and the acid turned slightly yellowish in colour.

- (a) What was the error made by Anil while storing the acid?
(b) Why were brown fumes observed in the container?
(c) How can the yellowish tinge in the acid be removed?

Ans :

- (a) He stored nitric acid in a transparent container exposed to sunlight instead of a dark coloured bottle.
(b) Nitric acid decomposes in sunlight to form nitrogen dioxide gas which appears as brown fumes.
(c) The yellow colour can be removed by passing a stream of air through the acid.



32.5 g of zinc reacts with concentrated nitric acid as given in the above equation.

- (a) How many moles of zinc was required in the reaction?
(b) Find the mass of nitric acid needed to react with 32.5 g of zinc.
(c) Find the volume of nitrogen dioxide liberated in (b).

[Atomic weight : H = 1, N = 14, O = 16, Zn = 65]

Ans :

- (a) Number of moles

$$= \text{mass} \div \text{molar mass}$$

$$= 32.5 \div 65$$

$$= 0.5 \text{ mol}$$

- (b) From the equation

1 mol Zn reacts with 4 mol HNO_3

0.5 mol Zn reacts with 2 mol HNO_3

Molar mass of $\text{HNO}_3 = 63$

$$\text{Mass} = 2 \times 63$$

$$= 126 \text{ g}$$

- (c) From the equation

1 mol Zn produces 2 mol NO_2

0.5 mol Zn produces 1 mol NO_2

At STP, 1 mol gas occupies 22.4 L

Volume = 22.4 L

QUESTION 7.

- (i) Carbon reacts with an acid to form carbon dioxide, water and nitrogen dioxide.

- (a) Name the acid used in the reaction.
(b) Write a balanced chemical equation for the reaction that occurs.

Ans :

- (a) Concentrated nitric acid.
(b) $\text{C} + 4\text{HNO}_3 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 4\text{NO}_2$

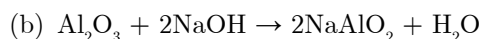
- (ii) Bauxite is the principal ore used in the commercial extraction of aluminium. The Bayer's process is used to refine bauxite into pure alumina, with caustic soda playing a crucial role in the initial stage of the process.

Based on this, answer the following questions:

- (a) Explain the reason behind the addition of caustic soda during the Bayer's process.
(b) Write a balanced chemical equation representing the reaction between bauxite and caustic soda during Bayer's process.

Ans :

- (a) Caustic soda dissolves alumina present in bauxite forming soluble sodium aluminate while impurities remain insoluble and can be filtered off.



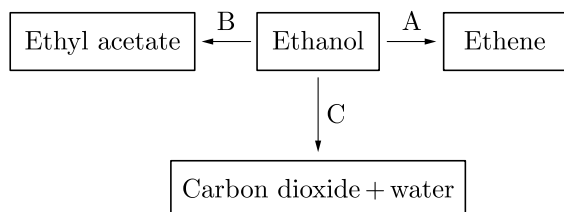
- (iii) Give one relevant observation for the following:

- (a) Sodium hydroxide is added dropwise to calcium nitrate solution.
(b) Dilute hydrochloric acid is added to iron (II) sulphide.
(c) An amphoteric metal is added to hot concentrated alkali.

Ans :

- (a) A white precipitate of calcium hydroxide is formed.
(b) A gas with a rotten egg smell (hydrogen sulphide) is evolved.
(c) Hydrogen gas is evolved.

- (iv) Study the reaction scheme shown below and identify the reactants A, B and C.



Ans :

- A : Concentrated sulphuric acid (dehydration of ethanol to ethene)
 B : Ethanoic acid (esterification to form ethyl acetate)
 C : Oxygen (combustion of ethanol to form carbon dioxide and water)

QUESTION 8.

- (i) 5.6 litres of gas Z weighs 32 g at STP. What is the molecular weight and vapour density of Z?

Ans :

At STP, 22.4 litres of a gas = 1 mole

$$5.6 \text{ litres} = 5.6/22.4$$

$$= 0.25 \text{ mol}$$

$$\text{Molecular weight} = \text{mass/moles}$$

$$= 32/0.25$$

$$= 128$$

$$\text{Vapour density} = \text{Molecular weight}/2$$

$$= 128 / 2$$

$$= 64$$

$$\text{Molecular weight} = 128$$

$$\text{Vapour density} = 64$$

- (ii) Name the following:
 (a) The most electronegative element of Period 2.
 (b) The largest atom of Period 3.

Ans :

- (a) Fluorine
 (b) Sodium

- (iii) Given below are a few elements:

Li, K, Ca, F

Identify the element which:

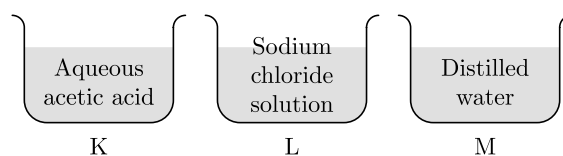
- (a) has the least atomic radius.
 (b) has two valence electrons.

- (c) is the most electropositive.

Ans :

- (a) F
 (b) Ca
 (c) K

- (iv) K, L and M are beakers containing the three different solutions as shown below:



Name the beaker which:

- (a) contains only ions.
 (b) contains only molecules.
 (c) has pH less than 7.

Ans :

- (a) L
 (b) M
 (c) K

ICSE CLASS X EXAMINATION PAPER 2025

CHEMISTRY

SCIENCE PAPER - 2

Time: 2 Hours

Max. Marks: 80

General Instructions:

1. Answer to this Paper must be written on the paper provided separately.
2. You will not be allowed to write during first 15 minutes.
3. This time is to be spent in reading the question paper.
4. The time given at the head of this Paper is the time allowed for writing the answers.
5. Section A is compulsory. Attempt any four questions from Section B.

SECTION-A

(Attempt all questions from this Section.)

QUESTION 1.

Choose the correct answers to the questions from the given options.

(Do not copy the questions, write the correct answer only.)

- (i) Which gas decolorises potassium permanganate (KMnO_4) solution?
- (a) Sulphur dioxide
 - (b) Ammonia
 - (c) Hydrogen chloride
 - (d) Carbon dioxide

Ans :

Potassium permanganate (KMnO_4) is a strong oxidising agent and is purple in color due to the presence of MnO_4^- ions. When sulphur dioxide (SO_2) is introduced into the solution, it acts as a reducing agent and reacts with KMnO_4 . This reaction results in the reduction of MnO_4^- ions (which are purple) to Mn^{2+} ions (which are colorless), leading to the decolourisation of the solution.

This property is commonly used in qualitative chemical analysis to detect the presence of sulphur dioxide gas.

$$2\text{MnO}_4^- + 5\text{SO}_2 + 2\text{H}_2\text{O}_2 \longrightarrow \text{Mn}^{2+} + 5\text{SO}_4^{2-} + 4\text{H}^+$$

Here, manganese (Mn) in MnO_4^- is reduced from +7 oxidation state to +2 oxidation state, while SO_2 is oxidised to SO_4^{2-} (sulphate ion).

Thus (a) is the correct option.

- (ii) Which formula represents a saturated hydrocarbon?
- (a) C_4H_8
 - (b) C_5H_{12}
 - (c) C_4H_6
 - (d) C_5H_{10}

Ans :

A saturated hydrocarbon is a compound that contains only single bonds between carbon atoms. These belong to the alkane family and follow the general formula:



Now, let's analyze the given options C_4H_8 follows the formula C_nH_{2n} , which means it is an alkene (unsaturated hydrocarbon) containing a double bond. C_4H_6 follows the formula $\text{C}_n\text{H}_{2n-2}$, meaning it is an alkyne (unsaturated hydrocarbon) containing a triple bond. C_5H_{10} also follows C_nH_{2n} , meaning it is an alkene with at least one double bond. C_5H_{12} follows the $\text{C}_n\text{H}_{2n+2}$ formula, which is the general formula for alkanes (saturated hydrocarbons). Since C_5H_{12} (pentane) is the only option that fits the formula for a saturated hydrocarbon, it is the correct answer.

Thus (b) is the correct option.

- (iii) The metal whose oxide can be reduced by common reducing agents:
- (a) Copper
 - (b) Sodium
 - (c) Aluminium
 - (d) Potassium

Ans :

1. The ability of a metal oxide to be reduced by a common reducing agent (such as carbon, hydrogen, or carbon monoxide) depends on the metal's position in the reactivity series.
2. Highly reactive metals such as Sodium (Na), Aluminium (Al), and Potassium (K) form very stable oxides that cannot be reduced by common reducing agents. Instead, their oxides must be reduced by electrolysis.
3. Less reactive metals like Copper (Cu) form oxides that are easily reducible by carbon (C) or hydrogen (H_2).

4. Reduction of Copper Oxide (CuO) using Carbon:



Here, carbon (C) removes the oxygen from CuO, reducing it to metallic copper. Because copper is a less reactive metal, its oxide can be easily reduced, making it the correct answer.

Thus (a) is the correct option.

- (iv) An organic compound has a vapour density of 22. The molecular formula of the organic compound is:

[Atomic weight C = 12, H = 1]

- (a) CH_4
- (b) C_2H_4
- (c) C_2H_6
- (d) C_3H_8

Ans :

Vapour density (V.D.) is related to the molecular mass by the formula:

$$\text{Molecular mass} = 2 \times \text{Vapour Density}$$

Given that V.D = 22,

$$\text{Molecular mass} = 2 \times 22 = 44$$

Now, let's check which of the given options has a molecular mass of 44:

$$\text{CH}_4 \text{ (Methane): } 12 + (4 \times 1) = 16$$

$$\text{C}_2\text{H}_4 \text{ (Ethene): } (2 \times 12) + (4 \times 1) = 28$$

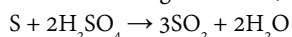
$$\text{C}_2\text{H}_6 \text{ (Ethane): } (2 \times 12) + (6 \times 1) = 30$$

$$\text{C}_3\text{H}_8 \text{ (Propane): } (3 \times 12) + (8 \times 1) = 44$$

Since C_3H_8 (Propane) has a molecular mass of 44, it is the correct answer.

Thus (d) is the correct option.

- (v) In the reaction given below, sulphuric acid acts as a/an:



- (a) Non-volatile acid
- (b) Dibasic acid
- (c) Oxidising agent
- (d) Reducing agent

Ans :

Sulphuric acid (H_2SO_4) is a strong acid that can act as : a strong acid, dehydrating agent and oxidising agent

In this reaction, sulphur (S) is converted to sulphur dioxide (SO_2). Initially, sulphur (S) has an oxidation state of Zero(0).

In SO_2 , sulphur has an oxidation state of +4.

Since the oxidation state of sulphur increases from 0 to +4, sulphur is oxidised.

The substance that causes oxidation (by accepting electrons) is called an oxidising agent.

Thus (c) is the correct option.

- (vi) **Assertion (A) :** The tendency of losing electrons increases down the group.

Reason (R) : The most reactive metal is placed at the top of Group 1.

- (a) Both (A) and (R) are true, and (R) is the correct explanation of (A).
- (b) Both (A) and (R) are true, and (R) is not the correct explanation of (A).
- (c) (A) is true but (R) is false.
- (d) (A) is false but (R) is true.

Ans :

The tendency to lose electrons increases down a group because as we go down a group in the periodic table, the atomic size increases. Due to an increase in atomic size, the valence electrons are farther from the nucleus and experience less nuclear attraction, making them easier to lose. This is why metals become more reactive down a group in the periodic table.

However, the most reactive metal is not placed at the top of Group 1; in fact, it is found at the bottom of the group.

For example, in Group 1 (alkali metals): Lithium (Li) is at the top, and it is the least reactive. Cesium (Cs) and Francium (Fr) are at the bottom, and they are the most reactive. Thus, while both (a) and (R) are true, (R) is not the correct explanation of (A).

Thus (b) is the correct option.

- (vii) The ore that can be concentrated by using magnetic separation:

- (a) Corundum
- (b) Hematite
- (c) Calamine
- (d) Bauxite

Ans :

Magnetic separation is a process used to separate magnetic materials from non-magnetic materials in an ore. Haematite (Fe_2O_3) is a magnetic ore of iron, meaning it can be separated from impurities using a magnetic separator. Calamine (ZnCO_3), Bauxite ($\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$), and Corundum (Al_2O_3) are non-magnetic ores and cannot be separated using this method.

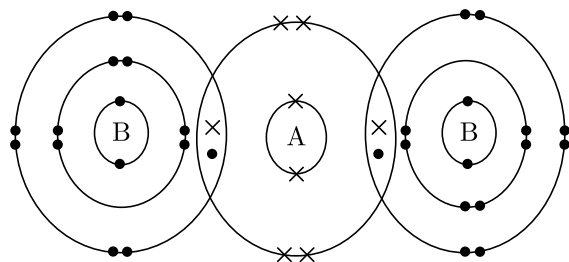
Magnetic Separation Process:

1. The powdered ore is placed on a conveyor belt moving under a magnet.
2. The magnetic particles (haematite) get attracted to the magnet and stick to the belt.
3. The non-magnetic impurities fall away and are separated.

This process is commonly used for iron ores like magnetite (Fe_3O_4) and haematite (Fe_2O_3).

Thus (b) is the correct option.

- (viii) The diagram given below shows the bonding in the covalent molecule AB_2 .



Which option represents the correct electronic configuration of atoms A and B before combining together to form the above molecule?

- A B
- (a) 2, 4 and 2, 8, 6
 (b) 2, 4 and 2, 8, 7
 (c) 2, 8 and 2, 8, 8
 (d) 2, 6 and 2, 8, 7

Ans :

A covalent bond is formed when atoms share valence electrons to complete their octet (8 electrons in the outer shell for stability).

The given molecule AB_2 suggests that A needs two more electrons to complete its octet and B provides these electrons by sharing.

The correct electronic configurations are:

$A = 2, 6$ (likely oxygen, which needs 2 electrons to complete its octet).

$B = 2, 8, 7$ (likely chlorine, which needs 1 electron, so two Cl atoms combine with one O atom).

This corresponds to Oxygen (O) forming a covalent bond with two Chlorine (Cl) atoms, as seen in compounds like OCl_2 .

Thus (d) is the correct option.

- (ix) Which of the following options has all the compounds which are members of the same homologous series?

- (a) CH_4 , C_2H_6 , C_3H_8
 (b) CH_4 , C_2H_6 , C_3H_6
 (c) C_3H_4 , C_3H_6 , C_3H_8
 (d) C_2H_4 , C_3H_6 , C_4H_{10}

Ans :

A homologous series is a group of organic compounds that:

- Have the same general formula.
- Differ by a CH_2 group between consecutive members.

3. Show similar chemical properties.

Each homologous series follows a specific general formula :

Alkanes (Saturated Hydrocarbons):

General formula: C_nH_{2n+2}

CH_4 (Methane) $\rightarrow$ C_2H_6 (Ethane) $\rightarrow$ C_3H_8 (Propane)

They all belong to the alkane series, so option (a) is correct.

- (x) **Assertion (A):** In the Contact Process, SO_3 gas is not directly dissolved in water to obtain sulphuric acid.

Reason (R): Dense fog or misty droplets of sulphuric acid are formed, which is difficult to condense.

- (a) Both (A) and (R) are true, and (R) is the correct explanation of (A).
 (b) Both (A) and (R) are true, and (R) is not the correct explanation of (A).
 (c) (A) is true but (R) is false.
 (d) (A) is false but (R) is true.

Ans :

The Contact Process is the industrial method for producing sulphuric acid (H_2SO_4).

The process involves the following steps:

- Burning sulphur in air to form SO_2 (Sulphur dioxide).
- Oxidizing SO_2 to SO_3 (Sulphur trioxide) using vanadium pentoxide (V_2O_5) as a catalyst.
- SO_3 cannot be directly dissolved in water because it forms a dense fog of fine sulphuric acid droplets, which is difficult to condense.

Thus, the assertion (A) is correct, and the reason (R) correctly explains it.

Thus (a) is the correct option.

- (xi) Given below are four ions: Cl^- , Li^+ , Al^{3+} , K^+ Identify the pair of ions which have the same electronic configuration.

[Atomic number : $Cl = 17$, $Li = 3$, $Al = 13$, $K = 19$]

- (a) Cl^- & Li^+ (b) Al^{3+} & K^+
 (c) Cl^- & K^+ (d) Li^+ & K^+

Ans :

To determine which ions have the same electronic configuration, we must look at their atomic numbers and electron distributions:

Ion	Atomic Number	Electron Configuration	After Gaining/Losing Electrons
Cl (Chlorine)	17	2, 8, 7	$Cl^- = 2, 8, 8$
Li (Lithium)	3	2, 1	$Li^+ = 2$
Al (Aluminium)	13	2, 8, 3	$Al^{3+} = 2, 8$
K (Potassium)	19	2, 8, 8, 1	$K^+ = 2, 8, 8$

Cl (Chloride ion) and K⁺ (Potassium ion) have the same electron configuration: 2, 8, 8.

Since they both have the same number of electrons, they are isoelectronic species.

Other pairs do not have the same electron configuration.

Thus, the correct answer is Cl⁻ & K⁺.

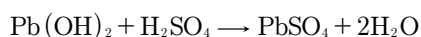
Thus (c) is the correct option.

(xii) Which pair of reactants can be best used to produce lead (II) sulphate?

- (a) Sulphuric acid + Lead
- (b) Sulphuric acid + Lead hydroxide
- (c) Sodium sulphate + Lead nitrate
- (d) Potassium sulphate + Lead oxide

Ans :

Lead(II) sulphate (PbSO₄) is an insoluble salt and is typically formed by precipitation reactions.



Lead hydroxide (Pb(OH)₂) reacts with sulphuric acid (H₂SO₄) to form insoluble lead(II) sulphate (PbSO₄) and water.

1. Option (a) is incorrect because metallic lead does not react readily with dilute sulphuric acid.
2. Option (c) is incorrect because both sodium sulphate and lead nitrate are soluble in water and do not form a precipitate.
3. Option (d) is incorrect because lead oxide (PbO) reacts with sulphuric acid, but the formation of PbSO₄ is less efficient.

Thus, the correct pair of reactants is sulphuric acid and lead hydroxide.

Thus (b) is the correct option.

(xiii) Aqueous copper(II) sulphate is electrolysed using copper electrodes. Which statement about the electrolysis is not correct?

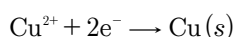
- (a) An oxidation reaction occurs at the positive electrode.
- (b) The current is carried through the electrolyte by ions.
- (c) The positive electrode loses mass.
- (d) The number of copper(II) ions in the electrolyte decreases.

Ans :

In the electrolysis of CuSO₄ solution using copper electrodes, the following occurs:

At the anode (positive electrode): Copper metal undergoes oxidation and dissolves into the solution as Cu²⁺ ions.

At the cathode (negative electrode): Cu²⁺ ions from the solution undergo reduction and get deposited as copper metal.



Since copper ions are leaving the anode and depositing at the cathode, the overall concentration of Cu²⁺ ions in the electrolyte remains the same. Thus, option (d) is incorrect because the number of Cu²⁺ ions in the electrolyte does not decrease.

Thus (d) is the correct option.

(xiv) X, Y & Z are three metallic atoms in successive order belonging to the same group such that the atomic radius of 'X' is the smallest. Which of the three atoms is the best reducing agent?

- (a) X
- (b) Y
- (c) Z
- (d) All three have the same reducing power

Ans :

Reducing agents donate electrons easily and the ability to lose electrons depends on atomic size.

As we move down a group in the periodic table, atomic radius increases because more electron shells are added.

A larger atomic radius means the outermost electrons are farther from the nucleus and are more easily lost.

This makes elements at the bottom of a group stronger reducing agents than those at the top.

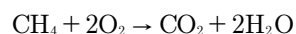
Since X has the smallest atomic radius and Z has the largest atomic radius, the best reducing agent is Z.

Thus, the correct answer is Z because reducing nature increases down the group.

Thus (c) is the correct option.

(xv) 40 cm³ of methane (CH₄) is reacted with 60 cm³ of oxygen (O₂).

The equation for the reaction is given below:

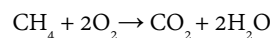


All gas volumes are measured at room temperature

What is the total volume of the gases remaining at the end of the reaction?

- (a) 60 cm³
- (b) 40 cm³
- (c) 45 cm³
- (d) 50 cm³

Ans :



1 Vol. 2 Vol.

40 m³ 80 m³

30 cm³ of CH₄ reacts with 60 cm³ of O₂ volume of CH₄ remaining = 10 cm³

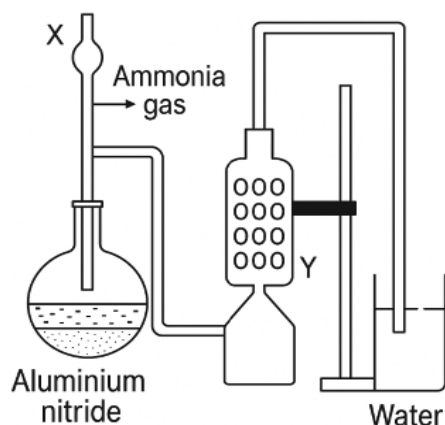
Volume of CO₂ formed = 30 cm³

Total volume of gases remaining at the end of reaction = 10 + 30 = 40 cm³

Thus (b) is the correct option.

QUESTION 2.

- (i) A student was instructed by the teacher to prepare and collect ammonia gas in the laboratory by using aluminium nitride. The student had set up the apparatus as shown in the diagram below. Study the given diagram and answer the following questions:



- Name the substance X added through the thistle funnel by the student.
- Write a balanced equation for the reaction occurring between Aluminium nitride and substance X.
- Identify the substance Y.
- State the function of Y.
- Why could the student not collect ammonia gas at the end of the experiment?

Ans :

- Water (H_2O) or dilute hydrochloric acid (HCl)
- Balanced equations:
With water: $\text{AlN} + 3\text{H}_2\text{O} \rightarrow \text{Al}(\text{OH})_3 + \text{NH}_3 \uparrow$
With hydrochloric acid: $\text{AlN} + 3\text{HCl} \rightarrow \text{AlCl}_3 + \text{NH}_3 \uparrow$
- Calcium oxide (CaO) or concentrated sulphuric acid (H_2SO_4).
- To dry the ammonia gas by absorbing moisture.
- Ammonia gas is highly soluble in water, so it dissolved in the water present in the apparatus instead of being collected.

- (ii) State the terms for the following:

- Undistilled alcohol containing a large amount of methanol.
- A salt formed by the partial replacement of the hydroxyl group of a di-acidic or a tri-acidic base by an acid radical.
- Organic compounds having the same molecular formula but different structural formula.
- The tendency of an atom to attract the shared pair of electrons towards itself when combined in a compound.

- The type of covalent bond in which electrons are shared unequally between the combining atoms.

Ans :

- Denatured alcohol
- Acid salt
- Isomers
- Electronegativity
- Polar covalent bond

- (iii) Complete the following sentences by choosing the correct word(s) from the brackets:

- _____ (Ferrous chloride/Copper nitrate) solution forms a coloured precipitate with ammonium hydroxide which is soluble in excess of ammonium hydroxide.
- Zinc blende is converted to zinc oxide by _____. (Calcination/Roasting)
- _____ conducts electricity by the movement of ions. (Molten iron/Molten sodium chloride)
- The reaction that takes place at the anode during the electrolysis of aqueous sodium argentocyanide with silver electrodes is _____. ($\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$ / $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$)
- The salt formed when ZnO reacts with hot concentrated NaOH is _____. (Sodium zincate/Zinc hydroxide)

Ans :

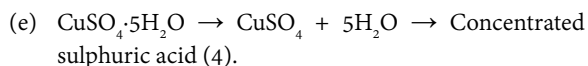
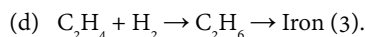
- Copper nitrate
- Roasting
- Molten sodium chloride
- $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
- Sodium zincate

- (iv) Matching Column A with Column B:

	Column A (Reaction)		Column B (Catalyst)
(a)	$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$	1.	Vanadium pentoxide
(b)	$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$	2.	Nickel
(c)	$2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$	3.	Iron
(d)	$\text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6$	4.	Concentrated sulphuric acid
(e)	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O} \rightarrow \text{CuSO}_4 + 5\text{H}_2\text{O}$	5.	Platinum

Ans :

- (a) $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \rightarrow$ Nickel (2).
 (b) $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O} \rightarrow$ Platinum (5).
 (c) $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3 \rightarrow$ Vanadium pentoxide (1).

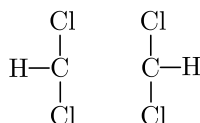


(v) (a) Draw the structural diagram for the following organic compounds:

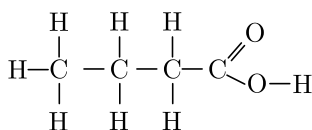
1. 2-Methyl propene
2. Butanal

(b) Give IUPAC name for the following organic compounds:

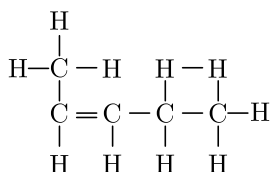
1.



2.

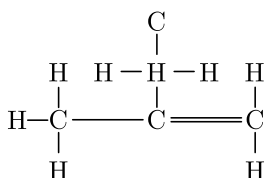


3.

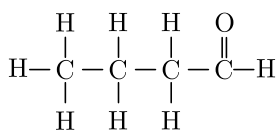


Ans :

(a) 1.



2.



- (b) 1. 1, 1, 2, 2-Tetrachloroethane
 2. Butanoic acid
 3. Pent-2-ene

SECTION-B

(Attempt any four questions from this section)

QUESTION 3.

- (i) The atomic number of two atoms 'X' and 'Y' are 14 and 8 respectively. State :
- (a) The period to which 'X' belongs.
 - (b) The formula of the compound formed between 'X' and 'Y'. (Do not identify X and Y.)

Ans :

The atomic number of two atoms 'X' and 'Y' are 14 and 8 respectively.

- (a) Period to which 'X' belongs: 3rd period.
- (b) Formula of the compound formed between 'X' and 'Y': XO_2 .

(ii) Justify the following statements:

- (a) Anode is known as the oxidizing electrode.
- (b) Graphite electrodes are preferred in the electrolysis of molten lead bromide.

Ans :

- (a) Anode is known as the oxidizing electrode. Oxidation is the loss of electrons and it occurs at the anode during electrolysis. Since oxidation takes place at the anode, it is called the oxidizing electrode.
- (b) Graphite electrodes are preferred in the electrolysis of molten lead bromide. Graphite is a good conductor of electricity and is chemically inert. Unlike metal electrodes, it does not react with molten lead bromide or liberated bromine gas, making it the preferred choice.

(iii) The reaction between concentrated sulphuric acid and magnesium can be represented by the equation given below:



If 60 g of magnesium is used in the reaction, calculate the following:

- (a) The mass of sulphuric acid needed for the reaction.
- (b) The volume of sulphur dioxide gas liberated at S.T.P. (Atomic weights: Mg = 24, H = 1, S = 32, O = 16)

Ans :

Reaction between concentrated sulphuric acid and magnesium:



Given:

Mass of Mg used = 60 g

Atomic masses:

Mg = 24, H = 1, S = 32, O = 16

- (a) Mass of sulphuric acid needed for the reaction:

Molar mass of Mg = 24 g/mol

Molar mass of H_2SO_4 = 98 g/mol

1 mole (24 g) of Mg reacts with 2 moles (196 g) of H_2SO_4 . So, 60 g of Mg will require:

$$\frac{60 \times 196}{24} = 490 \text{ g of } \text{H}_2\text{SO}_4$$

Mass of H_2SO_4 needed = 490 g

- (b) Volume of SO_2 gas liberated at S.T.P.:

1 mole of Mg (24 g) produces 1 mole (64 g) of SO_2 .

60 g of Mg will produce:

$$\frac{60 \times 64}{24} = 160 \text{ g of } \text{SO}_2$$

1 mole (64 g) of SO_2 occupies 22.4 L at S.T.P.

So, 160 g of SO_2 will occupy:

$$\frac{160 \times 22.4}{64} = 56 \text{ L}$$

Volume of SO_2 gas liberated = 56 L

- (iv) Give one significant observation when:

- A solution of barium chloride is added to zinc sulphate solution.
- Lead nitrate is heated in a test tube.
- Chlorine gas is passed over moist starch iodide paper.

Ans :

Give one significant observation when:

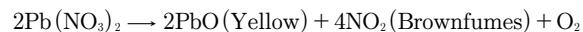
- A solution of barium chloride is added to zinc sulphate solution.

Observation : A white precipitate of barium sulphate (BaSO_4) is formed. Reaction:

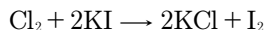


- Lead nitrate is heated in a test tube.

Observation : Reddish-brown fumes of nitrogen dioxide (NO_2) gas are evolved, and a yellow residue of lead(II) oxide (PbO) is left.



- Chlorine gas is passed over moist starch iodide paper. Observation: The starch iodide paper turns blue-black.



Chlorine oxidizes iodide (I^-) to iodine (I_2), which reacts with starch to give a blue-black color.

QUESTION 4.

- A gas cylinder can hold 150 g of hydrogen under certain conditions of temperature and pressure. If an identical cylinder with the same capacity can hold 450 g of gas 'G' under the same conditions of temperature and pressure, find:

- The vapour density of the gas 'G'.

- The molecular weight of gas 'G'.

Ans :

- Vapour density of gas 'G'

$$\text{Vapour density} = \frac{\text{Mass of gas 'G'}}{\text{Mass of hydrogen}} = \frac{450}{150} = 3$$

- Molecular weight of gas 'G'

$$\text{Molecular weight} = 2 \times \text{Vapour density}$$

$$= 2 \times 3 = 6 \text{ g/mol}$$

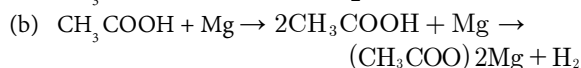
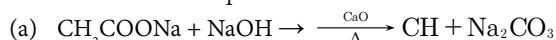
$$\text{Molecular weight of gas 'G'} = 6 \text{ g/mol}$$

- Complete and balance the following equations:



Ans :

Balanced Chemical Equations



- Name the gas produced during each of the following reactions:

- When copper is treated with hot, concentrated nitric acid.
- When ammonia is burnt in an atmosphere of oxygen.
- When ferrous sulphide reacts with dilute hydrochloric acid.

Ans :

- Nitrogen dioxide (NO_2)
- Nitric oxide (NO)
- Hydrogen sulphide (H_2S)

- Study the table given below. Use only the letters given in the table to answer the questions. Do not identify the elements.

IA	IIA	IIIA	IVA	VA	VIA	VIIA	0
			E		J		Q
	L			G			
	M	D				P	
	N						

- State the valency of element 'G'.
- Which element can exhibit catenation?
- Write the formula of the compound formed between 'M' and 'P'.

Ans :

- Three
- E
- MP_2

QUESTION 5.

- (i) Given below are two sets of elements from two different periods. Name the element with the highest ionisation potential in each of the following sets:

- (a) Al, Cl, Mg
(b) Ne, O, F

Ans :

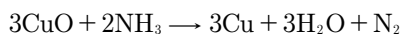
- (a) Chlorine (Cl) has the highest ionisation potential among Al, Cl, Mg because ionisation potential increases across a period and Cl is the farthest to the right.
(b) Neon (Ne) has the highest ionisation potential among Ne, O, F because noble gases have a completely filled stable electron configuration, making them require the most energy to remove an electron.

- (ii) Ammonia gas is passed over heated copper (II) oxide in a combustion tube:

- (a) Name the gas evolved.
(b) What will be the colour of the residue that is left in the combustion tube at the end of the reaction?

Ans :

- (a) Nitrogen gas (N_2) is evolved.
(b) The residue left in the combustion tube is reddish-brown due to the formation of copper metal (Cu).
Reaction:

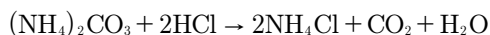


- (iii) Give balanced equations for the following:

- (a) Action of dilute hydrochloric acid on ammonium carbonate.
(b) Oxidation of sulphur with hot concentrated nitric acid.
(c) Reaction of concentrated sulphuric acid with carbon.

Ans :

- (a) Action of dilute hydrochloric acid on ammonium carbonate:



- (b) Oxidation of sulphur with hot concentrated nitric acid:

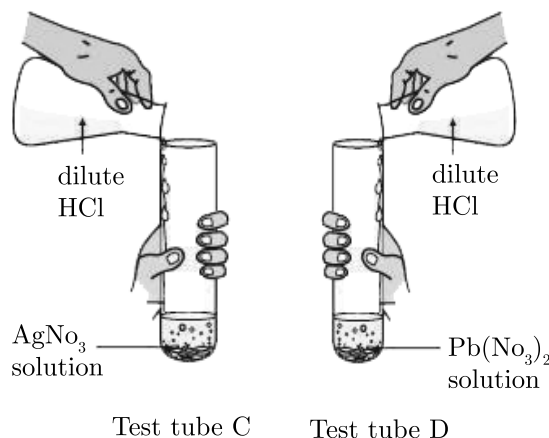


- (c) Reaction of concentrated sulphuric acid with carbon:

- (iv) Rohit took two different salt solutions in test tubes C and D as shown in the figure below. He added dilute HCl to each of the two test tubes. The products formed in test tube C and D are silver chloride and lead chloride respectively. State:

- (a) One common observation made by Rohit in both the reactions.

- (b) The observations made by him on addition of excess ammonium hydroxide to the products formed in



1. Test tube C
2. Test tube D

Ans :

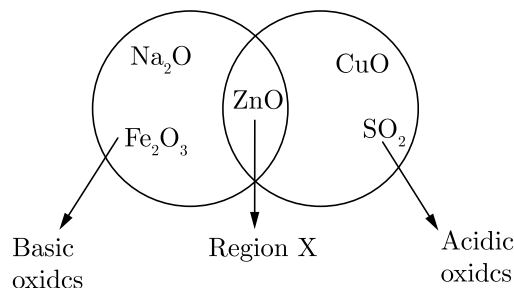
- (a) A white precipitate is formed in both test tubes C and D upon the addition of dilute HCl.

- (b) Observations on addition of excess ammonium hydroxide :

1. In Test tube C (Silver chloride, AgCl): The white precipitate dissolves completely in excess ammonium hydroxide, forming a colorless solution.
 $AgCl + 2NH_3 \longrightarrow [Ag(NH_3)_2]Cl$
2. In Test tube D (Lead chloride, PbCl₂): The white precipitate remains unchanged in excess ammonium hydroxide.

QUESTION 6.

- (i) Given below is a diagram showing the placement of five different oxides. With respect to the given diagram answer the following questions:



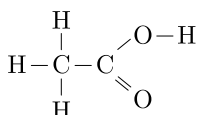
- Name the type of oxide represented in region X in the diagram.
- Identify the oxide which has been incorrectly placed in the above diagram.
- Name the oxide from the above diagram which will form an alkali when dissolved in water.

Ans :

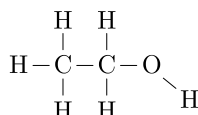
- The type of oxide represented in region X is Amphoteric Oxide.
- The incorrectly placed oxide is most likely a Neutral Oxide, which does not fit well in the diagram.
- The oxide that will form an alkali when dissolved in water is a Basic Oxide, such as Sodium Oxide (Na_2O) or Potassium Oxide (K_2O).

- (ii) Given below are organic compounds labelled A to F. Answer the questions that follow:

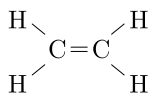
A.



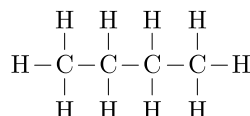
B.



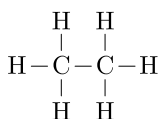
C.



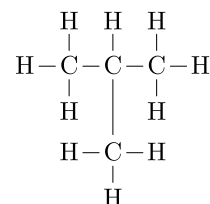
D.



E.



F.



- Which compound forms a single product with bromine?
- Which two compounds have the same molecular formula?
- Which two compounds will react together in the presence of concentrated H_2SO_4 to form a product with a fruity smell?

Ans :

- The compound that forms a single product with bromine is an Alkene, as it undergoes an addition reaction with bromine.
- The two compounds with the same molecular formula are likely Isomers (e.g., ethanol and dimethyl ether, both having $\text{C}_2\text{H}_6\text{O}$).
- An alcohol and a carboxylic acid will react together in the presence of concentrated H_2SO_4 to form an ester, which has a fruity smell.

- (iii) An organic compound 'X' contains carbon, oxygen, and hydrogen only. The percentage of carbon and hydrogen are 47.4% and 10.5% respectively. The relative molecular mass of 'X' is 76. Find the empirical formula and the molecular formula of 'X'.
(Atomic weight: C = 12, O = 16, H = 1)

Ans :

Step 1: Find the percentage of oxygen

$$\begin{aligned} \% \text{O} &= 100 - (47.4 + 10.5) \\ &= 42.1\% \end{aligned}$$

Step 2: Convert mass percentages to moles

$$\text{Carbon: } \frac{47.4}{12} = 3.95$$

$$\text{Hydrogen: } \frac{10.5}{1} = 10.5$$

$$\text{Oxygen: } \frac{42.1}{16} = 2.63$$

Step 3: Divide by the smallest value

$$\text{Carbon: } \frac{3.95}{2.63} \approx 1.5$$

$$\text{Hydrogen: } \frac{10.5}{2.63} \approx 4$$

$$\text{Oxygen: } \frac{2.63}{2.63} = 1$$

Step 4: Multiply by 2 to get whole numbers

$$\text{C} = 3, \text{H} = 8, \text{O} = 2$$

$$\text{Empirical formula} = \text{C}_3\text{H}_8\text{O}_2$$

Step 5: Find Molecular Formula

Empirical Formula Mass:

$$(3 \times 12) + (8 \times 1) + (2 \times 16) = 76$$

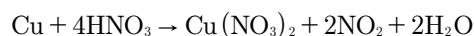
Since Empirical Formula Mass = Molecular Mass (76), the Molecular Formula is also $\text{C}_3\text{H}_8\text{O}_2$.

QUESTION 7.

- (i) Seema added a few pieces of copper turnings to a test tube containing concentrated acid P and she noticed that a reddish-brown gas evolved.
- Name the acid P used by Seema.
 - Write a balanced chemical equation for the reaction that took place.

Ans :

- The acid used by Seema is concentrated Nitric Acid (HNO_3).
- Balanced Chemical Equation:

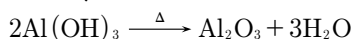


Copper reacts with concentrated nitric acid to form copper(II) nitrate ($\text{Cu}(\text{NO}_3)_2$), nitrogen dioxide (NO_2) gas (reddish-brown fumes), and water.

- (ii) Answer the following questions with reference to the concentration of bauxite ore.
- Name the process used to concentrate the ore.
 - Give a balanced chemical equation for the conversion of aluminium hydroxide to pure alumina.

Ans :

- (a) The process used to concentrate bauxite ore is called Bayer's Process.
- (b) Balanced Chemical Equation for the Conversion of Aluminium Hydroxide to Pure Alumina:



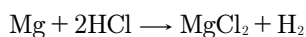
Aluminium hydroxide ($\text{Al}(\text{OH})_3$) is heated to form alumina (Al_2O_3) and water.

- (iii) Draw the dot and cross structure of the following:
- (a) An ionic compound formed when Mg reacts with dilute HCl.
- (b) A covalent compound formed when H_2 reacts with Cl_2 .
- (c) The positive ion produced when ammonia gas is dissolved in water.
- (Atomic numbers: Mg = 12, Cl = 17, H = 1, N = 7)

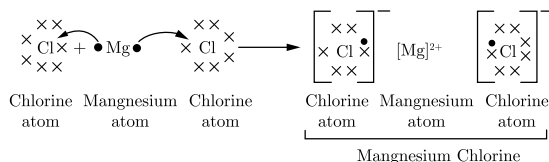
Ans :

Dot and Cross Structures:

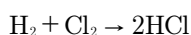
- (a) An ionic compound formed when Mg reacts with dilute HCl:



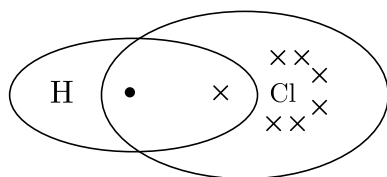
- Magnesium donates two electrons to two chlorine atoms, forming Mg^{2+} and two Cl^- ions.
- MgCl_2 has an ionic bond.



- (b) A covalent compound formed when H_2 reacts with Cl_2 :

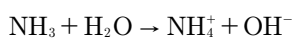


Each hydrogen and chlorine atom shares one electron, forming a covalent bond.

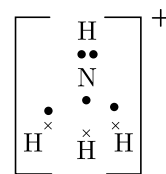


Hydrogen chloride

- (c) The positive ion produced when ammonia gas dissolves in water:



Ammonium ion (NH_4^+) is formed when ammonia reacts with water.



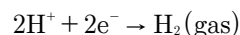
Ammonium ion

- (iv) Acidulated water is electrolysed using platinum electrodes.
- (a) Why is dilute sulphuric acid added to water?
- (b) Write the reaction taking place at the cathode.
- (c) What is the observation at the anode?

Ans :

- (a) Dilute sulphuric acid is added to water to increase its conductivity. Pure water is a poor conductor of electricity, and H_2SO_4 provides ions (H^+ and SO_4^{2-}) to facilitate electrolysis.

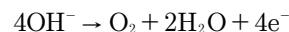
- (b) Reaction at the Cathode:



Hydrogen gas is liberated at the cathode.

- (c) Observation at the Anode:

- Bubbles of oxygen gas are observed at the anode.
- Reaction at the Anode:

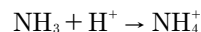


QUESTION 8.

- (i) (a) State Avogadro's Law.
- (b) Define co-ordinate bond.

Ans :

- (a) Avogadro's Law : "Equal volumes of all gases, under the same conditions of temperature and pressure, contain an equal number of molecules."
- (b) Co-ordinate Bond Definition : A co-ordinate bond (dative bond) is a type of covalent bond in which both shared electrons come from the same atom. Example: Formation of Ammonium ion (NH_4^+)



The lone pair on Nitrogen (N) forms a co-ordinate bond with H^+ .

- (ii) Differentiate between the following pairs of compounds using the reagent given in the bracket:

- (a) Ammonium chloride and Sodium chloride (using an alkali).
- (b) Zinc Nitrate solution and Calcium Nitrate solution (using excess sodium hydroxide solution).

Ans :

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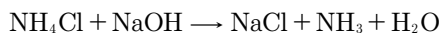
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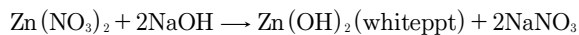
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- (a) Ammonium chloride vs. Sodium chloride (using an alkali - NaOH): Ammonium chloride (NH_4Cl) reacts with NaOH to release ammonia gas (NH_3), which has a pungent smell.

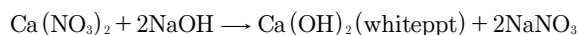


Sodium chloride (NaCl) does not react with NaOH.

- (b) Zinc Nitrate vs. Calcium Nitrate (using excess NaOH): Zinc Nitrate forms a white precipitate of $\text{Zn}(\text{OH})_2$, which dissolves in excess NaOH to form a soluble complex.



Calcium Nitrate forms a white precipitate of $\text{Ca}(\text{OH})_2$, which is insoluble in excess NaOH.



- (iii) You are provided with some compounds in the box:

PbO_2	CH_4	PbO_2	CO_2
HCl	NCl_3	SO_2	

Choose the most appropriate compound which fits the descriptions (a) to (c) given below:

- (a) A colourless gas which turns acidified $\text{K}_2\text{Cr}_2\text{O}_7$ from orange to green.
 (b) A yellow explosive oily liquid formed when excess chlorine gas reacts with ammonia gas.
 (c) A yellow metallic oxide formed on thermal decomposition of PbCO_3 .

Ans :

- (a) SO_2 (Sulphur dioxide)
 (b) NCl_3 (Nitrogen trichloride)
 (c) PbO (Lead(II) oxide)

- (iv) P, Q, R, and S are different methods of preparation of salts.

P – Simple displacement

Q – Neutralisation by titration

R – Precipitation

S – Direct combination

Choose the most appropriate method to prepare the following salts:

- (a) PbCl_2
 (b) FeCl_3
 (c) Na_2SO_4

Ans :

- (a) PbCl_2 (Lead(II) chloride) $\rightarrow$ Precipitation (Method R)
 (b) FeCl_3 (Iron(III) chloride) $\rightarrow$ Direct Combination (Method S)
 (c) Na_2SO_4 (Sodium sulfate) $\rightarrow$ Neutralisation by titration (Method Q)

CHAPTER 1

PERIODIC PROPERTIES AND VARIATIONS OF PROPERTIES

SUMMARY

1. DOBEREINER'S TRIADS

Relation between atomic weights and properties of elements was first observed by a German chemist Johann Wolfgang Dobereiner in 1817. He arranged closely related elements into three groups in which atomic weight of middle element was arithmetic mean of other two.

For example:

Elements	Ca	Sr	Ba
Atomic mass	40	88	137

$$\begin{aligned} \text{Average atomic mass of 1}^{\text{st}} \text{ and 3}^{\text{rd}} \\ = \frac{40 + 137}{2} = 88.5 \end{aligned}$$

Li	Na	K
7	23	39

$$= \frac{7 + 39}{2} = 23$$

This classification was discarded because many elements could not find their positions in the triad.

2. NEWLAND'S OCTAVE LAW

In 1865, John Newlands, an English chemist arranged all the elements known at that time into a table (as shown) in increasing order of their atomic weights. He found that every eighth element from any point had similar properties, called Newlands' Law of Octaves.

Notes of Music						
sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe

Notes of Music						
sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
I	Cs	Ba,V	Ta	W	Nb	Au
Pt, Ir	Tl	Pb	Th	Hg	Bi	Os

If we start with lithium (Li) [first element], we find that the eighth element from it is sodium (Na) and as per Newlands' law of octaves, properties of sodium should be same to lithium.

2.1 Drawbacks of Newlands' Law of Octaves

- The law of octaves was applicable only upto calcium (Ca) because after calcium, every eighth element did not have similar properties to the that of the first.
- New lands did not leave any space or slot in his table for yet undiscovered elements.
- To adjust elements in his table, Newlands put two elements in same space but also put some dissimilar elements under the same column.

3. MENDELEEV'S PERIODIC LAW

A Russian chemist Dmitri Ivanovich Mendeleev is credited for classification of elements. When he started his work, 63 elements were known and inert gases were unknown. He examined the relationship between atomic weights of elements and their physical and chemical properties. Among the chemical properties, Mendeleev concentrated on compounds formed by elements with oxygen and hydrogen, i.e., oxides and hydrides. Mendeleev arranged known elements in increasing order of atomic weights by putting elements together in group having same properties to form periodic table. Mendeleev, in 1869, proposed his periodic law as the properties of elements are periodic

functions of their atomic weights (masses).

Two guiding factors which led Mendeleev to create his periodic table were

1. arranging elements in increasing order of atomic mass, and
2. grouping the elements with similar properties together.

Mendeleev's periodic table has 8 vertical columns (groups) and 12 horizontal rows (periods).

3.1 Achievements of Mendeleev's Periodic Table

1. Systematic Study of Elements,
2. Prediction of New Elements,
3. Correction of Doubtful Atomic Weights, and
4. Noble gases.

3.2 Defects of Mendeleev's Periodic Table

1. Position of Hydrogen

The position of hydrogen in Mendeleev's periodic table is unsatisfactory as it has been placed in same column as Au, Ag and Cu.

2. Position of Isotopes

Isotopes are atoms of same element having different atomic weights. So, as per Mendeleev's periodic table, they should be placed at different positions. However, isotopes having similar chemical properties should not be placed at different positions.

3. Anomalous Pairs of Elements

Lots of these elements with higher atomic weight have been placed before the one with lower atomic weight, e.g., Co (At. Wt. 58.9) precedes Ni (At. Wt. 58.7).

4. Grouping Together of Some Elements with Dissimilar Properties

Cu, Ag and Au are grouped together with highly reactive alkali metals like Li, Na and K.

5. Cause of Periodicity

Mendeleev's classification is purely empirical and it could not justify the cause of periodicity of properties among the elements.

4. MODERN PERIODIC LAW

The physical and chemical properties of all elements are the periodic functions of their atomic numbers.

The properties of the elements are repeated after regular interval.

5. MOSELEY'S PERIODIC TABLE

Later on Bohr worked on the Moseley's periodic table and Bury in the year 1921 gave the extended form of the periodic table known as the long form of the periodic table.

6. MODERN PERIODIC TABLE

Periodic table may be defined as the table in which the elements are arranged in the increasing order of their atomic numbers.

1. In the modern periodic table, the vertical lines are called as groups.
2. There are eighteen groups in the periodic table. The order for the arrangement of the group is (from left to right) IA, IIA, IIIB, IVB, VB, VIB, VIIB, VIII (undivided), IB, IIB, IIIA, IVA, VA, VIA, VIIA and zero. But according to the latest recommendations of IUPAC, the groups are numbered from 1 to 18.
3. The elements of groups 1, 2, 13, 14, 15, 16 and 17 are called as normal or representative elements. These elements have incomplete outermost shell.
4. The elements of groups 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 are known as transition elements. These elements have incomplete penultimate shell.
5. The elements of group 18 or zero group are called as inert gases or noble gases or rare gases as they have stable configuration following the octet rule.
6. Group 1 elements are called as alkali metals.

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Diagram illustrating the periodic table with blocks and groups:

- s-BLOCK**: Groups 1 and 2.
- Metals**: Elements to the left of the metalloids.
- Metalloids**: Elements along the diagonal line.
- Non-metals**: Elements to the right of the metalloids.
- p-BLOCK**: Groups 13 to 18.
- d-BLOCK**: Groups 3 to 10.
- f-BLOCK**: Lanthanides and Actinides (shown separately below the main table).

The periodic table is organized into **Groups** (1 to 18) and **Periods** (1 to 7). The elements are color-coded by block:

- s-block** (Groups 1 and 2): Light blue.
- p-block** (Groups 13 to 18): Light green.
- d-block** (Groups 3 to 10): Light orange.
- f-block** (Lanthanides and Actinides): Light purple.

The diagram also shows the **Metals**, **Metalloids**, and **Non-metals** regions.

Lanthanides (f-block):

58	138.9	59	140.9	60	144.2	61	145	62	150.36	63	152.0	64	157.3	65	158.9	66	162.5	67	164.9	68	167.3	69	168.9	70	173.0	71	175.0
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu														
Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium														

Actinides (f-block):

90	232.0	91	231.0	92	238	93	237	94	244	95	243	96	247	97	247	98	251	99	252	100	257	101	258	102	259	103	262
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr														
Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium														

The diagram also shows the **Groups** (1 to 18) and **Periods** (1 to 7) on the left side.

7. Group 2 elements are called as alkaline earth metals.
 8. Group 17 elements are called as halogens (salt producers).
 9. The horizontal rows in the periodic table are called periods.
 10. There are seven periods in the periodic table. The number of shells present in an atom determines its period. Elements in period 1 have one shell, elements in period 2 have two shells, elements in period 3 have three shells and so on.
- For example :
14. Fourth period is a long period containing eighteen elements (K to Kr).
 15. Fifth period is also a long period with eighteen elements (Rb to Xe).
 16. Sixth period is a very long period containing thirty two elements (Cs to Rn).
 17. Seventh period is an incomplete period.
 18. In group III B and sixth period, the elements from atomic numbers 57 to 71 are present which are called as lanthanoides.
 19. In group III B and seventh period, the elements from atomic numbers 89 to 103 are present which are called as actinoides.

Name of the element	Atomic number	K, L, M, N	Period
Hydrogen	1	1	1st period
Helium	2	2	1st period
Lithium	3	2, 1	2nd period
Sodium	11	2, 8, 1	3rd period
Potassium	19	2, 8, 8, 1	4th period

11. First period is the shortest period containing only two elements, i.e. hydrogen and helium.
12. Second period is a short period containing eight elements (Li, Be, B, C, N, O, F and Ne).
13. Third period is also a short period containing eight elements (Na, Mg, Al, Si, P, S, Cl and Ar).

7. PERIODICITY

The properties which reoccur after a regular interval in periodic table are called as periodic properties and the phenomenon is called as periodicity.

The major cause for the periodicity is the re-occurrence of similar outer electronic configuration. In a particular group, the valence electrons remains the same and thus the valency is also the same. Hence, the properties are same.

7.1 Valence Electrons and Valency

The electrons present in the outermost shell of an atom are called valence electrons.

The combining capacity of an element is called its valency.

8. PROPERTIES OF AN ELEMENT

According to the Modern Periodic Law, the properties of an element depends upon: the following properties :

- Atomic size** : It is taken as the distance between the nucleus and the outermost shell of an atom.
- Metallic character** : It is the tendency to lose electrons easily.
- Non-metallic character** : It is the tendency to gain electrons.
- Ionisation energy** : It is the energy required to remove an electron from the outermost shell of an atom in its isolated gaseous state, thereby converting it into a positively charged ion.
 - Inert gases have maximum ionisation energy.
 - Metals have low ionisation energy.
- Electron affinity** : It is the energy released on adding an electron to the outermost shell of an atom in its isolated gaseous state, thereby converting it into an anion.
 - Inert gases have zero electron affinity.
 - Non-metals have high electron affinity.
 - Halogens have maximum electron affinity in their respective periods.
- Electro-negativity** : It is the tendency of an atom to attract the shared pair of electrons towards its side when combined in a compound.
 - The acidic character of oxides increases as we move across a period.

Example :

Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₂	Cl ₂ O ₇
Strongly basic	Basic	Amph- oteric	slightly acidic	Acidic	Acidic	Strongly acidic

- The basic character of oxides increases as we move down the group.
- The common feature seen at the end of every period is the presence of an inert gas with the complete octet or a stable configuration.
- The striking features of alkali metals are:
 - Highly electro-positive in nature.
 - Good reducing agents.
 - Valency is +1.
 - They have low ionization potential.
 - They form metal halides.
 - Good conductors of electricity.
 - They have largest atomic size in their periods.

- They react vigorously with dilute acids and cold water to liberate hydrogen. The reactivity increases on moving down the group.

(v) The striking features of halogens are :

- Highly electronegative in nature.
- Good oxidising agents.
- Valency is +1.
- They have high electron affinity.
- They undergo ionic bond formation with metals.
- Poor conductors of electricity.
- They have smallest size in their period.
- They do not react with dilute acids.

MULTIPLE CHOICE QUESTION

- ¹H² is an isotope of hydrogen. In the modern periodic table it will:
 - be placed before hydrogen
 - be placed after hydrogen
 - be placed at the same position as hydrogen
 - not have any position in the periodic table

Ans :

SQP 2025

¹H² is an isotope of hydrogen. In the modern periodic table it will be placed at the same position as hydrogen.

Thus (c) is correct option.

- In the 2nd period, Neon has maximum ionisation potential because:
 - It has unstable electronic configuration.
 - It easily accepts electrons.
 - It easily loses electrons.
 - The outer most shell is completely filled.

Ans :

MAIN 2024

Due to the stable configuration and the octet rule (outermost shell is completely filled with eight electrons), the electrons are tightly held by the nucleus in the 2nd period element Neon (Ne), and it requires a significant amount of energy to remove an electron from the outer shell.

Thus (d) is correct option.

- Electron Affinity is maximum in:
 - Mg
 - Ar
 - Li
 - Br

Ans :

MAIN 2024

Bromine has a relatively high electron affinity compared to the other elements because it is a halogen and tends to gain one electron to achieve a stable electronic configuration.

Thus (d) is correct option.

4. In a periodic table, the element of period 3 are arranged in the increasing order of ionisation potential as

(a) B, N, Cl, Ar (b) Mg, Si, S, Ar
(c) Ar, Si, S, Mg (d) Si, Ar, Cl, Mg

Ans :

SEM-I 2021

Thus (b) is correct option.

5. The tendency of an atom to attract shared pair of electrons to itself when forming a chemical bond is known as

(a) electron affinity
(b) electronegativity
(c) ionisation potential
(d) nuclear charge

Ans :

SEM-I 2021

Electro-negativity is a chemical property that describes the tendency of an atom or functional group to attract electrons towards itself. It is a dimensionless property because it is only a tendency. It indicates the net result of the tendencies of atoms in different elements to attract the bond-forming electron pairs.

Thus (b) is correct option.

6. Alkaline earth metals have the same

(a) number of valence electrons
(b) number of shells
(c) metallic property
(d) ionisation potential

Ans :

SEM-I 2021

Alkaline earth metals have the same number of valence electrons, which is two. These electrons are located in the outermost s orbital of the atom.

Thus (a) is correct option.

7. Element with an atomic number 19 will

(a) accept an electron and get oxidised
(b) accept an electron and get reduced
(c) lose an electron and get oxidised
(d) lose an electron and get reduced

Ans :

SEM-I 2021

Element with an atomic number 19 belongs to group-I, so it can lose an electron and get oxidised. Thus (c) is correct option.

8. If an element has low ionisation potential, then it is likely to be a

(a) metal (b) metalloid
(c) non-metal (d) inert gas

Ans :

SEM-I 2021

If an element has a low ionization potential, it is likely to be metallic. This is because low ionization potential means that less energy is needed to remove an electron from the outermost shell of an atom to form a cation. This increases the metallic character of the element, which is its tendency to lose electrons to form cations.

Thus (a) is correct option.

The non-metallic properties of elements from left to right in a periodic table

(a) increases
(b) decreases
(c) remains same
(d) first increases and then decreases

Ans :

SEM-I 2021

Non-metallic character from left to right increases due to decrease in atomic size and increase in nuclear charge.

Thus (a) is correct option.

10. The table below shows the electronic arrangements of six atoms, A to F.

Atom	A	B	C	D	E	F
Electronic configuration	2, 5	2	2, 6	2, 8, 6	2, 8, 8	2, 8, 3

With respect to the table select the following:

- (i) Two atoms from the same group of the periodic table.

(a) D and E (b) C and D
(c) E and F (d) C and E

Ans :

SEM-I 2021

The elements in each group have the same number of valence electrons. As a result, elements in the same group often display similar properties and reactivity.

Thus (b) is correct option.

- (ii) Two noble gases

(a) A and B (b) E and F
(c) B and E (d) D and E

Ans :

SEM-I 2021

Noble gases, which are also known as inert gases, are the elements that belong to group 18 of the modern periodic table. They are very non-

reacting in nature and hence do not react easily unlike other elements.

Thus (c) is correct option.

(iii) The atom which is the most electronegative.

- (a) *A* (b) *B*
(c) *C* (d) *F*

Ans :

SEM-I 2021

Thus (c) is correct option.

(iv) The atom which has the highest ionisation potential.

- (a) *A* (b) *B*
(c) *E* (d) *F*

Ans :

SEM-I 2021

Thus (c) is correct option.

11. The element with highest ionization potential is :

- (a) Hydrogen (b) Caesium
(c) Radon (d) Helium

Ans :

MAIN 2020

Helium (He) has the highest ionization potential among all elements because it has a completely filled orbital and a small atomic size. Helium also has two electrons in a duplet state, which means they are closer to the nucleus and require a lot of energy to remove.

Thus (d) is correct option.

12. The most electronegative element from the following elements is :

- (a) Magnesium (b) Chlorine
(c) Aluminium (d) Sulphur

Ans :

SQP 2019

Electro-negativity increases from left to right across a period. Among magnesium, chlorine, aluminium and sulphur, chlorine is at extreme right. Hence, chlorine is the most electronegative element.

Thus (b) is correct option.

13. Ionisation potential increases over a period from left to right because the:

- (a) Atomic radius increases and nuclear charge decreases
(b) Atomic radius decreases and nuclear charge increases
(c) Atomic radius increases and nuclear charge increases
(d) Atomic radius decreases and nuclear charge decreases

Ans :

COMP 2015

Ionization potential increases across a period from left to right because atomic radius decreases and nuclear charge increases. This pulls the valence electrons closer to the nucleus, making it harder to remove them and increasing the ionization energy.

Thus (b) is correct option.

14. Among the elements given below the element with the least electro-negativity is :

- (a) Lithium (b) Carbon
(c) Boron (d) Fluorine

Ans :

MAIN 2015

Highly electronegative elements, such as fluorine, are found on the right side of the periodic table. As a result, lithium is the least electronegative element in the second period of the periodic table. Thus (a) is correct option.

15. If an element A belongs to period 3 and Group II then it will have :

- (a) 3 shells and 2 valence electrons
(b) 2 shells and 3 valence electrons
(c) 3 shells and 3 valence electrons
(d) 2 shells and 2 valence electrons

Ans :

COMP 2014

In the modern periodic table, horizontal columns are referred to as groups, and vertical rows are referred to as periods. The number of shells is indicated by the period number, while the number of valence electrons is shown by the group number. Hence, the element A has 3 shells and 2 valence electrons.

Thus (a) is correct option.

16. Among the period 2 elements, the element which has high electron affinity is :

- (a) Lithium (b) Carbon
(c) Chlorine (d) Fluorine

Ans :

SQP 2013

Fluorine has the highest electron affinity of the elements in period 2 of the periodic table. This is because fluorine is the smallest element in period 2, which gives it a high effective nuclear charge compared to the other elements.

Thus (d) is correct option.

17. An element in period-3 whose electron affinity is zero:

- (a) Neon (b) Sulphur
(c) Sodium (d) Argon

Ans :

MAIN 2012

Argon belongs to period 3. It is an inert element and stable. It neither requires to gain electron nor lose. It has its octet complete and hence it has the zero electron affinity.

Thus (d) is correct option.

18. An alkaline earth metal.
- (a) Potassium (b) Calcium
(c) Lead (d) Copper

Ans :

COMP 2012

Alkaline earth metals are elements in Group 2 of the periodic table. The six alkaline earth metals are:

Barium (Ba), Beryllium (Be), Calcium (Ca), Magnesium (Mg), Radium (Ra), and Strontium (Sr)
Thus (b) is correct option.

19. Which of the following properties do not match with the elements of the halogen family ?
- They have seven electrons in their valence shell.
 - They are highly reactive chemically.
 - They are metallic in nature.
 - They are diatomic in their molecular form.

Ans :

SQP 2011

Halogens are non-metallic elements in group 17 of the periodic table. They have seven electrons in their valence shell, which gives them a strong tendency to gain one electron to complete their octet. This makes them highly reactive chemically. Thus (c) is correct option.

20. In the periodic table, alkali metals are placed in the group.
- | | |
|--------|--------|
| (a) 1 | (b) 11 |
| (c) 17 | (d) 18 |

Ans :

COMP 2011

Alkali metals are in group 1 of the periodic table, also known as group 1A. This group is located in the s-block on the leftmost column of the periodic table, along with hydrogen.
Thus (a) is correct option.

- 21.** The number of electrons present in the valence shell of a halogen is :
- (a) 1
(b) 3
(c) 5
(d) 7

Ans :

MAIN 2010

Each halogen atom has seven valence electrons in its outermost electron shell. Valence electrons are the electrons present in the outermost shell of an atom.

Thus (d) is correct option.

- 22.** Among the elements of period 2 the element which has high electron affinity is :
- (a) Lithium (b) Carbon
(c) Chlorine (d) Fluorine

Ans :

SQP 2009

Electron affinity increases across the period and decreases down the group. So, among period 2 elements fluorine has highest electron affinity.

Thus (d) is correct option.

- 23.** The positions of four elements A , B , C and D in the modern periodic table are shown below. Which element is most likely to form an acidic oxide?

- (a) A
(c) C

Ans :

COMP 2020

C is a non metal and non-metal oxides are acidic
' D ' is an inert gas.

Thus (c) is correct option

- 24.** With reference to the variation of properties in the periodic table, which of the following is generally true ?
- (a) Atomic size increases from left to right across a period.
 - (b) Ionisation potential increases from left to right across a period.
 - (c) Electron affinity increases going down a group.
 - (d) Electro-negativity increases going down a group.

Ans :

SQP 2009

With the reference to the variation of properties in the Periodic table, across a period the ionization potential increases from left to right.

Thus (b) is correct option.

- 25.** Why group IA elements are called alkali metals?
- When combined with water, their oxides produce acidic solutions.
 - When treated with water, their hydroxides produce acidic solutions.
 - When their peroxides are treated with water, they produce alkaline solutions.
 - When their oxides and hydroxides are treated with water, they produce alkaline solutions

Ans :

MAIN 2010

Group IA elements are called alkali metals because their oxides and hydroxides are soluble in water and form strong bases.

Thus (d) is correct option.

- 26.** Which of the following types of elements show variable valency?
- s-block elements
 - Transition elements
 - p-block elements
 - d-block elements

Ans :

COMP 2015

Variable valency is exhibited by transition elements and f-block elements.

Thus (b) is correct option.

- 27.** An element in period 2 whose electron affinity is zero:
- Carbon
 - Neon
 - Sodium
 - Sulphur

Ans :

SQP 2022

Electron affinity of noble gas such as neon is near zero. Noble gas has completely filled valence shells and stable octets. It does not accept electrons easily as they have no deficiency, also adding electrons produces repulsion between the electrons. Hence, electron affinity of neon is zero. Thus (b) is correct option.

- 28.** What is the fundamental property of classification in modern periodic law?
- Atomic radius
 - Atomic volume
 - Atomic number
 - Atomic mass

Ans :

MAIN 2023

The fundamental property on which the modern periodic table is based is atomic number, not atomic mass.

Thus (c) is correct option.

- 29.** On moving from left to right across a period of the periodic table, the electron affinity of the elements in groups 1 to 7 :

- Goes up and then down
- Decreases and then increases
- Decreases
- Increases

Ans :

COMP 2007

The tendency of elements to take electrons and complete their octet rises as we move from left to right, therefore electron affinity increases.

Thus (d) is correct option.

- 30.** Elements *P*, *Q*, *R* and *S* have atomic numbers 11, 15, 17 and 18 respectively. Which of them are reactive non-metals?

- P* and *Q*
- P* and *R*
- Q* and *R*
- R* and *S*

Ans :

SQP 2020

Element:	<i>P</i>	<i>Q</i>	<i>R</i>	<i>S</i>
Atomic No.:	11	15	17	18
Electronic configuration.:	2, 8, 1	2, 8, 5	2, 8, 7	2, 8, 8

Element '*P*' is a metal while element '*S*' is an inert gas. So *Q* and *R* are non-metals as they have tendency to gain 3 and 1 electron respectively.

Thus (c) is correct option

- 31.** Consider the following statements about an element '*X*' with number of protons 13.

- It forms amphoteric oxide
- Its valency is three
- The formula of its chloride is XCl_3

The correct statement(s) is/are

- Only 1
- Only 2
- 1 and 3
- 1, 2 and 3

Ans :

MAIN 2020

Aluminium (13) makes amphoteric oxide, has 3 as valency and makes AlCl_3 . The element is highly reactive. It has about one-third of stiffness and density of steel. Aluminium has good corrosion resistivity. It is capable of superconductivity. They are many unknown isotopes of hydrogen with the mass number ranging from twenty-one to forty-one.

Thus (d) is correct option

32. An element A belonging in Period 3 and Group II will have
(a) 3 shells and 3 valence electrons
(b) 2 shells and 3 valence electrons
(c) 3 shells and 2 valence electrons
(d) 2 shells and 2 valence electrons

Ans :

COMP 2007

In the modern periodic table, Horizontal columns are referred to as groups and vertical rows are referred to as periods. The number of shells is indicated by the period number, while the number of valence electrons is shown by the group number. Hence, the element A has 3 shells and 2 valence electrons.

Thus (c) is correct option.

33. The atoms of elements belonging to the same group of periodic table have the same:
(a) Number of valence electrons
(b) Number of electrons
(c) Number of neutrons
(d) Number of protons

Ans :

SQP 2004

The valence electrons of elements in the same group are the same. As a result, the number of electrons in the outermost shell is the same.

Thus (a) is correct option.

34. The metallic character in a period as one moves from left to right.
(a) increases (b) decreases
(c) remains same (d) none of the above

Ans :

MAIN 2015

Metallic character decreases across a period because atoms of elements across a period from right to left accept electrons more readily to fill their valence shell.

Thus (b) is correct option.

35. Which of the following is the atomic number of an element that forms basic oxide?
(a) 18 (b) 17
(c) 15 (d) 19

Ans :

COMP 2017

An element that produces basic oxide has an atomic number of 19 Potassium (K) is the element. KOH is a strong base and K_2O is a basic in nature. Potassium is an alkali metal and All alkali metal oxides are basic in nature.

Thus (d) is correct option.

36. If element 'X' forms a chloride with the formula $XC l_3$, then X would most likely belong to the same group of the Modern Periodic Table as :
(a) Na (b) Br
(c) Mg (d) Al

Ans :

SQP 2019

Because the element produces $XC l_3$, it generates a tri-chloride. So valency of element is 3. Among the following elements Na, Br, Al, Mg, X would belong to the same group as Al because its valency is 3.

Thus (d) is correct option.

37. The most active metals are present in 1 and 2 of the Periodic Table.
(a) Period (b) Group
(c) Both (a) and (b) (d) None of these

Ans :

COMP 2021

The majority of active metals are so reactive that they easily interact with oxygen and water. These metals belong to the periodic table's groups I A and II A. Because all of the alternatives are part of the same group, the activity rises as you move along the group.

Thus (b) is correct option.

38. The correct order of electron affinities of N, O, S and Cl is
(a) $O < S < Cl < N$
(b) $O < N < Cl < S$
(c) $O = Cl < N = S$
(d) $N < O < S < Cl$

Ans :

MAIN 2023

- (i) Electron affinities increases from left to right in a period and decreases down the group.
(ii) But, in case of oxygen and sulphur, sulphur has higher value of electron affinity due to larger size.

As oxygen is smaller in size with six valence electrons, which offer greater electron-electron repulsion as compared to sulphur (having six valence electrons).

Thus, has higher electron affinity.

Hence, correct order is $N < O < S < Cl$.

Thus (d) is correct option.

39. The properties of elements are periodic function of their
(a) atomic number (b) atomic mass
(c) both (b) and (d) (d) valency

Ans :

SQP 2010

The number of protons is equivalent to the atomic number of an atom (or is electrons in case of a neutral atom). Physical and chemical properties of elements depend on the number of electrons and their arrangement. Thus, properties of elements are periodic function of their atomic numbers and not atomic weights.

Thus (a) is correct option.

40. With reference to the variation of properties in the periodic table, which of the following is generally true?

- (a) Atomic size increases from left to right across a period.
- (b) Electro-negativity increases on moving down the group.
- (c) Electron affinity increases on moving down the group.
- (d) Ionisation potential increases from left to right across a period.

Ans :

COMP 2004

With the reference to the variation of properties in the Periodic table, across a period the ionization potential increases from left to right.

Thus (d) is correct option.

41. Arrange the following elements in the order of their increasing non-metallic character Li, O, C, Be, F

- (a) $F < O < C < Be < Li$
- (b) $F < C < Be < O < Li$
- (c) $Li < Be < C < O < F$
- (d) $F < O < Be < C < Li$

Ans :

MAIN 2012

Li, O, C, Be, F belong to same period i.e., 2nd period. In a period on moving from left to right, non-metallic character increases. Thus, the order of increasing non-metallic character is



Thus (c) is correct option.

42. The group of elements in which the differentiating electron enters in the anti-penultimate shell of atoms are called

- (a) *p*-block elements (b) *f*-block elements
- (c) *s*-block elements (d) *d*-block elements

Ans :

SQP 2014

Anti-penultimate shells means the differentiating electrons enters in $(n - 2)$ sub-shells.

Since, Differentiating electron (last electron) enters in *f*-block elements having general

electronic.

Configuration $(n - 2)f^{1-14}(n - 1)d^{0-1}ns^2$.

Thus (b) is correct option.

43. Which of the given elements A, B, C, D and E with atomic numbers 2, 3, 7, 10 and 30 respectively belong to the same period?

- (a) B, C, D (b) A, B, C
- (c) I, D, E (d) B, D, E

Ans :

MAIN 2017

The first period contains 2 elements. The second period contains 8 elements. The third period contains 8 elements. Therefore, the first period contains 1-2 atomic number. The second period contains 3 -10 atomic number. The third contains 11 to 18 atomic number. The fourth period contains 19 to 36 atomic number.

So B, C, D belong to the same period.

Thus (a) is correct option.

44. Which one of the following elements exhibit maximum number of valency electrons?

- (a) P (b) Al
- (c) Si (d) Na

Ans :

SQP 2000

Sodium belongs to group 1 and has 1 valence electron. Aluminium belongs to group 13 and has 3 valence electrons. Silicon belongs to group 14 and has 4 valence electrons. Lastly, phosphorus belongs to group 15 and has 5 valence electrons. Hence we can see that phosphorus has the maximum number of valence electrons.

Thus (a) is correct option.

45. The ionization potential :

- (a) goes up and down (b) decreases
- (c) remains the same (d) increases

Ans :

SQP 2013

Ionization energy or ionization potential is the minimum energy required to remove the most loosely bound electron of an isolated neutral gaseous atom or molecule. On moving from left to right across a period, the ionization energy of elements increases. This is due to the decrease in the size of atoms across a period.

Thus (d) is correct option.

46. Which of the following is a covalent chloride ?

- (a) Phosphorus Chloride
- (b) Potassium Chloride
- (c) Magnesium Chloride
- (d) Sodium Chloride

Ans :

COMP 2014

Phosphorus trichloride (PCl_3) is a covalent compound because both phosphorus and chlorine are non-metals that don't tend to donate electrons. At room temperature, it's a fuming liquid with weak intermolecular forces and doesn't conduct electricity.

Thus (a) is correct option.

47. The element having largest atomic size in periods.

- (a) Inert Gases
(b) Metals Halogen
(c) Alkaline Earth Metals
(d) Alkali

Ans :

MAIN 2017

Alkali metals have the largest atomic size in a period of the periodic table. This is because alkali metals have a charge of +1 and are highly reactive, forming ionic compounds and other compounds. Francium (Fr), with an atomic number of 87, is the alkali metal with the largest atomic radius in the periodic table

Thus (d) is correct option.

48. The number of electron shells in the elements of period 3,

- (a) One (b) Two
(c) Four (d) Three

Ans :

COMP 2019

All elements present in 3rd period contain 3 shells (K, L, M) in which the electrons are distributed. Thus (d) is correct option.

49. The tendency of an atom to attract shared pair of electrons to itself when combined in a compound is called along the period.

- (a) electro-positivity (b) electro-negativity
(c) inert (d) none of the above

Ans :

MAIN 2023

The tendency of an atom to attract electrons to itself when combined in a compound is electronegativity.

Thus (b) is correct option.

50. Beryllium exhibits diagonal relationship with

- (a) fluorine (b) calcium
(c) magnesium (d) aluminium

Ans :

COMP 2008

Beryllium shows a diagonal relationship with aluminium.

Thus (d) is correct option.

51. An element used in atomic clocks :

- (a) Rhodium (b) Cesium
(c) Francium (d) Radon

Ans :

SQP 2010

Caesium is widely used in highly accurate atomic clocks.

Thus (b) is correct option.

52. Aluminium oxide is:

- (a) Amphoteric oxide (b) Acidic oxide
(c) Neutral oxide (d) Basic oxide

Ans :

MAIN 2011

Aluminium oxide is an inorganic compound and true anhydride of aluminium hydroxide. It is amphoteric as it can react with both acids and bases acting as an acid with a base and a base with an acid neutralising the other and producing the salt.

Thus (a) is correct option.

53. Group IIA elements are known as :

- (a) Alkali metals
(b) Noble gases
(c) Halogens
(d) Alkaline earth metals

Ans :

SQP 2015

The alkaline earth metals are the elements that correspond to group 2 of the modern periodic table. This group of elements includes beryllium, magnesium, calcium, strontium, barium, and radium.

Thus (d) is correct option.

54. Which is not correct with reference to the elements of group 18 ?

- (a) Zero electron affinity
(b) Maximum ionisation energy
(c) Valency is variable
(d) Complete octet

Ans :

COMP 2017

Thus (c) is correct option.

55. If an electron energy it jumps to lower energy level from high energy level.

- (a) lose (b) gain
(c) equal (d) not of the above

Ans :

MAIN 2019

Thus (a) is correct option.

- 56.** Boiling point and melting point of halogens (increase/decrease) with increase in atomic number.

(a) increases
(b) remains same
(c) non-uniformly varies
(d) decreases

Ans :

COMP 2017

Thus (a) is correct option.

- 57.** The noble gas having an electronic configuration of 2, 8, 8,

(a) Neon (b) Xenon
(c) Argon (d) Radon

Ans :

SQP 2016

Argon (Atomic no. -18) is the noble gas having electronic configuration: 2, 8, 8.

Thus (c) is correct option.

- 58.** The electron affinity of the elements in group 1 to 7 :

(a) goes up and then down
(b) decreases and then increases
(c) decreases
(d) increases

Ans :

MAIN 2015

As we move from left to right, tendency of elements to accept electron and completes their octet increases so electron affinity increases.

Thus (d) is correct option.

- 59.** Noble gases have electron affinity.

(a) low (b) highest
(c) moderate (d) zero

Ans :

SQP 2012

Noble gases have zero electron affinity values.

Thus (d) is correct option.

- 60.** An element in period 3 whose electrons affinity is zero.

(a) Argon (b) Sulphur
(c) Sodium (d) Neon

Ans :

MAIN 2005

Argon belongs to period third. It is an inert element and stable. It neither requires to gain electron nor lose. It has its octet complete and hence it has the zero electron affinity.

Thus (a) is correct option.

- 61.** Arrange the following elements in the order of their decreasing metallic character

Na, Si, Cl, Mg, Al

(a) $\text{Na} > \text{Mg} > \text{Al} > \text{Si} > \text{Cl}$
(b) $\text{Cl} > \text{Si} > \text{Al} > \text{Mg} > \text{Na}$
(c) $\text{Na} > \text{Al} > \text{Mg} > \text{Cl} > \text{Si}$
(d) $\text{Al} > \text{Na} > \text{Si} > \text{Ca} > \text{Mg}$

Ans :

COMP 2007

Metallic characteristic decreases across a period on moving right. Therefore, the order comes out to be $\text{Na} > \text{Mg} > \text{Al} > \text{Si} > \text{Cl}$.

Thus (a) is correct option.

- 62.** Which one of the following does not increase while moving down the group of the periodic table?

(a) Atomic radius
(b) Metallic character
(c) Number of shells in an element
(d) Valency

Ans :

SQP 2009

The number of valence electrons does not increase while moving down the group in the periodic table

Thus (d) is correct option.

- 63.** If an element A belongs to period III and group II, then it will have

(a) 2 shells and 2 valence electrons
(b) 2 shells and 3 valence electrons
(c) 3 shells and 3 valence electrons
(d) 3 shells and 2 valence electrons

Ans :

MAIN 2010

Period defines the number of shells, and a group defines the number of valence electrons of the element. Since element A belongs to period 3 and group II thus, it will have 3 shells and 2 valence electrons.

Thus (d) is correct option.

- 64.** Element with atomic number 38 belongs to

(a) III A group and 5th period
(b) II A group and 2nd period
(c) V A group and 2nd period
(d) II A group and 5th period

Ans :

COMP 2011

Given atomic number (Z) = 38, has 5 shells and 2 electrons in its outermost shell, i.e. has electronic configuration 2, 8, 18, 8, 2.

Thus, member of 5th period and II(A) group.

Thus (d) is correct option.

- 65.** The electron affinity of Be is similar to

(a) Na (b) B
(c) Li (d) He

Ans :

SQP 2013

Electron affinity of Be is similar to He i.e. -50 kJ/mol because, both have fulfilled outermost shells with two electrons in s-sub shell and are nearly of same size.

Thus (d) is correct option.

66. Across a period, the ionization potential

- (a) decreases (b) increases
(c) remains the same (d) none of the above

Ans :

COMP 2014

Electrons are added to the same valence shell as we move from left to right in a period. As a result, atomic size decreases and nuclear charge increases. Thus, more amount of energy is required to remove an electron from the outermost shell and therefore ionisation potential increases.

Thus (b) is correct option.

67. If an element has seven electrons in its outermost shell then it is likely to have the atomic size among all the elements in the same period.

- (a) smallest (b) largest
(c) same (d) both (a) and (b)

Ans :

MAIN 2017

The atomic radii decreases when electrons are added to the same valence shell as we move from left to right in a period. The nuclear attraction decreases, and the element shrinks. As a result, the element with the smallest atomic size is one with seven electrons in its valence shell.

Thus (a) is correct option.

68. Three elements B, Si and Ge are

- (a) metalloid
(b) non-metals
(c) metals
(d) metal, non-metal and metalloid respectively

Ans :

SQP 2019

The metalloids; Boron (B), Silicon (Si), Germanium (Ge), Arsenic (As), Antimony (Sb), Tellurium (Te), Polonium (Po) and Astatine (At) are the elements found along the step like line between metals and non-metals of the Periodic table. Metalloids exhibit few properties similar to both metals and nonmetals.

Thus (a) is correct option.

69. Among the elements given below, the element with the least electro-negativity is :

- (a) Boron (b) Carbon
(c) Lithium (d) Fluorine

Ans :

COMP 2012

Lithium is an element with the least electro-negativity.

Thus (c) is correct option.

70. Arrange the following as per instruction given in the brackets : K, Cl, Na, S, Si (increasing order of atomic size)

- (a) $\text{Na} < \text{S} < \text{Cl} < \text{K} < \text{Si}$
(b) $\text{K} < \text{Na} < \text{Si} < \text{Cl} < \text{S}$
(c) $\text{K} < \text{Na} < \text{Si} < \text{S} < \text{Cl}$
(d) $\text{Si} < \text{S} < \text{Cl} < \text{Na}$

Ans :

MAIN 2014

Ionization energy increases across the period and decreases down the group. Hence, the correct order is $\text{K} < \text{Na} < \text{Si} < \text{S} < \text{Cl}$

Thus (c) is correct option.

71. Arrange the following as in the brackets : Cl, F, Br, electron affinity)

- (a) $\text{Br} < \text{I} < \text{F} < \text{Cl}$
(b) $\text{Br} < \text{Cl} < \text{I} < \text{F}$
(c) $\text{I} < \text{Br} < \text{Cl} < \text{F}$
(d) $\text{F} < \text{Cl} < \text{Br} < \text{I}$

Ans :

SQP 2016

On moving down the group as the atomic size increases, electron affinity decreases. The more electron affinity, the element is the more electronegative.

Thus (c) is correct option.

72. The elements in which electrons are progressively filled in 4f orbital are called:

- (a) actinoids
(b) transition elements
(c) halogens
(d) lanthanoids

Ans :

COMP 2002

In lanthanides, electrons are progressively filled in 4f orbital.

Thus (d) is correct option.

73. Magnesium atom is smaller than sodium atom. Why ?

- (a) Because the electron shells are pulled inward more strongly in Na atom than in Mg atom.
(b) Because the electron shells are pulled inward more strongly in Mg atom than in Na atom.
(c) Because the electrons in magnesium are contained in three shells.
(d) None of the above

Ans :

MAIN 2005

Magnesium come after sodium in the same period. Atoms of both elements have three electron shells (Na : 2, 8, 1; Mg : 2, 8, 2). But the nuclear charge of sodium is + 11 and that of magnesium is + 12. Hence, the electron shells are pulled inward more strongly in Mg atom than in Na atom. Hence, Mg atom is smaller than Na atom. Thus (c) is correct option.

74. Read the following Table.

Elements	A	B	C
Mass numbers	23	20	35
Number of neutrons	12	0	18

To which groups do A, B and C belong?

- (a) A belongs to IA group, B belongs to VIIA group, C belongs to zero group
 (b) A belongs to VIIA group/ B belongs to IA group, C belongs to zero group
 (c) A belongs to VIIA group/ B belongs to zero group/ C belongs to VIIA group
 (d) A belongs to IA group, B belongs to zero group, C belongs to VIIA group

Ans :

COMP 2007

Thus (d) is correct option.

75. The most distinctive property of the noble gases is that they are:

- (a) Metallic (b) Unreactive
 (c) Radioactive (d) Metalloid

Ans :

SQP 2000

The noble gases are distinguished by their exceptionally low chemical reactivity as compared to other elements. Because the noble gases contain a complete set of electrons in their outer shells, they have a low tendency to swap electrons with other elements to form compounds.

Thus (b) is correct option.

76. An element with highest electron affinity :

- (a) Neon (b) Chlorine
 (c) Sodium (d) Sulphur

Ans :

MAIN 2001

Chlorine has the highest electron affinity among the elements. Its high electron affinity can be attributed to its large atomic radius, or size. Because chlorine's outermost orbital is 3p, its electrons have a large amount of space to share with an incoming electron.

Thus (b) is correct option.

77. The electronic configuration of an element T is 2, 8, 7. What is the group number of T ?

- (a) Group 1 (b) Group 18
 (c) Group 17 (d) Group 2

Ans :

SQP 2002

It has 7 electrons in its valence shell. As after 4 valence electrons we add +10 for the valence electrons, we get $10 + 7 = 17$.

Hence, the group number is 17.

Thus (c) is correct option.

78. Given below is the part of Periodic Table :

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl

How does metallic character of an element change as one moves from left to right in period and top to bottom in group respectively ?

- (a) From left to right in period, the metallic character of an element increases. And from top to bottom in period, the metallic character of the elements increases.
 (b) From left to right in period, the metallic character of an element decreases. And from top to bottom in period, the metallic character of the elements increases.
 (c) From left to right in period, the metallic character of an element increases. And from top to bottom in period, the metallic character of the elements decreases.
 (d) From left to right in period, the metallic character of an element decreases. And from top to bottom in period, the metallic character of the elements decreases.

Ans :

COMP 2010

Thus (a) is correct option.

79. Elements of Group 16 have 6 valence electrons. The valency of Group 16 elements is:

- (a) 5
 (b) 6
 (c) 3
 (d) 2

Ans :

MAIN 2000

The electronic configuration of group 16 elements is 2, 8, 6. These elements need 2 electrons to complete their octet. So the valency of these elements is 2.

Thus (d) is correct option.

80. Moving across a of the periodic table, the elements show increasing character.
- group, non-metallic
 - group, metallic
 - period, non-metallic
 - period, metallic

Ans :

SQP 2017

Moving across a period of the periodic table the element show increasing non-metallic character because the tendency to gain electrons increases on moving across a period due to an increase in the nuclear charge and decrease in the atomic size. Hence, the non-metallic character increases across a period.

Thus (c) is correct option.

81. The most reactive non-metals comprise Group of the Periodic Table.
- 14
 - 15
 - 17
 - 16

Ans :

COMP 2012

The halogen family (group 17th) is extremely reactive in non-metals because it is the most electronegative family and may readily acquire an electron to complete its octet.

Thus (c) is correct option.

82. Which of the following is correct order for ionisation energy?
- $N > O > F$
 - $N > O < F$
 - $N < O < F$
 - $N < O > F$

Ans :

SQP 2010

Ionisation energy (I.E.) increases from left to right in a period, but. I.E. of elements having half or fully-filled outermost electronic configuration are more stable and show higher value of ionisation energy.

Thus (b) is correct option.

83. Among the following, the atom of smallest radius is
- Na
 - K
 - Li
 - Br

Ans :

MAIN 2000

Na, K and Li belongs to the same group and atomic radius increases down the group, thus Li has smallest radius. Also, Br belongs to 17th group but below the chlorine with ($Z = 35$). Hence, Li show smallest radius amount the given options.

Li = 152 pm (atomic radius)

Br = 114 pm (atomic radius)

Na = 186 pm (atomic radius)

K = 231 pm (atomic radius)

Thus (c) is correct option.

84. The non-metallic character of the elements down the group
- remains the same
 - increases
 - decreases
 - depends on the period

Ans :

SQP 2023

As we move down the group, size increases and also tendency to loose electron increases, non metallic character decreases and metallic character increases.

Thus (c) is correct option.

85. Which of the following statements is not a correct statement about the trends when going from left to right across the Periodic Table?
- The elements become less metallic in nature.
 - The atoms lose their electrons more easily.
 - The number of valency electrons increases.
 - The oxides become more acidic.

Ans :

MAIN 2021

On moving from left to right across the periods, the number of shells remains the same and nuclear charge increases. An increase in nuclear charge results in more difficulty for the atoms to lose their valency electrons and the electrons is not lost readily.

Thus (b) is correct option.

86. has the highest ionisation energy in the periodic table.
- Helium
 - Lithium
 - Chlorine
 - Hydrogen

Ans :

COMP 2020

Helium has the highest ionization potential. This is because Helium has 2 electrons and is in a duplet state. Electrons here are more close to the nucleus, as a result, it would need a lot of energy to remove an electron from it.

Thus (a) is correct option.

87. The non-metal in the period 3 having a valency of 1.
- Krypton
 - Galium
 - Chlorine
 - Berryllium

Ans :

SQP 2018

Na, Mg and Al are the metals in the modern periodic table with valency +1, +2, +3 respectively. The only non-metal in period 3 with valency 1 is chlorine

Thus (c) is correct option.

88. Maximum number of electrons in the M shell

- (a) 18 (b) 8
(c) 2 (d) 32

Ans :

MAIN 2017

Maximum number of electrons = $2n^2$
 $= 2 \times 3^2 = 18$

Thus (a) is correct option.

89. Dobereiner arranged similar atoms in a group of ?

- (a) three (b) two
(c) one (d) four

Ans :

COMP 2016

In the year 1817, Dobereiner, arranged the elements with similar properties into groups. He identified some groups having three elements each. So he named them 'triads'.

Thus (a) is correct option.

90. The most electronegative element in its respective period is present in:

- (a) Group 1 (b) Group 17
(c) Group 13 (d) Group 18

Ans :

SQP 2013

Electro-negativity is the tendency of an atom to attract electrons. An atom's electro-negativity is affected by its atomic number so the group 17 elements are short of one electron to attain noble gas configuration and that is why they are highly electronegative in nature.

Thus (b) is correct option.

91. Which period of the periodic table consist of elements known as typical elements?

- (a) 3rd period (b) 2nd period
(c) 1st period (d) 4th period

Ans :

MAIN 2006

The third period elements are called typical elements or representative elements because they represent the properties of their own group without anomalies. The third period consists of eight elements which are: sodium, magnesium, aluminium, silicon, phosphorus, sulfur, chlorine, and argon.

Thus (a) is correct option.

92. Which of the following is not a periodic property?

- (a) Atomic radius (b) Atomic volume
(c) Atomic mass (d) Electro-negativity

Ans :

SQP 2007

Atomic mass of an element is not a periodic property. It will not show regular trend (in periods). e.g. Co (Atomic mass = 58.93) and (Z = 27)

Ni (Atomic mass = 58.69) and (Z = 28)

Thus (c) is correct option.

93. An element X has an atomic number 15. With which of the following elements will it show similar chemical properties?

- (a) N (7) (b) Ne (10)
(c) O (8) (d) Be (4)

Ans :

COMP 2009

Since out of the given elements only nitrogen has the same number of valence electrons and identical outer shell electronic configuration. Therefore, nitrogen is the element that will have similar chemical properties as X. Hence, the answer is N (7).

Thus (a) is correct option.

94. The element with lowest ionization energy among the following is:

- (a) Rb (b) N
(c) K (d) Li

Ans :

MAIN 2004

As we move from top to bottom in group the ionisation energy will be decreased, because the atomic radius will be increased so the removal of electron will be easy. Li, Na, K, Rb are IA group elements. From Li to Rb the ionisation energy will be decreased. Thus, among the following element Rb has the lowest ionisation energy.

Thus (a) is correct option.

95. Amongst the following select the element with highest ionisation enthalpy.

- (a) Sodium (b) Potassium
(c) Magnesium (d) Beryllium

Ans :

COMP 2006

- (i) Ionisation enthalpy $\propto$ effective nuclear charge and $\propto \frac{1}{\text{atomic size}}$
 (ii) Atomic size decreases in period and increases in group.
 (iii) Elements with fully-filled/half filled outermost sub-shell configuration are more stable.

Hence, ionisation enthalpy of beryllium (Be)

is highest, as it has full-filled outermost electronic configuration

$$\text{Be}(4) = \begin{smallmatrix} \text{K} & \text{L} \\ 2 & 2 \end{smallmatrix} \text{ or } 1s^2 2s^2$$

Thus (d) is correct option.

96. Elements in a period, all have the same number of in their atoms.

- (a) electron shells (b) valence electrons
(c) valency (d) None of the above

Ans :

MAIN 2023

This occurs because the number of valence electrons in an atom always remains between 1 and fill it becomes a noble gas, i.e. 2 or 8 (in increasing order), therefore when the valence electrons reach 8 or 2, there is no chance of another shell formation.

Thus (a) is correct option.

97. Down the group, electron affinity

- (a) remains same (b) decreases
(c) increases (d) none of the above

Ans :

SQP 2021

Because each atom is larger than the atom above it, electron affinity decreases diminishes down a set of elements (this is the atomic radius trend). This signifies that an extra electron is farther away from the nucleus of the larger atom than it was in the smaller atom.

Thus (b) is correct option.

98. Number of shells across the period:

- (a) Remains same (b) Decreases
(c) Increases (d) All of above

Ans :

COMP 2020

In a period, there is only one electron difference between consecutive elements, but in a shell, there can be as many as two, eight, and so on but not one. As a result, the shell remains the same.

Thus (a) is correct option.

99. In a group, the atomic size

- (a) Increases from top to bottom
(b) Decreases from top to bottom
(c) Remains same
(d) First decreases then increases

Ans :

MAIN 2011

In the modern periodic table, Horizontal columns are referred to as groups, and vertical rows are referred to as periods. The number of shells is indicated by the period number, while the

number of valence electrons is shown by the group number. Hence, the element A has 3 shells and 2 valence electrons.

Thus (a) is correct option.

100. Match the columns:

	Column A		Column B
1.	Proton	A	An alkaline earth metal
2.	Sodium	B	Halogen
3.	Barium	C	Noble gas
4.	Chlorine	D	An alkali metal
5.	Electron	E	Responsible for nuclear charge
6.	Completed shell	F	Occupied sub-shell

(a) 1-E, 2-D, 3-A, 4-B, 5-F, 6-C

(b) 1-D, 2-E, 3-C, 4-A, 5-B, 6-F

(c) 1-A, 2-C, 3-F, 4-B, 5-E, 6-D

(d) 1-E, 2-D, 3-A, 4-B, 5-C, 6-F

Ans :

COMP 2004

Thus (a) is correct option.

101. The set representing the correct order of first ionisation energy is

- (a) $\text{Be} > \text{Mg} > \text{Ca}$ (b) $\text{K} > \text{Na} > \text{Li}$
(c) $\text{B} > \text{C} > \text{N}$ (d) $\text{Ge} > \text{Si} > \text{C}$

Ans :

SQP 2007

The group $\text{Be} > \text{Mg} > \text{Ca}$ shows the correct order of first ionization potential. The ionization energy decreases down the group with an increase in size. These elements ($\text{Be} > \text{Mg} > \text{Ca}$) are 2nd group elements and the order correctly reflects a trend in ionization energy.

Thus (a) is correct option.

102. Identify the element belonging to third period and 17th group of the periodic table.

- (a) Silicon (b) Bromine
(c) Sulphur (d) Chlorine

Ans :

COMP 2009

Because the element belongs to the 17th group of the periodic table category. As a result, it's a halogen. Period 3 has Chlorine, as determined by counting the periods and comparing them to the periods of halogens. Chlorine is the element. It has 7 electrons in its valence shell, therefore it will receive 1 electron, giving it a valency of 1.

Thus (d) is correct option.

103. Elements in a group, all have the same number of

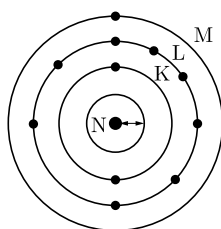
- (a) electron shells
- (b) outermost valence electrons
- (c) atomic number
- (d) none of the above

Ans :

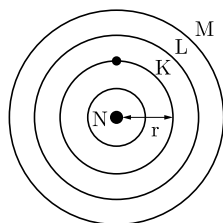
SQP 2010

The elements in a given group of the periodic table have the same number of valence electrons in their outer shell. For example take lithium and sodium electronic configuration of Li is $[\text{He } 2s^1]$ electronic configuration of Na is $[\text{Ne } 3s^1]$ Therefore their valencies are same. Thus (b) is correct option.

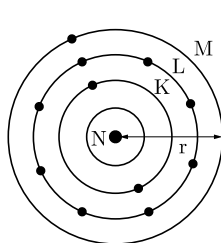
104. Which one of the following depict the correct representation of atomic radius (r) of an atom?



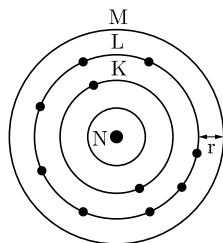
(i)



(ii)



(iii)



(iv)

- (a) (i) and (ii)
- (b) (i) and (iv)
- (c) (iii) and (iv)
- (d) (ii) and (iii)

Ans :

MAIN 2000

Thus (d) is correct option.

105. The element A, B, C, D and E have atomic numbers 9, 11, 17, 12 and 30 respectively belong to the same period?

- (a) A and B
- (b) B and D
- (c) D and E
- (d) A and C

Ans :

SQP 2017

The distribution of electrons into orbitals of an atom is called its electronic configuration. The electronic configuration of element A, B, C, D and E are respectively $1s^2, 2s^2, 2p^5$,

$1s^2, 2s^2, 2p^6, 3s^1$, $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$, $1s^2, 2s^2, 2p^6, 3s^2, 3p^1$.

Thus (d) is correct option.

106. Inner transition elements comprise of block.

- (a) c
- (b) d
- (c) f
- (d) e

Ans :

SQP 2015

The elements of f-block are also called inner transition elements. The two series of inner transition elements that are 4f and 5f series are known as lanthanoids and actinoids respectively. Thus (c) is correct option.

107. Number of elements present in the shortest period.

- (a) 8
- (b) 2
- (c) 18
- (d) 32

Ans :

MAIN 2020

The shortest period in the modern periodic table contains only two elements i.e., hydrogen and helium. This is the first period in the periodic table.

Thus (b) is correct option.

108. The amount of energy released when one or more electron is added to the neutral atom.

- (a) Ionisation energy
- (b) Electron affinity
- (c) Electro-negativity
- (d) Atomicity

Ans :

COMP 2023

Electron affinity of an element is defined as the amount of energy liberated when an electron is added to the neutral isolated atom in its ground state. Greater the amount of energy released, greater is the electron affinity.

Thus (b) is correct option.

109. Lithium exhibits diagonal relationship with

- (a) Calcium
- (b) Barium
- (c) Magnesium
- (d) Beryllium

Ans :

SQP 2021

Lithium shows a diagonal relationship with Magnesium. The small size of Lithium differs from other alkali metals but resembles more with Magnesium.

Thus (c) is correct option.

110. Horizontal rows of periodic table are called

- (a) Groups
- (b) Compounds
- (c) Elements
- (d) Periods

Ans :

MAIN 2022

Horizontal rows in the periodic table are called periods.

Thus (d) is correct option.

- 111.** Hydrogen chloride is a
 (a) pure covalent compound
 (b) molecular covalent compound
 (c) non polar covalent compound
 (d) polar covalent compound

Ans :

COMP 2012

HCl is polar covalent compound as the chloride ion is more electronegative than hydrogen ion. So chloride ion carries partial negative character while hydrogen carries partial positive character. Thus (d) is correct option.

- 112.** The colour of alkali halides is
 (a) Yellow (b) Red
 (c) White (d) None of these

Ans :

MAIN 2017

The alkali metal halides exist as colourless crystalline solids, although as finely ground powders appear white.

Thus (c) is correct option.

- 113.** The atomic size :
 (a) increases
 (b) decreases
 (c) remains the same
 (d) sometimes increases and sometimes decreases.

Ans :

COMP 2019

Thus (b) is correct option.

- 114.** How many elements have been discovered till now?
 (a) 118 (b) 120
 (c) 116 (d) 114

Ans :

SQP 2020

Thus (a) is correct option.

- 115.** The non-metals are present
 (a) On the left hand side of the periodic table.
 (b) In the middle of the periodic table.
 (c) On the right hand side of the periodic table.
 (d) In the centre of the periodic table

Ans :

COMP 2021

If we look at the oxidising power of elements, we can see that it rises as we move from left to right over time, and we already know that non-metals are powerful oxidizer. Non-metals are thus located on the periodic table's right hand side.

Thus (c) is correct option.

- 116.** The electro-negativity on moving from left to right in a period
 (a) depends on the number of valence electrons
 (b) remains the same
 (c) increases
 (d) decreases

Ans :

MAIN 2012

Thus (c) is correct option.

- 117.** On moving from left to right in a given period, the number of shells
 (a) increases (b) decreases
 (c) remains the same (d) none of the above

Ans :

COMP 2023

The number of electrons in the valence shell increases from one to eight as you move from left to right in a given time. While the number of shells remains the same.

Thus (c) is correct option.

- 118.** An element with the atomic number 19 will most likely combine chemically with the element whose atomic number is :
 (a) 18 (b) 11
 (c) 17 (d) 20

Ans :

SQP 2004

The octet of this element with atomic number 17 is missing one electron, but the octet of the element with atomic number 19 has 1 valence electron. As a result, an element with atomic number 19 is most likely to combine with the element with atomic number 17.

Thus (c) is correct option.

- 119.** Which of the following is a most reactive element of the group 17?
 (a) Sodium (b) Oxygen
 (c) Fluorine (d) Magnesium

Ans :

COMP 2007

The small size, high electronegativity and low dissociation energy of F-F bond is responsible for the high reactivity of Fluorine.

Thus (c) is correct option.

- 120.** The modern Periodic table has periods.
 (a) 18 (b) 8
 (c) 7 (d) 9

Ans :

SQP 2010

At the moment, there are seven periods. It

contains 118 known elements, both naturally occurring and artificially synthesized.

Thus (c) is correct option.

- 121.** In a group, the larger the atomic size of an element, the metallic is the element.

(a) more (b) same
(c) less (d) more or less

Ans :

COMP 2013

The atomic size of elements increases due to addition of new valence shells. This is due to the fact that while moving down the group ionic radii increases so tendency to lose electrons is increased and hence they are more metallic.

Thus (a) is correct option.

- 122.** Select the element in period 3 whose electron affinity is zero:

(a) Neon (b) Argon
(c) Sodium (d) Sulphur

Ans :

MAIN 2017

The change in energy (in kJ/mole) of a neutral atom (in the gaseous phase) when one electron is added to create a negative ion is called electron affinity. So, Argon belongs to period 3. It is an inert element and stable. It neither requires to gain electron nor lose. Thus, its electron affinity is zero.

Thus (b) is correct option.

- 123.** Which of the following is most electronegative?

(a) Tin (b) Silicon
(c) Lead (d) Carbon

Ans :

COMP 2019

Now, based on atomic size, carbon is smallest, then comes silicon, then tin and finally lead. Hence, due to increasing atomic size, carbon is the most electronegative among the given elements.

Thus (d) is correct option.

- 124.** Down the group, electron affinity ?

(a) decreases (b) increases
(c) remains same (d) None of these

Ans :

COMP 2021

Electron affinity usually decreases down a group of elements in the periodic table.

Thus (a) is correct option.

- 125.** Modern periodic table was given by

(a) John Newlands (b) Antoine Lavoisier
(c) Mendeleev (d) Moseley

Ans :

MAIN 2012

The Modern periodic law and table was invented by Henry Moseley in 1913. The first who was able to arrange all the known elements was Mendeleev, he gave the law called the Mendeleev's periodic law.

Thus (d) is correct option.

- 126.** is liquid at room temperature.

(a) Iron (b) Francium
(c) Hydrogen (d) Caesium

Ans :

COMP 2013

The only liquid elements at standard temperature and pressure are Bromine (Br) and Mercury (Hg). Although, elements Caesium (Cs), Rubidium (Rb), Francium (Fr) and Gallium (Ga) become liquid at or just above room temperature.

Thus (d) is correct option.

- 127.** The element having maximum atomic size in its respective group is present:

(a) At the top (b) At the bottom
(c) In the middle (d) None of these

Ans :

SQP 2015

Generally, the atomic radius decreases across a period from left to right and increases down a given group. The atoms with the largest atomic radii are located in Group I and at the bottom of groups.

Thus (b) is correct option.

- 128.** The alkali metal in the period 2.

(a) Beryllium (b) Boron
(c) Lithium (d) Carbon

Ans :

SQP 2021

The second period of the periodic table has Lithium (Li), Beryllium (Be), Boron (B), Carbon (C), Nitrogen (N), Oxygen (O), Fluorine (F) and Neon (Ne). Hence, the alkali metal in the second period is Lithium (Li).

Thus (c) is correct option.

- 129.** Element X forms a chloride with the formula, XCl_2 , which is a solid with a high melting point. X would most likely be in same group of the Periodic Table as:

(a) Mg (b) Na
(c) Al (d) Si

Ans :

MAIN 2020

The formula XCl_2 indicates the valency of X (i.e., 2) and X (Mg) is metal. Also XCl_2 being an ionic

solid possesses high melting point.

Thus (a) is correct option.

- 130.** Electronic configuration of an element X having atomic number 24 is

- (a) 2, 8, 8, 6 (b) 2, 8, 8, 3
(c) 2, 8, 2, 8 (d) 2, 8, 7, 7

Ans :

SQP 2017

Given (Z) = 24, thus its electronic configuration is

K	L	M	N
2	8	8	6

Thus (a) is correct option.

- 131.** The metallic character in a group as one moves from top to bottom.

- (a) remains same (b) decreases
(c) increases (d) none of the above

Ans :

MAIN 2019

Metallic character increases as you move down the periodic table. Because the ionisation energy reduces as you go down a group (and increases as you go up a group), metals lower in the group have a greater propensity to lose electrons, making them more reactive.

Thus (c) is correct option.

- 132.** Ionisation Potential increases over a period from left to right because the :

- (a) Atomic radius increases and nuclear charge increase
(b) Atomic radius decreases and nuclear charge increase
(c) Atomic radius increases and nuclear charge decreases
(d) Atomic radius and nuclear charge decrease

Ans :

COMP 2023

The electrons are held tighter by the greater effective nuclear charge as one goes through a period in the periodic table, because of the smaller atomic radius and greater nuclear charge. Thus, the ionisation energy of an element increases.

Thus (b) is correct option.

- 133.** The elements having the least number of electron shells:

- (a) F (b) Li
(c) Na (d) K

Ans :

MAIN 2021

Lithium has the least number of electron shells.

This is because of its position in the periodic table, which is higher than sodium and potassium.

Thus (b) is correct option.

- 134.** Why sodium is a metal while sulphur is a non-metal ?

- (a) Sodium has a larger atomic radii.
(b) Specific gravity of sodium is 0.97.
(c) Boiling point of sodium is 882.8 °C.
(d) Sodium belongs to which group The Alkali Metals.

Ans :

SQP 2012

Sulphur has a lower ionisation potential and has a greater atomic radius than sodium. As a result, sodium is a metal while sulphur is a non-metal.

Thus (a) is correct option.

- 135.** The electro-negativities of the elements in period 3 of the portion of Periodic Table are as follows when the elements arranged in alphabetical order:

Al	Cl	Mg	Na	P	S	Si
1.5	3.0	1.2	0.9	2.1	2.5	1.8

Arrange the elements in the order in which they occur in the Periodic Table from left to right. (The group 1 element first, followed by the group 2 element and so on, up to group 7)

- (a) Na, Al, Mg, P, Si, Cl, S
(b) Mg, Na, Al, Si, Cl, P, S
(c) Na, Mg, Al, Si, P, S, Cl
(d) Mg, Al, Cl, P, S, Si, Na

Ans :

COMP 2013

Thus (c) is correct option.

- 136.** Alkaline earth metals include:

- (a) Group 2 element (b) Group 1 element
(c) Group 18 element (d) Group 17 element

Ans :

SQP 2017

Group 2 elements include beryllium, magnesium, calcium, strontium, barium, and radium. These elements are known as Alkaline Earth metals for two reasons. Their oxides are heat-stable and persist in the earth's crust.

Thus (a) is correct option.

- 137.** In the periodic table alkali metals are placed are in the group?

- (a) 18 (b) 11
(c) 17 (d) 1

Ans :

COMP 2018

Thus (d) is correct option.

138. Vertical columns of periodic table are known as

- (a) Periods (b) Groups
(c) Elements (d) Compounds

Ans :

SQP 2018

Thus (b) is correct option.

139. With reference to hydrogen and chlorine which statement is correct?

- (a) Hydrogen is more electronegative than chlorine
(b) Hydrogen and chlorine have same electronegativity.
(c) Chlorine is more electronegative than hydrogen.
(d) None of the above.

Ans :

MAIN 2013

Thus (c) is correct option.

140. Atoms of which elements have their outer layers occupied by seven electrons.

- (a) Alkali metals
(b) Halogens
(c) Inert gases
(d) Alkaline earth metals

Ans :

COMP 2015

Thus (b) is correct option.

141. The atomic radii of inert gases are larger than those of preceding elements due to in completely filled shells.

- (a) high I.E.
(b) force of repulsion
(c) low I.E.
(d) force of attraction

Ans :

SQP 2017

Thus (b) is correct option.

142. In general, non-metals are electronegative than metals.

- (a) more
(b) less
(c) equal
(d) none of the above

Ans :

COMP 2011

Because metals have few valence electrons, they tend to lose electrons and form cations, which increase their stability. Non-metals have more valence electrons and acquire electrons to create anions, which increases their stability. Non-metals have high electro-negativity in general.

Thus (a) is correct option.

143. Position of is controversial in Mendeleev's periodic table.

- (a) Helium (b) Chlorine
(c) Hydrogen (d) Fluorine

Ans :

MAIN 2019

Thus (c) is correct option.

144. Which element was placed before iodine in Mendeleev's periodic table ?

- (a) Vanadium (b) Scandium
(c) Tellurium (d) Polonium

Ans :

SQP 2010

Thus (b) is correct option.

145. Arrange the following as per instruction given in the brackets : Cs, Na, Li, K, Rb (Increasing order of metallic character)

- (a) $Cs < Li < Na < K < Rb$
(b) $Li < Na < Cs < K < Rb$
(c) $K < Rb < Cs < Li < Na$
(d) $Li < Na < K < Rb < Cs$

Ans :

COMP 2020

As we move down the group, atomic radius increases so the metallic character also increases. Thus, the increasing order of metallic character is:



Thus (d) is correct option.

146. The element with highest ionization potential is :

- (a) Hydrogen (b) Radon
(c) Caesium (d) Helium

Ans :

MAIN 2000

The noble gases, inert gases, and other elements in Group VIII-A have the highest ionisation energy. If we only consider one element, Helium is claimed to have the highest initial ionisation energy of all the neutral elements.

Thus (d) is correct option.

147. Consider the section of the periodic table given below

Group	IA	IIA	IIIA	IVA	VA	VIA	VIIA	O
Numbers	1	2	13	14	15	16	17	18
	Li		D			O	J	Ne
	A	Mg	E	Si		H	K	
	B	C		F	G			L

In this table:

B does not represent Boron
 C does not represent Carbon
 F does not represent Fluorine
 H does not represent Hydrogen
 K does not represent Potassium

You must see the position of the element in the periodic table. Some elements are given in their own symbol and position in the periodic table. While others are shown with a letter. With reference to the table :

- (i) Which is the most electronegative?
 (a) A (b) D
 (c) J (d) O

Ans :

COMP 2001

Thus (c) is correct option.

- (ii) How many valence electrons are present in G?
 (a) 2 (b) 3
 (c) 4 (d) 5

Ans :

SQP 2005

Thus (b) is correct option.

- 148.** Element present in the beginning of periodic table
 (a) Hydrogen (b) Chlorine
 (c) Lithium (d) Helium

Ans :

COMP 2010

Thus (a) is correct option.

- 149.** Which of the following elements would lose an electron easily?
 (a) Na (b) Mg
 (c) K (d) Ca

Ans :

SQP 2013

Thus (c) is correct option.

- 150.** The non-metallic character of the elements :
 (a) increases
 (b) decreases
 (c) remains the same
 (d) depends on the period

Ans :

MAIN 2017

Thus (a) is correct option.

- 151.** The group whose elements show zero valency.
 (a) Group 18
 (b) Group 6
 (c) Group 12
 (d) Group 1

Ans :

COMP 2019

Thus (a) is correct option.

- 152.** Inert gas present in the second period
 (a) Helium (b) Xenon
 (c) Neon (d) Radon

Ans :

MAIN 2012

Thus (c) is correct option.

- 153.** Representative elements have
 (a) Incomplete penultimate shell
 (b) Both of the above
 (c) Inert gas
 (d) Complete penultimate shell

Ans :

SQP 2014

Thus (d) is correct option.

- 154.** Second period elements are known as :
 (a) Type metals (b) Bridge metals
 (c) Type elements (d) Bridge elements

Ans :

COMP 2016

Thus (d) is correct option.

- 155.** period is the longest period of the present periodic table.
 (a) eighth (b) sixth
 (c) seventh (d) second

Ans :

SQP 2011

Thus (b) is correct option.

- 156.** Across a period, the ionization potential ?
 (a) decreases (b) increases
 (c) remains same (d) None of these

Ans :

MAIN 2010

Thus (b) is correct option.

- 157.** The electron affinity of the elements in groups 1 to 7 :
 (a) increases goes
 (b) decreases and then increases
 (c) up and then down
 (d) decreases

Ans :

COMP 2018

Thus (a) is correct option.

- 158.** Which among the following elements has the largest atomic radii?
 (a) K (b) Mg
 (c) Na (d) Ca

Ans :

SQP 2011

Thus (a) is correct option.

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159. The valency of alkali metal is:

- (a) +2 (b) -1
(c) +1 (d) -2

Ans :

COMP 2015

Thus (c) is correct option.

160. An element with the atomic number 19 will most likely combine chemically with the element whose atomic number is

- (a) 11 (b) 17
(c) 18 (d) 20

Ans :

MAIN 2012

Thus (b) is correct option.

161. The energy required to remove an electron from a neutral isolated gaseous atom and convert it into a positively charged gaseous ion is called

- (a) electron affinity (b) electro-negativity
(c) valency (d) ionization potential

Ans :

COMP 2013

The energy required to remove an electron from a neutral isolated gaseous atom and convert it into a positively charged gaseous ion is called ionization potential. It is also called as ionisation energy.

Thus (d) is correct option.

162. Lanthanide and actinides are also called:

- (a) normal elements
(b) transition elements
(c) inner transition elements
(d) noble gases

Ans :

MAIN 2018

The lanthanide and actinide are the two rows produced when electrons are being added to f orbitals. Therefore, this block of elements is referred to as the “f - block” or “inner transition metals.”

Thus (c) is correct option.

163. Noble gases have zero electron affinity values. Why ?

- (a) Noble gases have same numbers of electrons at their outermost shell
(b) All of them have equal numbers of electrons on protons
(c) Because they have stable electronic configuration
(d) None of the above

Ans :

SQP 2017

Noble gases have zero electron affinity values because they have stable electronic configuration and have no tendency to take an additional electron. Hence, no energy is released and their electron affinity is zero.

Thus (c) is correct option.

164. The elements occupying left and right side groups of periodic table are called elements.

- (a) special (b) common
(c) transition (d) representative

Ans :

COMP 2011

The elements occupying left and right side groups of periodic table are called representative elements
Thus (d) is correct option.

165. Which of the following set of elements is written in order of their increasing metallic character?

- (a) Na, Li, K (b) Be, Mg, Ca
(c) Mg, Al, Si (d) C, O, N

Ans :

MAIN 2005

Thus (b) is correct option.

166. An element in period-3 whose electron affinity is zero.

- (a) Argon (b) Sulphur
(c) Sodium (d) Neon

Ans :

SQP 2013

Thus (a) is correct option.

167. Number of elements present in longest period

- (a) 32 (b) 8
(c) 18 (d) 2

Ans :

COMP 2015

Thus (a) is correct option.

168. If an element has two electrons in

- (a) Metal (b) Non-metal
(c) Metalloid (d) Inert gas

Ans :

MAIN 2017

Thus (a) is correct option.

169. Newland law of octave arranged elements in increasing order of ?

- (a) atomic radius
(b) atomic number
(c) atomic structure
(d) atomic masses

Ans :

COMP 2019

Thus (d) is correct option.

170. Chlorine has electron affinity than fluorine.

- (a) less (b) same
(c) more (d) none of the above

Ans : SQP 2021

Thus (c) is correct option.

171. An element with atomic number 19 will most likely combine chemically with element whose atomic number is :

- (a) 20 (b) 11
(c) 28 (d) 17

Ans : COMP 2000

Thus (d) is correct option.

172. Which of the following elements does not lose an electron easily?

- (a) Na (b) Mg
(c) F (d) Al

Ans : SQP 2005

Thus (c) is correct option.

173. The inert gas which lies in third period is :

- (a) Argon (b) Neon
(c) Helium (d) Xenon

Ans : MAIN 2007

Thus (c) is correct option.

174. The atomic size on moving across the period

- (a) increases
(b) decreases
(c) remains the same
(d) sometimes increases and sometimes decreases

Ans : COMP 2010

Thus (b) is correct option.

175. Why are the elements sodium and chlorine in the same period of the periodic table ?

- (a) Because their electronic configurations are same
(b) Because the electrons in both elements are contained in three shells
(c) Because their atomic sizes are same
(d) None of the above

Ans : SQP 2017

Thus (b) is correct option.

176. Among the following, which are the bridge elements?

- (a) C-Mg (L) Be-B
(c) Be-Si (d) Li-Mg

Ans :

COMP 2023

Thus (d) is correct option.

177. The elements having a lower nuclear charge:

- (a) Li (b) Mg
(c) Be (d) K

Ans : MAIN 2018

Be has a lower nuclear charge than other elements. Nuclear charge increases down the group.

Thus (c) is correct option.

178. (Mendeleev/Moseley) left gaps in the periodic table for the undiscovered elements.

- (a) Moseley (b) Mendeleev
(c) John Newlands (d) William Ramsay

Ans : SQP 2000

Thus (b) is correct option.

179. The elements in the periodic table are placed in the increasing order of their:

- (a) Atomic number (b) Atomic weight
(c) Both (a) and (b) (d) None of these

Ans : COMP 2001

Thus (b) is correct option.

180. The minimum amount of energy required to remove the loosely bound electron from an isolated, neutral gaseous atom is known as

- (a) Bond enthalpy
(b) I.E.
(c) EA
(d) force of attraction

Ans : MAIN 2005

Thus (b) is correct option.

181. Among the period 2 elements, the element which has high electron affinity is :

- (a) Lithium (b) Fluorine
(c) Chlorine (d) Carbon

Ans : SQP 2008

Thus (b) is correct option.

182. Which of the following pairs have both the members from the same group of periodic table?

- (a) Mg, Cl (b) Mg, Na
(c) Mg, Cu (d) Mg, Be

Ans : COMP 2010

Mg-Be pair is in the same group of modern periodic table (II-A group).

Thus (d) is correct option.

Metallic character decreases across a period in the periodic table from left to right. This happens because atoms accept electrons more readily to fill a valence shell than to lose them to remove an unfilled shell.

Thus (b) is correct option.

- 191.** The element in the period 3 which does not form an oxide.

(a) Silicon (b) Argon
(c) Selenium (d) Chlorine

Ans :

SQP 2019

Thus (b) is correct option.

- 192.** Fifth period contains elements.

(a) 6 (b) 18
(c) 12 (d) 32

Ans :

COMP 2023

Thus (b) is correct option.

ASSERTION AND REASON

- 193. Assertion :** Chlorine is called halogen.

Reason : It is because chlorine reacts with metals to form salts.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is false, but reason is true
(d) Assertion is true, but reason is false.

Ans :

MAIN 2021

Elements such as chlorine, bromine and iodine are called halogens because they react with metals to form salts. Thus, assertion is false but reason is true.

Thus (c) is correct option.

- 194. Assertion :** The ionization energy of Mg is more than sodium.

Reason : The ionization energy decreases in a period from left to right.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion and reason both are correct statements, but reason is not the correct

explanation of the assertion.

- (c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true

Ans :

COMP 2000

The ionization energy increases in a period from left to right. Therefore, ionisation energy of Mg is more than sodium. Thus, both assertion and reason are true but reason is not the correct explanation of the assertion.

Thus (b) is correct option.

- 195. Assertion :** Metalloids are present in zig-zag rows in periodic table.

Reason : Metalloids have same properties.

- (a) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
(b) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true

Ans :

SQP 2005

Metalloids are present in zig-zag rows because they have some properties of metals and some properties of non-metals. Thus, both assertion and reason are true but reason is not the correct explanation of the assertion.

Thus (a) is correct option.

- 196. Assertion :** Noble gases are placed in different group in periodic table.

Reason : Noble gases are inert in nature.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion is true, but reason is false.
(c) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
(d) Assertion is false, but reason is true

Ans :

MAIN 2010

Noble gases are placed in a separate group because these are inert elements. They have properties which are different from all other elements. Thus, both assertion and reason are true and reason is the correct explanation of the assertion.

Thus (a) is correct option.

- 197. Assertion:** The elements of the different group have similar chemical properties.

Reason: It is because they have same number of valence electrons.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
 (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
 (c) Assertion is false, but reason is true
 (d) Assertion is true, but reason is false.

Ans : COMP 2015

The elements of the same group have similar chemical properties because of the presence of same number of valence electrons. Thus, assertion is false but reason is true.

Thus (b) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following :

- 198.** The alkali metal in the third period.

Ans : COMP 2019

Sodium

- 199.** An alkaline earth metal in the third period.

Ans : SQP 2017

Magnesium

- 200.** The number of shells in the third period.

Ans : MAIN 2000

Three

- 201.** Two metals present in the third group.

Ans : COMP 2011

Aluminium and Gallium

- 202.** The family of elements to which chlorine belongs.

Ans : SQP 2010

Halogen

- 203.** The elements present in the first period.

Ans : COMP 2018

Hydrogen and Helium

- 204.** A non-metal which has three electrons in the valence shell.

Ans : SQP 2023

Boron

- 205.** The most electronegative element in the third period.

Ans : MAIN 2021

Chlorine

- 206.** An inert gas present in third period.

Ans : COMP 2019

Argon

- 207.** An element having highest electron affinity.

Ans : SQP 2017

Chlorine

- 208.** An element having highest electro-negativity.

Ans : MAIN 2018

Fluorine

- 209.** An element of period which does not form an oxide.

Ans : COMP 2019

Neon

- 210.** Name an inert gas having two electrons in its outermost orbit.

Ans : COMP 2023

Helium

- 211.** Identify the following substance which is underlined :

The element which has the highest ionisation potential.

Ans : MAIN 2017

Fluorine.

DIRECTION : Fill in the blanks from the choices given in bracket :

- 212.** If an element has one electron in the outermost shell, then it is likely _____ to have the [smallest/largest] atomic size amongst all the elements in the same period.

Ans : SQP 2025

Largest

- 213.** In Period 3, the most metallic element is _____.
(sodium/magnesium/aluminium)

Ans : SQP 2019
Sodium

- 214.** The energy required to remove an electron from a neutral isolated gaseous atom and convert it into a positively charged gaseous ion is called _____ (electron affinity, ionisation potential, electronegativity)

Ans : MAIN 2017
Ionisation potential

- 215.** Down the group, electron affinity _____ (increases, decreases, remains same).

Ans : MAIN 2011
Decreases

- 216.** The properties of the elements are a periodic function of their _____ (atomic numbers, mass number, relative atomic masses).

Ans : COMP 2001
Atomic numbers

- 217.** Moving across a _____ of the periodic table the elements show increasing _____ character. (group, period, metallic, non-metallic).

Ans : SQP 2001
Period, non-metallic

- 218.** The element at the bottom of a group would be expected to show _____ metallic character than the element at the top (less, more).

Ans : COMP 2001
More

- 219.** The similarities in the properties of group of elements are because they have the same _____ (electronic configuration, number of outer electrons, atomic numbers).

Ans : MAIN 2001
Number of outer electrons.

- 220.** If an element has a low ionisation energy then it is likely to be _____ (metallic/non-metallic).

Ans : COMP 2016
Metallic

- 221.** If an element has seven electrons in its outermost

shell then it is likely to have the _____ (largest/smallest) atomic size among all the elements in the same period.

Ans : SQP 2016
Smallest

- 222.** If an element has one electron in its outermost energy level (shell) then it is likely to be _____ (metallic / non-metallic).

Ans : COMP 2019
Non-metallic

- 223.** The element below sodium in the same group would be expected to have a _____. (lower/higher) electro-negativity than sodium and element above chlorine would be expected to have a _____ (lower/higher) ionisation potential than chlorine.

Ans : MAIN 2004
Lower, higher

- 224.** On moving from left to right in a given period, the number of shells _____ (remains the same/increases/decreases).

Ans : COMP 2004
Remains the same

- 225.** On moving down a group, the number of valence electrons _____ (remains the same/increases/decreases)

Ans : SQP 2004
Remains the same

- 226.** Element A has low ionisation potential and a low electro-negativity. Element A is likely to be a _____ (metal/non-metal)

Ans : MAIN 2015
Metal

- 227.** In period 3, element B is to the left of element C.
- The atom of element B would be expected to be _____ (larger/smaller) than the atom of element C.
 - Element B would be _____ (more/less) metallic in character than element C.
 - The element with greater electron affinity would be _____. (B/C).
 - B would have a _____ (greater/lesser) ionisation potential than element C.

Ans : SQP 2010

- (a) larger
- (b) more
- (c) C
- (d) lesser

228. Rewrite the following sentences by using the correct symbol > (greater than) or < (less than) in the blanks given :

- The ionisation potential of Potassium is _____ that of Sodium.
- The electronegativity of Iodine is _____ that of Chlorine.

Ans : COMP 2016

- < (less than)
- < (less than)

DIRECTION : Fill in the blanks in the following statements :

229. The horizontal rows in a periodic table are called _____.

Ans : SQP 2012

Periods

230. In going across a period from left to right in a periodic table, the atomic size of the atoms _____.

Ans : MAIN 2010

Decreases

231. On moving from left to right in the second period, the number of valence electrons _____.

Ans : COMP 2018

Increases

232. Atomic size _____ as we move across the period as _____ remain same but the _____ increases.

Ans : COMP 2018

Decreases, number of shells, nuclear charge

233. Elements of Group 1 are called _____.

Ans : MAIN 2020

Alkali metals

234. There are _____ groups and _____ periods in the periodic table.

Ans : SQP 2023

Eighteen, seven

235. Metals form _____ chlorides

Ans : COMP 2021

Ionic

236. Metals have low _____ and non-metals have high _____.

Ans : SQP 2010

Ionization energy, electron affinity

237. The properties of element which reoccur after a regular interval are called properties.

Ans : MAIN 2015

Periodic

238. Non-metals have _____ electron affinity.

Ans : COMP 2017

High

239. Inert gases have _____ ionisation energy.

Ans : SQP 2011

Maximum

240. The major cause of periodicity is the recurrence of similar _____.

Ans : MAIN 2019

Electronic configuration

241. The atomic size _____ as we move from left to right across the periods because the _____ increases but the _____ remains the same.

Ans : SQP 2020

Decreases, magnitude of nuclear charge, number of shells.

DIRECTION : Arrange the following according to the instructions given in brackets :

242. K, Pb, Ca, Zn. (In the increasing order of the reactivity)

Ans : COMP 2019

Pb < Zn < Ca < K

(According to the position in reactivity series)

243. Li, K, Na, H (In the decreasing order of their ionization potential)

Ans : SQP 2019

H > Li > Na > K

(Smaller the size greater is the ionization potential)

- 244.** F, B, N, O (In the increasing order of electron affinity)

Ans : MAIN 2019

$B < N < O < F$

(Smaller the size more is the electron affinity)

- 245.** He, Ar, Ne (Increasing order of the number of electron shells)

Ans : SQP 2017

He , Ne , Ar
1 shell 2 shells 3 shells

- 246.** Na, Li, K (Increasing Ionisation Energy)

Ans : MAIN 2017

K , Na , Li
Least I.E. $\longrightarrow$ Highest I.E.

- 247.** F, Cl, Br (Increasing electronegativity)

Ans : COMP 2017

Br , Cl , F
Big size $\longrightarrow$ Small size
(Less electronegative) (More electronegative)

- 248.** Na, K, Li (Increasing atomic size)

Ans : SQP 2017

Li , Na , K
2 shells 3 shells 4 shells
 $\longrightarrow$

- 249.** Cs, Na, Li, K, Rb (increasing order of metallic character).

Ans : COMP 2015

$Li < Na < K < Rb < Cs$

- 250.** Mg, Cl, Na, S, Si (decreasing order of atomic size).

Ans : MAIN 2015

$Na > Mg > Si > S > Cl$

- 251.** Na, K, Cl, S, Si (increasing order of ionization energy).

Ans : COMP 2015

$K < Na < Si < S < Cl$

- 252.** Cl, F, Br, I (increasing order of electron affinity).

Ans : SQP 2015

$I < Br < F < Cl$

- 253.** Rearrange the following elements in the order of increasing chemical reactivity (keeping the least reactive element first)

(i) Na, K, Li
(ii) Na, Mg, Al
(iii) Cl, Br, I

Ans : SQP 2015

(i) Li, Na, K
(ii) Al, Mg, Na
(iii) I, Br, Cl

DIRECTION : Give one word or phrase for the following:

- 254.** An alkaline earth metal present in group 2 and period 3.

Ans : SQP 2020

Magnesium.

- 255.** The tendency of an atom to attract electrons towards itself when combined in a covalent compound.

Ans : COMP 2019

Electro-negativity

- 256.** The amount of energy released when an atom in the gaseous state accepts an electron to form an anion.

Ans : COMP 2014, SQP 2018

Electron affinity

- 257.** The energy released when an electron is added to a neutral gaseous isolated atom to form a negatively charged ion.

Ans : MAIN 2018

Electron affinity

- 258.** Name a metal present in period 3, group 1 of the periodic table.

Ans :

COMP 2012

Sodium

2, 8, 8
K L M (electronic configuration of element)

: Three shells indicate third period.

: Eight valence electrons indicate eight group.

DIRECTION : Answer the following :

- 259.** Give the number of the group and the period of the element having three shells with three electrons in the valence shell.

Ans :

SQP 2011

Element having three shells and three valence electrons belong to 13th group and 3rd period.

- 260.** Give reasons as to why the oxidising power of elements increases on moving from left to right along a period in the periodic table.

Ans :

COMP 2011

As we move from left to right along a period in the periodic table, the size of the element decreases, hold of nucleus on electrons increases, incoming electrons is accepted easily. Thus, oxidising power increases.

- 261.** Why the oxidising power of elements increases on moving left to right along a period in the periodic table?

Ans :

SQP 2011

Electro-negativity and the non-metallic character increases from left to right.

- 262.** Define the following term : Ionisation potential.

Ans :

MAIN 2009

Ionisation potential is the amount of energy absorbed to remove one or more electrons from the valence shell of an isolated gaseous atom.

- 263.** What are lanthanide's ?

Ans :

SQP 2010

The 14 elements which follow lanthanum and have atomic numbers 58 to 71 are called lanthanide's.

- 264.** Which is the longest period in the modern periodic table ?

Ans :

MAIN 2008

Sixth period and it has 32 elements.

- 265.** An element has atomic number 18. To which group and period of the periodic table does this element belong ?

Ans :

COMP 2007

- 266.** Name an element which is most electronegative among all the elements.

Ans :

SQP 2001

Fluorine

- 267.** What is meant by a group in the Periodic Table?

Ans :

MAIN 2008

The vertical column in the Periodic Table is called a Group.

- 268.** An element has atomic number 15. To which group and period of the periodic table does this element belong.

Ans :

COMP 2004

$$\text{Atomic number} = 15 \Rightarrow \begin{pmatrix} 2 & 8 & 5 \\ \text{K} & \text{L} & \text{M} \end{pmatrix}$$

It has got 3 shells hence it belongs to 3rd period.

It has 5 valence electrons, hence its group number is VA.

- 269.** What is the cause of periodicity ?

Ans :

SQP 2009

It is the repetition of similar outer electronic configuration of the elements after certain typical, fixed intervals of atomic numbers.

- 270.** What are actinides ?

Ans :

MAIN 2015

The 14 elements which follow actinium and have atomic numbers 90 to 103 are called actinides.

- 271.** Name two factors which influence ionisation energy of an element.

Ans :

COMP 2017

1. Atomic size
2. Magnitude of nuclear charge

- 272.** What is modern periodic law ?

Ans :

SQP 2019

It states that the properties of the elements are the periodic functions of their atomic numbers.

- 273.** Name a group of elements whose oxides react with water to form strong alkalis.

Ans :

MAIN 2017

Alkali metals.

274. How many elements are there in Period 2 ?

Ans :

SQP 2013

Eight

275. State whether the ionisation potential increases or decreases on going down a group.

Ans :

COMP 2011

Ionisation potential decreases going down a group because of increase in size.

276. If an element is in Group 17 (or Group VII A), is it likely to be metallic or non-metallic in character ?

Ans :

MAIN 2010

Non-metallic

277. Name all the elements of the first period.

Ans :

COMP 2000

Elements of the first period are (i) hydrogen, (ii) helium.

278. How does the atomic size of elements change while moving in a period from left to right?

Ans :

SQP 2000

The atomic size gradually decreases while moving from left to right in a period.

the atomic size decreases due to the increase in nuclear charge thus more energy is required to remove the electron, hence ionisation potential increases.

281. An element X is in group IV of the periodic table.

- (i) What will be its valency ?
- (ii) What type of bonds will it form ?

Ans :

COMP 2010

- (i) 4
- (ii) Covalent bond

282. The metals of Group 2 from top to bottom are Be, Mg, Ca, Sr and Ba.

- (i) Which one of these elements will form ions most readily and why?
- (ii) State the common feature in the electronic configuration of all these elements.

Ans :

MAIN 2015

- (i) Barium, as it is present at the bottom having maximum atomic size.
- (ii) They all contain two valence electrons.

283. Within a group where would you expect to find the element with ?

1. the greatest metallic character.
2. the largest atomic size.

Ans :

COMP 2010

1. Bottom of the group
2. Bottom of the group.

284. State two factors which affect or influence the atomic size of the elements in a periodic table.

Ans :

SQP 2017

These are :

- (a) Magnitude of nuclear charge
- (b) Number of shells

285. Give reasons for the following :

- (i) Ionisation potential of the element increases across a period.
- (ii) Alkali metals are good reducing agents.

Ans :

MAIN 2012

- (i) Ionisation potential of an element is the amount of energy required to remove one or more electrons from the outermost shell of an isolated gaseous atom.

Across a period, the atomic radii decreases due to increase in nuclear A charge due to addition of electrons which results in greater attraction of valence shell electrons. Hence,

TWO MARKS QUESTIONS

279. Identify the term/substance in each of the following :

- (i) The tendency of an atom to attract electrons to itself when combined in a compound.
- (ii) The electrons present in the outermost shell of an atom.

Ans :

COMP 2016

- (i) Electro-negativity
- (ii) Valence electrons

280. Give a reason for each of the following :
Ionisation potential increases across a period, from left to right.

Ans :

MAIN 2018

As we move from left to right along a period,

I.P. increases.

- (ii) Alkali metals are good reducing agents because alkali metals have one valence electron which they lose to attain stability. Hence, they themselves undergo oxidation causing reduction of others and are good reducing agents.

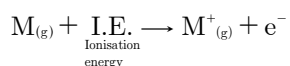
286. Define the following terms :

- (i) Ionisation energy.
(ii) Electron affinity.

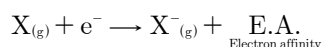
Ans :

SQP 2010

- (i) Ionisation energy : It is the minimum amount of energy required to remove the most loosely bond electron from an isolated, neutral gaseous atom :



- (ii) Electron affinity : It is the amount of energy released when an isolated neutral gaseous atom of an element takes up an extra electron to form uni-negative gaseous ions.



287. Match the column A with column B.

	Column A	Column B
(i)	Electro-negativity across the period	Increases
(ii)	Non-metallic character down the group	Decreases

Ans :

COMP 2010

- (i) Increases
(ii) Decreases

288. How does the chemical reactivity vary down?

- (a) alkali metals.
(b) halogens.

Ans :

MAIN 2017

- (a) As we move from top to bottom in alkali metals reactivity goes on increasing.
(b) As we move from top to bottom in the halogen family, the reactivity goes on decreasing.

289. What are the following groups known as (a) Group 1 (IA), (b) Group 17 (VII A) ?

Ans :

SQP 2012

- (a) Alkali metals
(b) Halogen

290. In each of the following pairs choose the atom having the bigger size.

- (a) Mg (Z = 12) or Cl (Z = 17)
(b) Na (Z = 11) or K (Z = 19)

Ans :

COMP 2012

- (a) Mg
(b) K

291. An element Z has atomic number 16. Answer the following questions on Z.

- (i) State the period and group to which Z belongs.
(ii) Is Z a metal or a non-metal?

Ans :

SQP 2014

- (i) Period - 3, Group - 16
(ii) Non-metal

292. Give any two characteristics of a period.

Ans :

MAIN 2015

- (i) The elements of the same period have the same number of electron shells.
(ii) Ionisation potential increases on moving from left to right along a period.

293. How does atomic radius vary along a period and down a group ?

Ans :

SQP 2017

Along a period : As we move from left to right, atomic radius goes on decreasing.

Down a group : As we move from top to bottom in a group atomic radius increases.

294. An element has atomic number 11 where would you expect this element in the periodic table and why?

Ans :

MAIN 2019

The electronic configuration of the element is 2,8,1.

- (i) As the element has three electronic shells, it belongs to the 3rd period.
(ii) As the element has one valence electron, it belongs to IA group. Thus, the element is expected to be in IA group of the 3rd period.

295. Name four periodic properties.

Ans :

COMP 2017

These are :

- (a) Atomic radius

- (b) Ionisation energy
- (c) Electron affinity
- (d) Electro-negativity.

296. What are bridge elements ?

Ans :

MAIN 2016

The elements of second period are called bridge elements because they connect their own group elements with the elements of next group lying diagonally to them in the periodic table. e.g., lithium resembles magnesium.

297. How does electro-positive character (metallic character) vary in period ?

Ans :

SQP 2013

In a period, as we move from left to right, the metallic or electro-positive character decreases. This is due to the decrease in ionisation energy. For example, consider the third period.

$\text{Na}_{11} \text{ Mg}_{12} \text{ Al}_{13} \text{ Si}_{14} \text{ P}_{15} \text{ S}_{16} \text{ Cl}_{17} \text{ Ar}_{18}$

Electro-positive character decreases.

298. Lithium, sodium and potassium were put in one group on the basis of their similar properties,

- (a) What are those similar properties ?
- (b) What is the common name of this group?

Ans :

COMP 2014

- (a) Same number of valence electrons, ionisation energy, electron affinity and valency.
- (b) Alkali metals

THREE MARKS QUESTIONS

299. The electron affinity of an element X is greater than that of element Y .

- (i) How is the oxidising power of X likely to compare with that of Y ?
- (ii) How is the electronegativity of X likely to compare with that of Y ?
- (iii) State whether X is likely to be placed to the left or to the right of Y in the periodic table?

Ans :

SQP 2025

- (i) X has more oxidising power than Y
- (ii) X will be more electronegative than Y
- (iii) X will be placed to the right of Y

300. Arrange the following as per the instructions given in the brackets:

- (a) Carbon, fluorine, Beryllium (decreasing order of atomic size)
- (b) Sulphuric acid, phosphoric acid, Acetic acid (increasing order of number of replaceable H atoms per molecule)
- (c) Potassium, Lithium, Sodium (increasing order of ionisation potential)

Ans :

MAIN 2024

- (a) The decreasing order of their atomic size is as follow :
Beryllium (Be) > Carbon (C) > Fluorine (F)
- (b) The increasing order of their replaceable hydrogen ions is as follow :
Acetic acid (CH_3COOH) < Sulphuric acid (H_2SO_4) < Phosphoric acid (H_3PO_4)
- (c) The increasing order of their ionisation potential is as follows :
Potassium (K) < Sodium (Na) < Lithium (Li)

301. Identify the following:

- (a) An element in period 1 which can be placed in both group 1 and group 17 of the periodic Table.
- (b) The element having electronic configuration 2, 8, 6.
- (c) The most electronegative element of period 3.

Ans :

MAIN 2024

- (a) Hydrogen (H)
- (b) Sulphur (S)
- (c) Chlorine (Cl)

302. The following table shows the electronic configuration of the atoms A, B, C and D.

Element	A	B	C	D
Electronic configuration	2,8,8,2	2,6	2,8,7	2,4

- (a) Write the formula of the compound formed between:
 - 1. A and B
 - 2. D and C
- (b) Which of the above elements will exhibit catenation?

Ans :

MAIN 2024

- (a) 1. A is Calcium (Ca) with atomic number 20 and B is oxygen with atomic number 8. The compound formed with these two elements is calcium oxide and its chemical formula is CaO .

2. C is Chlorine (Cl) with atomic number 17 and D is carbon with atomic number 6. The compound formed with these two elements is carbon tetrachloride and its chemical formula is CCl_4 .
- (b) The element that will exhibit catenation is D as it is carbon atom.

303. The following table represent the elements and the atomic number.

With reference to this answer the following using only the alphabets given in the table.

Element	Atomic number
P	13
Q	7
R	10

- (i) Which element combines with hydrogen to form a basic gas ?
- (ii) Which element has an electron affinity zero ?
- (iii) Name the element, which forms an ionic compound with chlorine.

Ans :

COMP 2020

- (i) Q (It forms ammonia which is basic)
- (ii) R (because it is a noble gas)
- (iii) P (because it has a positive charge of +3)

304. An element has an atomic number 16. State

- (i) the period to which it belongs.
- (ii) the number of valence electrons.
- (iii) whether it is a metal or non-metal.

Ans :

SQP 2010

Atomic Number 16 $\rightarrow$ $2, 8, 6,$
 $K \quad L \quad M$

- (i) 3rd period (Because it has three shells)
- (ii) 6 valence electrons (valence electrons are present in outermost orbit).
- (iii) Non - metal (elements having 5, 6 or 7 valence electrons are non-metals).

305. In Period 3 of the Periodic Table, element B is placed to the left of element A.

On the basis of this information, choose the correct word from the brackets to complete the following statements :

- The element B would have (lower/higher) metallic character than A.
- The element A would probably have (lesser/higher) electron affinity than B.
- The element A would have (greater/smaller) atomic size than B.

Ans :

COMP 2018

- (i) Higher
- (ii) Higher
- (iii) Smaller

306. How many elements are there in the periodic table in the ?

- (i) first period
- (ii) second period
- (iii) third period

Ans :

SQP 2000

- (i) First period $\rightarrow$ 2 elements
- (ii) Second period $\rightarrow$ 8 elements
- (iii) Third period $\rightarrow$ 8 elements

307. How do the following vary in period 3 ? (from left to right)

- Atomic size
- Metallic character
- Non-metallic character

Ans :

MAIN 2014

- Atomic size decreases due to the increase in effective nuclear charge.
- Metallic character decreases due to increase in ionisation energy.
- Non-metallic character increases due to increase in ionisation energy.

308. How do the following vary in period 3 ? (from left to right)

- (a) Ionisation energy
- (b) Electron affinity
- (c) Electro-negativity

Ans :

SQP 2017

- Ionisation energy increases due to decrease in size.
- Electron affinity increases due to the decrease in size.
- Electro-negativity increases due to decrease in size.

309. Consider the following elements :

Ca, O, Ar, S, Be, He

Which of the above elements would you expect to be,

- (i) very stable.
- (ii) in group IIA of the periodic table.
- (iii) in group VIA of the periodic table.

Ans :

COMP 2019

- (i) Ar and He
- (ii) Ca and Be

(iii) O and S

- 310.** Explain clearly, why atomic number of an element is most important to the chemist than its relative atomic mass.

Ans :

MAIN 2023

This is because atomic number being equal to the number of electrons in an atom of the element, it enables him to write down the electronic configurations of elements. The elements having similar electronic configurations can then be put together in the same group. This helps in the systematic classification of elements. On the other hand, the atomic mass of an element does not tell us anything about the number of electrons present in one atom of the element.

- 311.** The position of three elements A, B and C in the periodic table is as shown below :

Group VIA	Group VIIA
	A
B	C

- (a) State whether C is a metal or non-metal.
 (b) State whether C is more or less reactive than A.
 (c) Will C be larger or smaller than B ?

Ans :

COMP 2021

- (a) Non-metal
 (b) C is less reactive than A
 (c) C will be smaller than B.

- 312.** Explain why reducing power of elements increases as one goes down a group ?

Ans :

SQP 2022

When an atom loses an electron/electrons from its valence shell, the element is said to be reducing agent and the property of the element is called reducing property. The reducing power of an element depends upon the ease with which it can lose electrons. In case of elements at the bottom of a group, the valence electrons are held very loosely by the nucleus. Thus, such elements easily lose their valence electrons and hence have a higher reducing power.

- 313.** Explain :

- (i) Group VII elements are strong non-metals while group I elements are strong metals.
 (ii) Metallic character of elements decreases from left to right in a period.

Ans :

COMP 2012

- (i) Group VII elements are strong non-metals because they can easily accept an electron to form an anion whereas group 1 elements are strong metals because they can very easily lose one electron to form cation.
 (ii) Metals have the tendency to lose their valence electrons and form positive ions, so metallic character is related to the ionisation potential. Elements having low ionisation potential, lose electrons easily. Thus, metallic character generally decreases across a period and increases down a group.

- 314.** What are the following groups known as ? Give two examples of each.

- (a) Group IA elements
 (b) Group VII A elements
 (c) Group zero elements.

Ans :

MAIN 2014

- (a) Group IA elements are called alkali metals. For example – Lithium and Sodium.
 (b) Group VII A elements are called halogens. For example – Fluorine, Chlorine.
 (c) Group zero elements are called noble gases. For example – Helium, Neon.

- 315.** The following table represents a part of the periodic table.

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K						Br

From these elements, answer the following:

- (i) Which is the element having biggest atomic size ?
 (ii) Which element has the highest ionisation energy?
 (iii) Which elements constitute alkali metals?

Ans :

SQP 2017

- (i) K
 (ii) F
 (iii) Li, Na, K.

FOUR MARKS QUESTIONS

316. Match the atomic number 2, 4, 8, 15 and 19 with each of the following:

- (i) A solid non-metal belonging to the third period.
- (ii) A metal of valency 1.
- (iii) A gaseous element with valency 2.
- (iv) An element belonging to Group 2.
- (v) A rare gas.

Ans :

COMP 2017

- (i) $\rightarrow$ 15 (ii) $\rightarrow$ 19
- (iii) $\rightarrow$ 8 (iv) $\rightarrow$ 4
- (v) $\rightarrow$ 2

317. Arrange the elements of group VII A according to the given conditions.

- (a) Increasing atomic size
- (b) Increasing non-metallic character
- (c) Increasing ionisation potential
- (d) Increasing electron affinity
- (e) Decreasing electro-negativity.

Ans :

SQP 2019

- (a) $F < Cl < Br < I < At$
- (b) $At < I < Br < Cl < F$
- (c) $At < I < Br < Cl < F$
- (d) $At < I < Br < F < Cl$
- (e) $F > Cl > Br > I > At$

318. An element Z has atomic number 16. Answer the following questions on Z :

- (i) State the period and group to which Z belongs.
- (ii) Is Z a metal or a non-metal ?
- (iii) State the formula between Z and Hydrogen.
- (iv) What kind of a compound is this ?

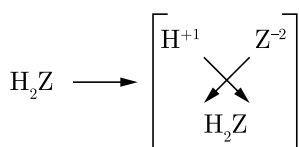
Ans :

MAIN 2014

- (i) $2(16) \rightarrow 2, 8, 6$
K L M

It is in 3rd period and 16th group.

- (ii) Non-metal
- (iii)



- (iv) Covalent compound

319. An element X belongs to group IIA and another element Y belongs to group VA of the periodic table.

- (a) What is the number of valence electrons in X?
- (b) What is the valency of X ?
- (c) What is the number of valence electrons in Y?
- (d) What is the valency of Y ?

Ans :

SQP 2013

- (a) Element X belongs to group IIA, so it will have 2 valence electrons.
- (b) Element X is a metal so its valency will be equal to its group number, which is 2.
- (c) Element Y belongs to group VA, so it will have 5 valence electrons.
- (d) Element Y is non-metal so its valency will be equal to "8 minus group number". That is, valency = $8 - 5 = 3$.

320. Define the following and give their trends in the periodic table:

- (a) Ionisation potential
- (b) Metallic character
- (c) Electron affinity
- (d) Electro-negativity

Ans :

COMP 2017

- (a) The energy required to remove an electron from the outermost shell of an atom in its gaseous, isolated state is called ionisation potential.
As we move down the group, ionisation potential decreases.
As we move across the period, ionisation potential increases.
- (b) The tendency to lose electrons is called as metallic character.
Metallic character increases as we move down the group.
Metallic character decreases as we move across the period.
- (c) The energy released when an electron is added to a neutral atom in its gaseous isolated state is called as electron affinity.
Electron affinity decreases as we move down the group.
Electron affinity increases as we move across a period.
- (d) The tendency of an atom to attract the electron towards its side when combined in a compound is called electro-negativity. It decreases as we move down the group and

increases as we move from left to right in the periodic table.

- 321.** (i) What do you understand by the term electron affinity ?
 (ii) Does electron affinity represent energy released or absorbed ?
 (iii) Arrange Br, F, I and Cl in the order of increasing electron affinity.

Ans :

MAIN 2019

- (i) It is defined as the amount of energy released on adding extra electron to isolated gaseous atom in its lowest state of energy.
 (ii) It represents the energy released.
 (iii) $I < Br < F < Cl$

Lowest	Highest
electron	electron
affinity	affinity

- 322.** Give the name and the symbol of the elements which occupy the following positions in the periodic table.

- (i) Period 4, group II A
 (ii) Period 2, group III A
 (iii) Period 3, group zero

Ans :

COMP 2023

- (i) Period 4 = K L M N (4 shells)
 Group II = 2, 8, 8, 2
 (2 electrons in the valence shell)
 Atomic no. = 20
 Element = Calcium [Ca]
 (ii) Period 2 = K L (2 shells)
 Group III A = 2, 3
 (3 electrons in the valence shell)
 Atomic no. = 5
 Element = Boron [B]
 (iii) Period 3 = K, L M Group zero = 2, 8, 8
 (8 electrons in the valence shell)
 Atomic no. = 18
 Element = Argon [Ar]

- 323.** The electronic configuration of an element T is 2,8,7.

- (a) What is the group number of T ?
 (b) What is the period number of T ?
 (c) What is the valency of T ?
 (d) Is T a metal or a non-metal ?
 (e) How many valence electrons are there in an atom of T?

Ans :

MAIN 2017

- (a) VII A
 (b) Three
 (c) 1
 (d) Non-metal
 (e) 7

- 324.** An element A belongs to third period and group IA of the periodic table. Find out :

- (i) the number of valence electrons in its atom
 (ii) valency of the element
 (iii) metal or non-metal
 (iv) name of the family to which this element belongs and
 (v) name of the element

Ans :

COMP 2018

- (i) One
 (ii) One
 (iii) Metal
 (iv) The alkali metals
 (v) Sodium

- 325.** An element A belongs to third period and group I of the periodic table. Find out :

- (i) the number of valence electrons in its atoms.
 (ii) valency of the element.
 (iii) metal or non-metal.
 (iv) name of the element, and
 (v) name of the family to which this element belongs.

Ans :

MAIN 2017

- (i) Since element A belongs to group I, it has 1 valence electron in its atom.
 (ii) An atom of A can lose its 1 valence electron to form an ion A^+ having 1 unit of positive charge. So, the valency of element A is 1.
 (iii) Group I is on the left side of periodic table and consists of metals. So, element A is a metal.
 (iv) The first element of third period is sodium. So, the element A is sodium (Na).
 (v) Sodium belongs to alkali metal family.

- 326.** Six elements A, B, C, D, E and F have the following atomic numbers :

$A = 12, B = 17, C = 18, D = 7, E = 9, F = 11$

Answer the following :

- (i) Which of them has the lowest electron affinity?
 (ii) Which of them has the highest electron affinity ?
 (iii) Which of them has the largest atomic size ?
 (iv) Which of these belongs to the third period

and has the highest I.E. ?

- (v) Arrange the elements of the same group in increasing order of I.E.

Ans :

COMP 2019

A (12) - 2, 8, 2 B (17) - 2, 8, 7

C (18) - 2, 8, 8 D (7) - 2, 5

E (9) - 2, 7 F (11) - 2, 8, 1

(i) F

(ii) E

(iii) F

(iv) B

(v) B, E

CASE BASED QUESTION

- 327.** The table below gives information about three elements from Group 1, including atomic number and electronic configuration.

Group 1 element	Atomic number	Electronic configuration
lithium	3	
sodium	11	2,8,1
potassium	19	2,8,8,1

- (i) Complete the table to show the electronic configuration of lithium.
 (ii) Describe the relative reactivities of the three elements.
 (iii) Describe the trend of the relative distance of the outer electron to the nucleus in comparison to the atomic number.

Ans :

(i) 2, 1

(ii) Lithium is least reactive.

Potassium is most reactive.

(iii) As the atomic number increases, the relative distance increases.

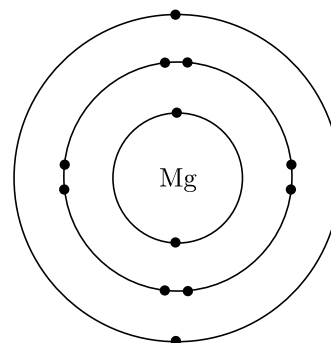
- 328.** Magnesium and calcium are in the same group of the periodic table. Magnesium reacts with many other elements to make compounds.

- (i) Draw diagrams to show the electronic configuration of :
 (a) magnesium
 (b) calcium.
 (ii) Explain, in terms of electronic configurations, why magnesium and calcium are in the same group of the periodic Table.

- (iii) Explain, in terms of electronic configurations, why magnesium is more reactive than argon.

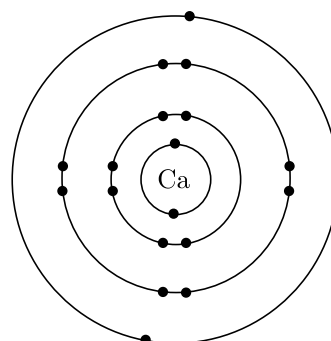
Ans :

(i) (a)



Magnesium

(b)

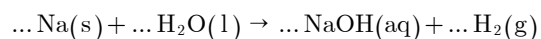


Calcium

- (ii) They both have two outer electrons. Elements with the same number of outer electrons are in the same group.
 (iii) Magnesium has (two) outer electrons it can lose. Argon has no outer electrons/has a full outer electron shell.

- 329.** Sodium is a metal in Group 1 of the periodic table. It has the atomic number 11. Sodium reacts violently with water.

- (i) What is the electronic configuration of a sodium atom?
 (ii) Describe what you would observe during the reaction of sodium with water.
 (iii) Balance the chemical equation for the reaction of sodium with water.

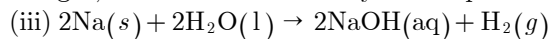


Ans :

(i) 2, 8, 1

(ii) The sodium readily interacts with water. It

reacts vigorously with water to produce a solution of sodium hydroxide and hydrogen gas. The nature of the reaction is very exothermic. The solution of sodium hydroxide results from the simple evolution of hydrogen gas, which occurs naturally as a vapor.



330. This is an outline of the periodic table. The letters below represent elements but are not their chemical symbols.

- (i) Which elements are in the same period ?
- (ii) Which element is a transition metal ?
- (iii) What is the charge on an ion of element L ?
- (iv) Which element is very un-reactive? Explain why?

Ans :

- (i) N and L
- (ii) K
- (iii) -1
- (iv) M , It is a noble gas.

331. Three student arranged the elements (A, B and C) in the a table .The atomic numbers of three elements A, B and C are given below :

Element	Atomic number
A	5
B	7
C	10

With reference of the above table answer the following

- (i) Which element belongs to group zero?
- (ii) Which element belongs to group VA ?
- (iii) Which element belongs to group MA?
- (iv) To which period/periods do these elements belong?

Ans :

- (i) C
- (ii) B
- (iii) A
- (iv) 2nd period

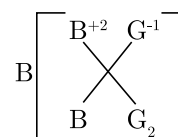
332. Study the extract of the Periodic Table given below and answer the questions that follow. Give the alphabet corresponding to the element in question. DO NOT repeat an element.

[illegible]

- (i) Which element forms electrovalent compound with G ?
- (ii) The ion of which element will migrate towards the cathode during electrolysis ?
- (iii) Which non-metallic element has the valency of 2?
- (iv) Which is an inert gas ?

Ans :

- (i)



- (ii) A [Positive ions migrate towards cathode, hence A will form A^+ and migrate towards cathode]
- (iii) E
- (iv) F

333. An element X belongs to 3rd period and group II of Use the letters only written in the periodic table given below to answer the questions that follow:

[illegible]

- State the number of valence electrons in atom J .
- Which element shown forms ions with a single negative charge?
- Which metallic element is more reactive than R ?
- Which element has its electrons arranged in four shells?

Ans :

- $$\begin{array}{ll} \text{(i)} & 5 \\ \text{(ii)} & M \end{array}$$

- $$\begin{array}{l} \text{(iii)} \quad T \\ \text{(iv)} \quad T \end{array}$$

334. The question given below refers to the elements of the periodic table with atomic number from 3 to 18. These elements are shown by letters. (not the usual symbols of the elements)

3	4	5	6	7	8	9	10
<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>H</i>	<i>G</i>
11	12	13	14	15	16	17	18
<i>I</i>	<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>N</i>	<i>O</i>	<i>P</i>

Which of these ?

- (i) is a noble gas.
- (ii) is a halogen.
- (iii) is an element with valency 4.
- (iv) is an alkali metal.

Ans :

- (i) H and P
- (ii) G and O
- (iii) D and L
- (iv) A and I

335. Use the letters only written in the Periodic Table given below to answer the questions that follow :

[illegible]

- State the number of valence electrons in atom J.
- Which element shown forms ions with a single negative charge ?
- Which metallic element is more reactive than R ?
- Which element has its electrons arranged in four shells ?

Ans :

- (i) J $\rightarrow$ (5 valence electrons)
- (ii) M $\rightarrow$ (7 valence electrons) so it forms a uni-negative ion
- (iii) T
- (iv) T

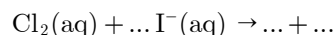
336. Bromine, chlorine and iodine are known as the halogens. They can be dissolved in water to make bromine water, chlorine water and iodine water, respectively.

A student wanted to investigate which of the three halogens is most reactive. She reacted each

colourless halogen water with solutions of sodium chloride, sodium bromide and sodium iodide. She noted any colour changes and recorded her results in a table.

Solution	Colour of solution after adding halogen water		
	Chlorine water	Bromine water	Iodine water
sodium chloride		colourless	colourless
sodium bromide	orange		colourless
sodium iodide	brown	brown	

- (i) Name the solutions, if any, that reacted with bromine water.
- (ii) Name the solutions, if any, that reacted with iodine water.
- (iii) Use information from the table to list bromine, chlorine and iodine in order of their reactivity with each other. Place the most reactive first.
- (iv) Chlorine water reacts with sodium iodide. Complete the ionic equation for the reaction.



- (v) Explain, in terms of electrons, the reaction between bromine water and sodium iodide.

Ans :

- Sodium iodide
- None
- Chlorine, bromine, iodine
- $\text{Cl}_2(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{Cl}^-(\text{aq})$
- The bromine atoms become ions by taking the extra electrons from the iodide ions making them into iodine atoms.

337. This is an outline of the Periodic Table. The letters below represent elements but are not their chemical symbols.

	S								T
					P				
			W				Q		
R									
					X				

- Which two elements are in the same group?
- Which two elements are in the same period?
- Which two elements have similar chemical properties?

- (iv) Which two elements form only $2+$ ions?
Explain your answer.
- (v) Deduce the electronic configurations of elements S , P and T .

Ans :

- (i) S and R
- (ii) W and Q or S and T
- (iii) S and R
- (iv) S and R
Elements in the same group always have the same number of outer electrons.
- (v) $S = 2,2$
 $P = 2,8,4$
 $T = 2,8$

338. Consider the section of the periodic table given below :

Group numbers	IA	II A	II IA	IV A	VA	VI A	VI IA	0
	1	2	13	14	15	16	17	18
	Li		F			O	J	Ne
	A	Mg	E	Si		H	K	
	B	C		F	G			L

Note : In this table B does not represent boron, C does not represent carbon

F does not represent fluorine

H does not represent hydrogen

K does not represent potassium

You must see the position of the element in the periodic table.

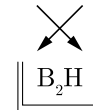
Some elements are given in their own symbol and position in the periodic table, while others are shown with a letter. With reference to the table :

- (i) Which is the most electronegative ?
- (ii) How many valence electrons are present in G?
- (iii) Write the formula of the compound between B and H.
- (iv) In the compound between F and J, what type of bond will be formed ?
- (v) Draw the electron dot structure for the compound formed between C and K.

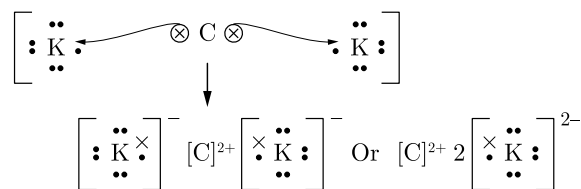
Ans :

- (i) J is the most electronegative.
- (ii) G has group no. 15 or VA that means it will have 5 electrons in its outermost shell.
- (iii) B has 1 valence electron or its valency will be $+1$. It will be represented as B^{1+} . H has 6 valence electrons so its valency will be -2 . It will be represented as H^{2-} .

Chemical formula = $B^{1+} H^{2-}$



- (iv) Since F belongs to 14th group or IVA group. It has four valence electrons which means it will share electrons and the bond will be covalent.
- (v) C has two valence electrons and K has seven valence electrons. K needs 1 electron to complete its octet and C needs to lose 2 electrons.



339. The element belongs to third period and group IIIA or 13.

Group number	IA	II A	II IA	IV A	VA	VI A	VI IA	0
2nd period	1	2	13	14	15	16	17	18
	Li		D			O	J	Ne
	A	Mg	E	Si		H	M	
	R	T	I		Q	U		Y

1. In this table H does not represent hydrogen.
2. Some elements are given in their own symbol and position in the periodic table.
3. While others are shown with a letter.

With reference to the table answer the following questions :

- (i) Identify the most electronegative element.
- (ii) Identify the most reactive element of group 1.
- (iii) Identify the element from period 3 with least atomic size.
- (iv) How many valence electrons are present in Q?
- (v) Which element from group 2 would have the least ionisation energy ?

Ans :

- (i) J (fluorine)
- (ii) R (potassium)
- (iii) M (chlorine)
- (iv) 5 valence
- (v) T (calcium)

340. A group of elements in the Periodic Table are given below (Boron is the first member of the group and Thallium is the last).

Boron, Aluminium, Gallium, Indium, Thallium

Answer the following questions in relation to the above group of elements :

- Which element has the most metallic character ?
- Which element would be expected to have the highest electro-negativity ?
- If the electronic configuration of Aluminium is 2, 8, 3, how many electrons are there in the outer shell of Thallium ?
- The atomic number of Boron is 5. Write the chemical formula of the compound formed when Boron reacts with chlorine.
- Will the elements in the group to the right of this Boron group be more metallic or less metallic in character? Justify your answer.

Ans :

- Thallium
- Boron
- 3
- BCl_3
- Less metallic due to increase in ionisation energy.

341. The elements of one short period of the table are given below in order from left to right :

Li Be B C O F Ne

- To which period do these elements belong?
- One element of this period is missing. Which is the missing element and where should it be placed ?
- Which one of the elements in this period shows the property of catenation ?
- Place the three elements Fluorine, Beryllium and Nitrogen in the order of increasing electro-negativity.
- Which one of the above elements belongs to the halogen series ?

Ans :

- Second period
- N (Nitrogen) and it should be placed after Carbon before Oxygen.
- C (Carbon)
- The increasing order of electro-negativity is $\text{Be} < \text{N} < \text{F}$
- F (Fluorine)

342. With reference to the first three periods of the modern periodic table, answer the questions given

below.

- Write the formula of the sulphate of the element with atomic number 13.
- Name the element which has the highest ionisation potential.
- What features of the atomic structure accounts for the similarities in the chemical properties of the elements in group VII A of the periodic table?
- How many electrons are present in the valence shell of the element with atomic number 18 ?
- What is the electronic configuration of the element in the third period which gains one electron to change into an anion?

Ans :

- $\text{Al}_2(\text{SO}_4)_3$
- Helium
- Seven electrons in their valence shells
- Eight
- 2, 8, 7

343. Study this table related to electronic configuration of six elements and answer the questions that follow :

Elements	Electronic configuration
P	2, 1
Q	2, 4
R	2, 7
S	2, 8, 7
T	2, 8, 8
U	2, 8, 8, 1

- Give the formula of the compound formed between elements P and S.
- What type of bonding would you expect in the compound formed?
- Name the two elements that are in the same group of the periodic table.
- Name the elements which forms positive ion.

Ans :

- PS
- Ionic bonding
- P and U (one valence electron)
or R and S (seven valence electron)
- P or U (due to one valence electron)

344. Matter around us is found in the form of elements, compounds and mixtures. The elements contain atoms of only one type. Around the year 1800, only 30 elements showing different properties

were known. Scientists of that age discovered a pattern in their properties and based on that pattern, several attempts were made to classify elements. The earliest attempt was to classify the elements as metals and non-metals. The latest is the 'Modern Periodic Table'.

- Write the need to classify elements.
- How many groups are there in the 'Modern Periodic Table'?

Ans :

- Classification of elements in groups provides as a fixed pattern in which the element change their properties periodically. Periodic table made the study of physical and chemical properties of element simple and organized.
- 18 groups.

345. Study the given periodic table and answer the questions that follow :

Period → Group ↓	1	2	3	4
I	H	Li	Na	K
II		Be	Mg	Ca
III		B	Al	
IV		C	Si	
V		N	P	
VI		O	S	
VII		F	Cl	
VIII	He	Ne	Ar	

With reference of the above table answer the following

- Na has physical and chemical properties similar to which element(s) and why?
- Write the electronic configuration of N and P.
- Which one of these (N and P) will be more electronegative and why?
- State a chemical property common to fluorine and chlorine.

Ans :

- Na has physical and chemical properties similar to Li and K because these contain one electron only in their outermost shell.
- N = 2, 5; P = 2, 8, 5
- N is more electronegative as its nucleus is nearer to outermost shell and has more tendency to attract the outermost electrons.
- Both fluorine and chlorine form electrovalent Compounds with alkali metals.

346. Study the table and answer the following questions:

Atomic number	Element	Electronic configuration
1	Hydrogen	1
8	Oxygen	2, 6
6	Carbon	2, 4
9	Fluorine	2, 7

With reference of the above table answer the following

- What is valency of oxygen?
- Give the chemical formula formed by hydrogen and oxygen.

Ans :

- Valency of oxygen is 2.
- $2\text{H} + \underset{2,6}{\text{O}} \longrightarrow \text{H}_2\text{O}$

The chemical formula formed is H_2O .

347. For question number (i) - (iv), a table is shown. Study the table and answer the four questions that follow :

Groups → Periods ↓	1	2	3
I	A		
II			C
III	D	B	

With reference of the above table answer the following :

- Why is element D a metal?
- Why does element B have a larger size than element A?
- Why does element B have a valency 2?
- Why is element A less reactive than element D?

Ans :

- Element D is metal with valency one. It can lose one electron.
- Element B has larger size than A because B contains more number of shells.
- Element B have valency 2, because its outermost shell contains two electrons.
- Element A is less reactive than D because down the group reactivity increases.

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- 348.** Study the table and answer the four questions that follow :

1 Lithium	X	Y	Z
2			
13			
14 Carbon	A		
15			
16 Oxygen			
17 Fluorine	B	C	D

With reference of the above table answer the following

- Which is the most reactive metal?
- Name the family of fluorine, B, C and D.
- Name an element from group 2 and 13.
- What is the name of the element placed below carbon?

Ans :

- The most reactive metal is Z, as it belongs to alkali metals and placed down the group. Down the group, reactivity increases.
- The family of fluorine, B, C and D is called halogens.
- An element from group 2 is magnesium and an element from group 13.
- Silicon

- 349.** Study the table and answer the four questions that follow. Four elements V, W, X, Y and Z along with their electronic configurations are given below :

Elements	Electronic configuration
V	2, 1
W	2, 8
X	2, 8, 1
Y	2, 8, 8
Z	2, 8, 8, 2

With reference of the above table answer the following

- Which two elements belong to the same period?
- Which two elements belong to the same group?
- Which element out of V and X is more reactive and why?
- What is the name of the element Z?

Ans :

- Element V and W belong to same period i.e. second period. Elements X and Y belong to same period i.e. third period.
- V and X have one valence electron, so they belong to same group.
- X is more reactive because X is placed below V in the periodic table and reactivity of an element increases down the group.
- The electronic configuration of Z is 2, 8, 8, 2 with 20 electrons. The element with atomic number 20 is Calcium.

- 350.** Study the table and answer the four questions that follow. Four elements A, B, C, D and E along with their electronic configurations are given below :

Elements	Electronic configuration
A	2, 1
B	2, 2
C	2, 3
D	2, 4
E	2, 5

With reference of the above table answer the following

- Which one of the above is known as an alkali metal?
- Element D forms covalent bonds. Give reason. Why?
- Write the name of common oxide formed by the element D.
- Element E gives laughing gas. What is the chemical formula of laughing gas?

Ans :

- Element A, which is lithium.
- Element D forms covalent bonds, because it contains 4 electrons in its valence shell.
- CO₂
- N₂O

- 351.** The position of eight elements in the modern periodic table is given below with atomic numbers.

Period Number	Elements	
2	Li (3)	Be (4)
3	Na (11)	Mg (12)
4	K (19)	Ca (20)
5	Rb (37)	Sr (38)

With reference of the above table answer the following

- Write the electron configuration of Calcium (Ca).
- Predict the number of valence electrons in Strontium (Sr).
- What is the number of shells in Rubidium (Rb)?
- Predict whether K is a metal or a non-metal?

Ans :

- Electronic configuration of Calcium is 2, 8, 8, 2.
- The number of valence electrons in Strontium (Sr) is 2.
- The number of shells in Rubidium (Rb) is five.
- Potassium (K) is a metal, which has one valence electron.

352. The position of six elements is shown in the periodic table.

1 Lithium	2 Barium	13	14 Carbon	15
A	E			D
B				
C				

With reference of the above table answer the following

- Identify the elements which have similar physical and chemical properties as the element A.
- Identify the element E.
- Among the elements A, E and D, which one has bigger size?
- What is the family of elements of group 1 called?

Ans :

- Lithium A and C
- Magnesium
- A
- Alkali metals

353. The table given below shows the periodic table classification with four elements.

Group 1	Group 16	Group 17
	A	X
Z	B	Y

With reference of the above table answer the following

- What are the Group 16 elements called?
- What is the name of the element Z?
- Compare the atomic radius of elements B and Y?
- Which type of ion will be formed by element X?

Ans :

- Group 16 elements are called chalcogens.
- The name of the element Z is potassium.
- The atomic radius of elements B is bigger than Y, because in a period atomic radius decreases from left to right.
- The element X forms anion with a negative charge.

354. Study these table related to answer the questions that follow :

Element	Atomic Number
P	11
Q	17
R	6
S	19
T	15

- Which of the given elements can be cut with a knife?
- Which element can form an ionic compound with Q?

Ans :

- Element P (Na) can be cut with a knife.
- Element P (Na) can form an ionic compound with Q (Cl).

355. Four elements V, W, X, Y and Z along with their electronic configurations are given below :

Elements	V	W	X	Y	Z
Electronic configuration	2, 1	2, 2	2, 3	2, 4	2, 5

With reference of the above table answer the following

- Which one of the above element is a gas ?
- Which one of the element is the smallest in the above period?
- Identify the element X.
- Which one of the above element can form a large number of covalent compounds?

Ans :

- (i) Element Z is a gas with atomic number 7.
- (ii) Element Z is the smallest, because along the period the atomic radius decreases from left to right.
- (iii) Element X is boron.
- (iv) Element Y is carbon with atomic number 6, which can form a large number of covalent compounds.

356. Study the table and answer the four questions that follow.

The position of ten elements is shown in the periodic table.

1 Lithium	2 Beryllium	13 Boron	14 Carbon	15 Phosphorus
A	E	I		D
B	J	F		G
C		H		

- (i) Identify the elements which have similar physical and chemical properties as the element F.
- (ii) Identify the element I.
- (iii) Among the elements B, J, F and G which one has the smaller size?
- (iv) What is the family of elements of group 2 called?

Ans :

- (i) I and H
- (ii) Aluminium
- (iii) Element G
- (iv) Alkaline earth metals

357. The table given below shows the periodic table classification with four elements.

Group 15	Group 16
	X
Z	Y

- (i) State whether X is a metal or non-metal.
- (ii) State whether Y is more reactive or less reactive than X.
- (iii) Will X be smaller or larger in size than Y?
- (iv) Which type of ion will be formed by element Z?

Ans :

- (i) X is non-metal.
- (ii) Y is less reactive than X. As reactivity

decreases down the group.

- (iii) X is smaller in size. In a periodic table, atomic size increases down the group.
- (iv) Group 15 mostly form anions with charge negative 3.

358. Study the table and answer the four questions that follow. The position of six elements is shown in the periodic table.

Period → Group ↓	1	2
1	A	
2		
3-12		
13		D
14		E
15	B	
16		
17		
18	C	F

- (i) Which one of the above element will form covalent compounds?
- (ii) Name the element which is a non-metal with valency three.
- (iii) Out of D and E, which is smaller in size and why?
- (iv) Name the element which is a metal with valency three.

Ans :

- (i) Element E will form only covalent compounds which has valency four. It will form covalent compounds by sharing its four valence electrons.
- (ii) Element B is a non-metal with valency three.
- (iii) Element E is smaller than D, because, in a period, from left to right the nuclear charge increases. Hence, atomic radius decreases.
- (iv) Element D is a metal with valency 3.

359. Ionic bonding occurs between elements that have a large difference in electro-negativity. In ionic bonding a metal atom with a low electro-negativity loses electrons to form a positively charged ion or cation and a non-metal atom with a high electro-negativity gains electrons to form a negatively charged ion or anion. As a result, there is an electrostatic attraction between these ions which results in ionic bonding. This type of

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compounds formed are ionic compounds. The table below gives the electronic structure of pairs of elements A and B.

S. No.	Element A	Element B
1.	2, 1	2, 8, 7
2.	2, 6	2, 8, 8, 2
3.	2, 8, 1	2, 8, 6
4.	2, 8, 3	2, 7
5.	2, 5	2, 8, 2

- Find out the metals from the table.
- Write the formula of the compound formed in 1 and 3.
- Write any two properties of ionic compounds.

Ans :

- Element A $\rightarrow$ 1, 3, 4, Element B $\rightarrow$ 2, 5
- Compounds formed in 1 and 3 are AB and A_2B respectively.
- (a) Ionic compounds have high melting point and boiling point.
(b) Ionic compounds are soluble in water.

360. The positions of three elements A, B, C and D in the periodic table are shown below :

Groups $\rightarrow$ Periods $\downarrow$	1	2	3
I	A		
II			C
III	D	B	

- Why is element A a metal?
- Why element B has larger size than C?
- Why element C has a valency-3?
- Why element D is more reactive than A?

Ans :

- Element A is a metal because it is present in the group 1 which has one valence electron and can lose one electron easily.
- Element B has larger size than C because it has more number of shells than C.
- Element C is placed in the group 3, which has three valence electrons.
- Element D is more reactive than A, because down the group reactivity increase.

361. Study these table related to answer the questions that follow :

Element	Atomic Number	Electronic Configuration
A	11	2, 8, 1
B	13	2, 8, 3
C	19	2, 8, 8, 1
D	20	2, 8, 8, 2
E	17	2, 8, 7

- Which of the given elements are non-metals?
- Which element can form amphoteric oxide?

Ans :

- Element E is a non-metal.
- Element B can form amphoteric oxide, i.e. Al_2O_3 .

362. Study these table related to answer the questions that follow :

S. No.	Element	Atomic Number
1.	A	18
2.	B	19
3.	C	17
4.	D	9
5.	E	6

- Which element exhibits catenation?
- Which element has the highest electronegativity?

Ans :

- Element E exhibits catenation as it shares its four electrons to form bonds.
- Both elements C and D are electronegative. Between C and D, D is more electronegative due to smaller size.

363. A non-metal A is an important constituent of our food and forms two oxides B and C. Oxide B is toxic whereas C causes global warming. An element E combines with O_2 to form an oxide E_2O which is a good conductor of electricity.

- Identify A, B and C.
- To which group of periodic table does A belong?
- How many electrons will be present in the outermost shell of E?
- Write the formula of the compound formed when E combines with chlorine.

Ans :

- (i) A is carbon, B is carbon monoxide and C is carbon-dioxide.
- (ii) Carbon has atomic number 6. Its electronic configuration is 2, 4. It is present in group 14 of the periodic table.
- (iii) Valency of element E is (+)1. This means that it has one electron in the valence shell.
- (iv) $E^+ + Cl^- \longrightarrow ECl$
Valency of Cl is (-)1, while that of E is (+)1. Therefore, the formula will be ECl.

364. Study these table related to atomic number and electronic configuration and answer that follows

Table – A

Element	Atomic number	Electronic Configuration
H	1	1
He	2	2
Li	3	2, 1
Be	4	2, 2
B	5	2, 3

Table – B

Student	Element	Electronic configuration
Student A	C	2, 4
	N	2, 5
	O	2, 6
Student B	F	2, 7
	Ne	2, 7
	Na	2, 8, 1

- (i) In the table B which student write the incorrect electronic configuration and write the its name?
- (ii) How many cells are used to write the electronic configuration of element?

Ans :

- (i) Student B, Ne
(ii) four (K, L, M, N)

365. The periodic table of chemical elements, often called the periodic table, organizes all discovered chemical elements in rows (called periods) and columns (called groups) according to increasing atomic number. Scientists use the periodic table to quickly refer to information about an element, like atomic mass and chemical symbol. The periodic table's arrangement also allows scientists

to discern trends in element properties, including electro-negativity, ionization energy, and atomic radius. Atomic radii of the elements of the second period are given as follows :

Period II elements	B	Be	O	N	Li	C
Atomic radius (pm)	88	111	66	74	152	77

- (i) Arrange them in decreasing order of their atomic radii.
- (ii) Are the elements now arranged in the pattern of a period in the periodic table ?
- (iii) Which elements have the largest and smallest atoms ?
- (iv) How does the atomic radius change as you go left to right in a period ?

Ans :

(i)

Li	Be	B	C	N	O
152	111	88	77	74	66

- (ii) Yes.
- (iii) Largest atoms : Li, Smallest atoms : O
- (iv) The atomic radius decreases as we go left to right in a period.

366. Scientists use the periodic table to quickly refer to information about an element, like atomic mass and chemical symbol. The periodic table's arrangement also allows scientists to discern trends in element properties, including electro-negativity, ionization energy, and atomic radius. The variations in the atomic radii of first group elements given below

Group I : elements	Na	Li	Rb	Cs	K
Atomic : radius (pm)	86	152	244	262	231

- (i) Arrange them in an increasing order.
- (ii) Name the elements which-have the smallest and the largest atoms.
- (iii) How does the atomic size vary as you go down a group?

Ans :

(i)

Na	Li	Rb	Cs	K
86	152	244	262	231

- (ii) Smallest atom : Na (Sodium)
Largest atom : Cs (Cesium)
- (iii) Atomic size increases as we go down a group.

367. In order to fit elements into his table, Newland adjusted two elements in the same slot, but also put some unlike elements under the same note. Newlands' law of octaves worked well with lighter elements only.

- How many elements the Newlands' assumed that existed in nature ?
- Name two unlike elements which were placed together in the Newlands' periodic table.
- Up to which elements, the Newlands' law of octaves is applicable. What is the electronic configuration of their element ?
- State Newlands' law of octaves.

Ans :

- 56 elements.
- Cobalt and nickel were placed along with fluorine and chlorine. Cobalt and nickel are metals while fluorine and chlorine are non-metals and they have totally different properties.
- Newlands' law of octaves is applicable up to calcium and the electronic configuration of calcium is 2, 8, 8, 2.
- The Newlands 'law of octaves' states that. If elements are arranged in order of increasing atomic masses, the properties of the every eighth element is a repetition of the first one, just like the notes of music.

368. Mendeleev was the most important contributor to the early development of a Periodic table of elements where in the elements were arranged on the basis of their fundamental property, the atomic mass and also on the similarity of chemical properties.

- Why Mendeleev studied compounds formed by elements with oxygen and hydrogen ?
- Sodium (Na) and Potassium (K) were placed together with same vertical column by Mendeleev. Write the chemical formula of oxide of sodium and hydroxide of potassium.
- How many elements were known at the time of Mendeleev ?
- State Mendeleev's periodic law.

Ans :

- He selected hydrogen and oxygen as they are very reactive and formed compounds with most elements.
- Sodium Oxide : Na_2O
Potassium Hydride : KH
- 63 elements were known at the time of Mendeleev.

(iv) Mendeleev's periodic law states that 'the properties of elements are the periodic function of their atomic masses'.

369. While developing the periodic table, there were a few instances while Mendeleev had to place an element with slightly greater atomic mass before and element with a slightly lower atomic mass. Mendeleev also left some gaps in his periodic table.

- Name the element discovered later which shows same properties as eka-boron.
- Why does he left some gaps in the periodic table ?
- Give one pair of elements in Mendeleev periodic table where the elements with higher atomic mass was placed before an element with a slightly lower atomic mass.
- Why he placed elements with greater atomic mass before and element with a slightly lower atomic mass ?

Ans :

- Scandium is an eka-boron element, has same properties as boron.
- He left some gaps for the elements that had not been discovered at that time.
- Cobalt (atomic mass: 58.9) was placed before nickel (atomic mass: 58.7) in the Mendeleev's Periodic Table.
- This was done so that elements with similar properties could be grouped together.

370. Henry Moseley showed that the atomic number of an element is a more fundamental property than its atomic mass. Elements, when arranged in order of increasing atomic number gives Modern Periodic Table. Prediction of properties of elements could be, made with more precision when elements were arranged on the basis of increasing atomic number.

- How were the positions of cobalt and nickel resolved in the Modern Periodic Table ?
- How were the positions of isotopes of various elements decided in the Modern Periodic Table ?
- State Modern Periodic Law.
- Why atomic number was chosen as a fundamental property to classifying elements?

Ans :

- Although cobalt has a slightly higher atomic mass than nickel, but cobalt has a lower atomic number ($Z = 27$) than nickel ($Z = 28$)

. That's why cobalt was placed before nickel in the Modern Periodic Table.

- (ii) Isotopes are the atoms of the same elements having same atomic number, so all isotopes of the given element will occupy the same position in the Modern Periodic Table.
- (iii) Modern Periodic Law states that 'Properties of elements are a periodic function of their atomic number'.
- (iv) Atomic number gives the number of protons in the nucleus of an atom and their number increases by one in going from one element to the next. That's why the atomic number was chosen as a fundamental property.

371. The position of an element in the Modern Periodic Table can be predicted with the help of electronic configuration. The element in the periodic table show various trends in atomic size, metallic character, electro-positivity and valence etc.

- (i) Identify the elements having the same valency.
Mg ($Z = 12$), Ca ($Z = 20$), Cl ($Z = 17$)
- (ii) Arrange the following elements in order of their increasing size Al, Ca, Na, Mg.
- (iii) Write the electronic configuration of fluorine ($Z = 9$) and write its valence.
- (iv) Identify the group number and period number of sodium ($Z = 11$), Calcium ($Z = 20$).

Ans :

- (i) Mg ($Z = 12$) 2, 8, 2 (two valence electron)
Ca ($Z = 20$) 2, 8, 8, 2 (two valence electron)
Cl ($Z = 17$) 2, 8, 7 (seven valence electron)
Mg and Ca will have same valence.
- (ii) $Al < Mg < Na < Ca$
Atomic size increases down the group and decreases across the period from left to right.
Mg is larger in size than Al, therefore, Mg and lose electrons more easily than Al. Hence, Mg is more metallic than Al.
- (iii) F ($Z = 9$), 2, 7, the value of F is 1.
- (iv)

		Group No.	Period No.
Sodium ($Z = 11$)	2, 8, 1	1	3
Calcium ($Z = 20$)	2, 8, 8, 2	2	4

CHAPTER 2

CHEMICAL BONDING

SUMMARY

1. ATOM

An atom is electrically neutral. The number of positively charged particles (i.e. protons) are equal to the number of negatively charged particles (i.e. electrons). Every atom tries to attain the stable electronic configuration of nearest inert gas, i.e. eight electrons in the valence shell (except helium which is having 2 electrons in the valence shell). Atom attains the stable electronic configuration by either losing, gaining or sharing electrons.

1.1 Ion

When an atom loses or gains electron(s), it gets converted to electrically charged particle called an ion.

1.2 Cation

When an atom loses electron, it gets converted to positively charged particle called cation.

1.3 Anion

When an atom gains electron, it gets converted to negatively charged particle called anion.

2. ELECTRO-POSITIVE ELEMENTS

The elements which easily lose electrons and acquire positive charge are called electro-positive elements. Metals are electro-positive elements. For example,

Na^+ , K^+ , Ca^{2+} , Mg^{2+} , Al^{3+} , etc.

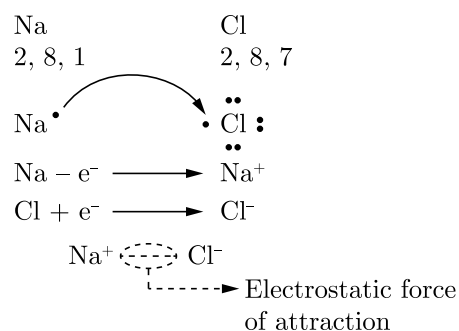
3. ELECTRONEGATIVE ELEMENTS

The elements which easily gain electrons and acquire negative charge are called electronegative elements. Non-metals are electronegative elements. For Example,

Cl^- , Br^- , I^- , F^- , O^{2-} , S^{2-} , N^{3-} , etc.

4. IONIC BOND

The bond formed as a result of transfer of electrons from the outermost shell of a metal to the outermost shell of a non-metal is called an ionic bond or electrovalent bond. Ionic bonds are formed between metals and non-metals. Metals lose electrons and non-metals gain electrons.



As a result of transfer of electron(s), ions are formed which are held by strong electrostatic force of attraction. The metals participating in an ionic bond formation should have low ionisation potential. The non-metals participating in an ionic bond formation should have high electron affinity.

The chemical compounds formed as a result of the transfer of electrons from the outermost shell of a metal to the outermost shell of non-metal are called ionic or electrovalent compounds. The compounds formed by the transference of electrons are called Ionic or electrovalent compounds.

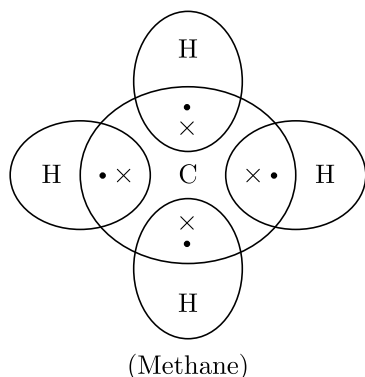
5. COVALENT BOND

The bond formed as a result of mutual sharing of electrons is called covalent bond. The covalent bond formation takes place between two non-metallic elements. When the same or different non-metallic atoms present in groups 14, 15, 16 and 17 of periodic table combine together, covalent bonds are formed.

Both the atoms participating in covalent bond formation should have high electro-negativity, high ionisation energy and high electron affinity.

During covalent bond formation, ions are not formed, only molecules are formed.

1. **Non-polar covalent compounds:** The covalent compounds in which the combining elements have no or very slight difference in their electro-negativities are called non-polar covalent compounds.

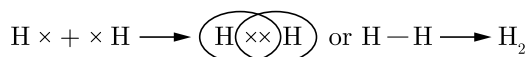


Example : H_2 , Cl_2 , N_2 , O_2 .

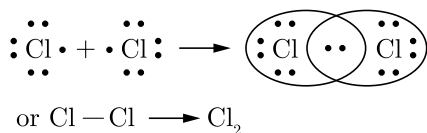
All hydrocarbons are non-polar covalent compounds, e.g. methane (CH_4), ethane (C_2H_6), ethyne (C_2H_4), ethyne (C_2H_2) and carbon tetrachloride (CCl_4).

- (i) A single covalent bond is formed by the sharing of one pair of electrons between atoms, each of which contributes only one electron. It is denoted by putting a single short line (—) between the two atoms.

(a) Formation of hydrogen molecule ($H = 1$)



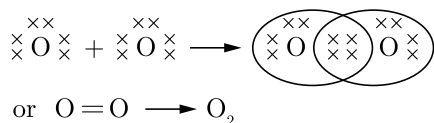
- (b) Formation of chlorine molecule ($Cl = 2, 8, 7$)



- (ii) A double covalent bond is formed by the sharing of two pairs of electrons between the two atoms each of which contributes two electrons. A double covalent bond is denoted by putting two short lines $\equiv$ between the two atoms.

Example :

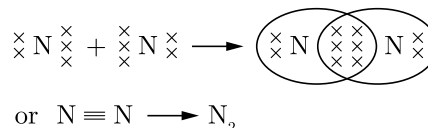
Formation of oxygen molecule ($O = 2, 6$)



- (iii) A triple covalent bond is formed by the sharing of three pairs of electrons between the two atoms each of which contributes three electrons. A triple covalent bond is denoted by putting three short lines ($\equiv$) between the two atoms.

Example :

Formation of nitrogen molecule ($N = 2, 5$)

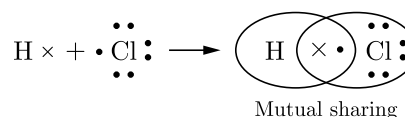


2. **Polar covalent compounds:** The covalent compounds in which the combining elements have comparatively large difference in their electro-negativities are called polar covalent compounds.

Example :

Hydrogen chloride gas (HCl), water (H_2O) and ammonia (NH_3).

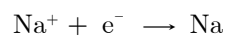
In case of hydrogen chloride gas, chlorine is more electronegative than hydrogen, therefore chlorine attracts the shared pair of electrons towards its side. Hence, chlorine acquires a partial negative charge and hydrogen acquires a partial positive charge. Thus, the bond becomes polar.



Chlorine is more electronegative than hydrogen

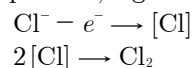
6. REDUCTION

Reduction is the process of gain of electrons. It takes place at cathode. During reduction, cation gains electrons and gets converted to neutral particle, e.g.



7. OXIDATION

Oxidation is the process of loss of electrons. It takes place at anode. During oxidation; anion loses electrons and gets converted to neutral particle, e.g.

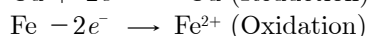
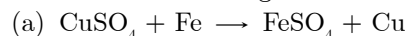


8. OXIDISING AGENTS AND REDUCING AGENT

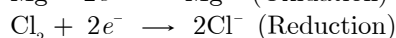
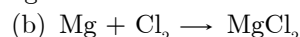
Oxidising agents are electron acceptors. Non-metals are oxidising agents.

Reducing agent during the reaction gets oxidised and oxidising agent during the reaction gets reduced.

Consider the following reaction:



Copper ion gets reduced and iron metal gets oxidised, thus copper sulphate is an oxidising agent and iron is a reducing agent.

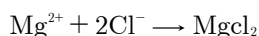
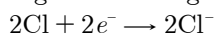
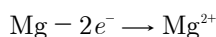
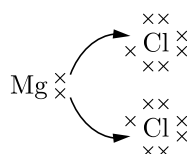
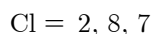
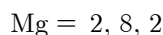


Magnesium is getting oxidised and chlorine is getting reduced, thus magnesium is the reducing agent and chlorine is the oxidising agent.

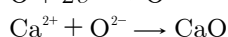
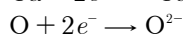
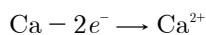
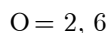
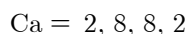
9. STRUCTURES OF A FEW ELECTROVALENT COMPOUNDS

The structures of a few electrovalent compounds are given below :

1. Magnesium chloride



2. Calcium oxide

**10. THE STRUCTURES OF A FEW COVALENT MOLECULES**

The structures of a few covalent molecules are given below.

1. Hydrogen (H_2) or $\text{H} - \text{H}$

A single covalent bond is formed between two hydrogen atoms to form a hydrogen molecule.

2. Chlorine (Cl_2) or $\text{Cl} - \text{Cl}$

A single covalent bond is formed between two chlorine atoms to form a chlorine molecule.

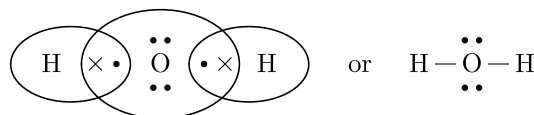
3. Nitrogen (N_2) or $\text{N} \equiv \text{N}$

A triple covalent bond is formed between two nitrogen atoms to form a nitrogen molecule.

4. Oxygen (O_2) or $\text{O} = \text{O}$

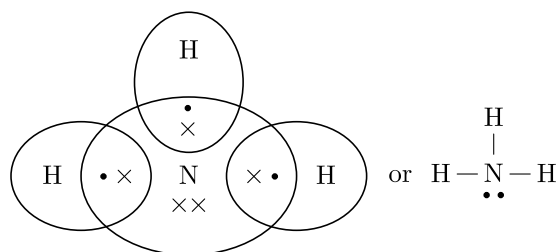
A double covalent bond is formed between two oxygen atoms to form an oxygen molecule.

5. Water (H_2O)



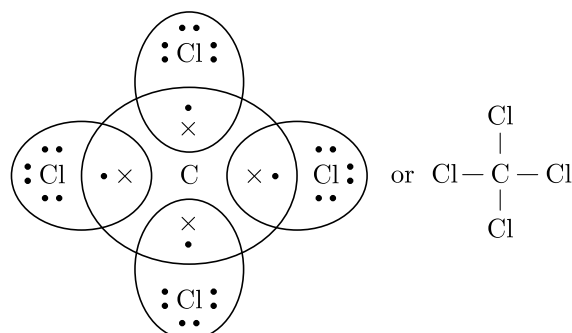
Oxygen atom has electronic configuration 2,6. It has six electrons in its valence shell and achieves octet by sharing two electrons, one each with hydrogen atom.

6. Ammonia (NH_3)



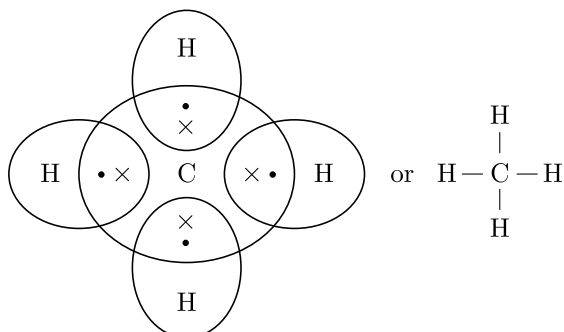
Nitrogen atom have five electrons in its valence shell and can achieve octet (stable configuration) by sharing three electrons, one each with three hydrogen atoms.

7. Carbon tetrachloride (CCl_4)



Carbon has four valence electrons. It can achieve octet by sharing four electrons one each with four chlorine atoms.

8. Methane (CH_4)



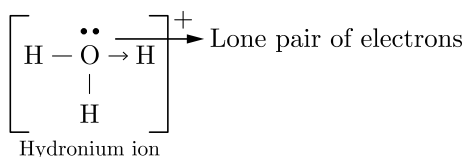
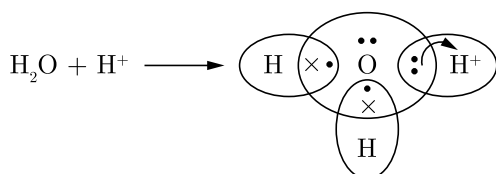
Carbon atom has four electrons in its valence shell. In order to complete its octet, it shares four electrons, one each with four hydrogen atoms.

A pair of electrons which does not take part in bond formation is called as lone pair of electrons.

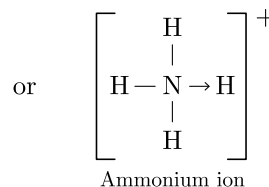
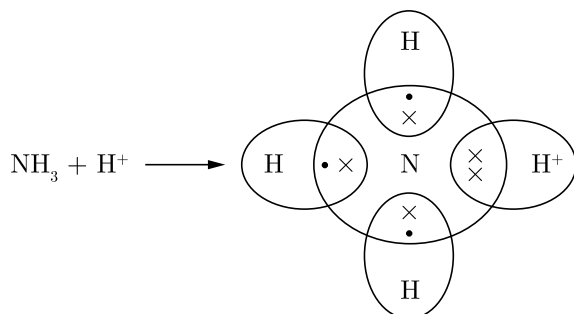
11. COORDINATE OR DATIVE BOND

The bond in which the sharing of electrons takes place on the part of entirely one atom is called coordinate or dative bond.

- The formation of hydronium ion (H_3O^+) takes place by coordinate bond.



- The formation of ammonium ion (NH_4^+) also takes place by coordinate bond.



MULTIPLE CHOICE QUESTION

- In the molecule of water, oxygen atom has:
 - One shared pair of electrons.
 - Three shared pair of electrons.
 - Two lone pairs of electrons.
 - One lone pair of electrons.

Ans :

MAIN 2024

Oxygen has six electrons in its valence shell. So, it shares two electrons with the two hydrogen atoms to form the H_2O molecule and the remaining four electrons do not take part in bonding is called lone pair of electrons. Therefore, in water molecule oxygen has two bond pairs and two lone pairs of electrons.

Thus (c) is correct option.

The table shows the electronic configuration of four elements.

Element	Electronic configuration
W	2, 6
X	2, 8
Y	2, 8, 1
Z	2, 8, 7

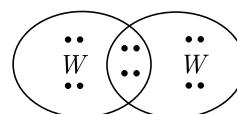
Which pair of atoms will form a covalent compound?

- Two atoms of W.
- Two atoms of X.
- An atom of W and atom of X.
- An atom of Y and an atom of Z.

Ans :

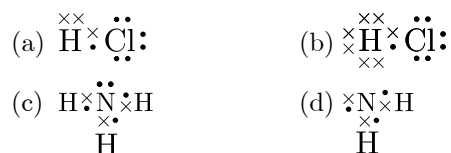
SQP 2021

In the given table configuration of W is 2, 6. So, it needs two electrons to complete its octet. Thus two W-atoms shares their two pairs of electrons of form W_2 covalent compound.



Thus (a) is correct option.

3. Which electron arrangement for the outer shell electrons in a covalent compound is correct?



Ans :

MAIN 2021

Thus (c) is correct option.

4. A compound with low boiling point, is :

- (a) Sodium chloride
(b) Calcium chloride
(c) Potassium chloride
(d) Carbon tetrachloride

Ans :

COMP 2020

CCl_4 is a covalent compound, rest all are ionic compounds, thus it has low melting and boiling point.

Thus (d) is correct option.

5. The most electronegative element from the following elements is :

- (a) Magnesium (b) Chlorine
(c) Aluminium (d) Sulphur

Ans :

SQP 2019

Electronegativity increases from left to right across a period. Among, magnesium, chlorine, aluminium and sulphur, chlorine is at extreme right. Hence, chlorine is the most electronegative element.

Thus (b) is correct option.

6. Which of the following is a common characteristic of a covalent compound?

- (a) High melting point
(b) Consist of molecules
(c) Always soluble in water
(d) Conducts electricity when it is in the molten state

Ans :

COMP 2017

The common characteristic of a covalent compound is consists of molecules.

Thus (b) is correct option.

7. An element with the atomic number 19 will most likely combine chemically with the element whose atomic number is:

- (a) 17 (b) 11
(c) 18 (d) 20

Ans :

MAIN 2016

An element with the atomic number 19 is potassium (K) and is likely to combine chemically with an element with the atomic number 17, which is chlorine (Cl).

Thus (a) is correct option.

8. A compound X consists of only molecules. Hence, X will have:

- (a) A crystalline hard structure
(b) A low melting point and low boiling point
(c) An ionic bond
(d) A strong force of attraction between its molecules.

Ans :

SQP 2014

Compound X has a molecule means it is formed with the atom of the same element. So it will have a covalent bond. In a covalent bond because of weak intermolecular force, the boiling and melting point is low.

Thus (b) is correct option.

9. The molecule containing a triple covalent bond is

- (a) nitrogen (b) methane
(c) water (d) ammonia

Ans :

MAIN 2014

The atomic number of nitrogen is 7 with the electronic configuration 2, 5. In order to complete its octet it needs 3 electrons. Now, both the atoms of nitrogen needs 3 electrons each to become stable. Hence, they share 3 electrons with each other and forms triple covalent bonds. As the bond is formed by the sharing of electrons it is known as covalent bond.

Thus (a) is correct option.

10. Which of the following is not a typical property of an ionic compound?

- (a) High melting point.
(b) Conducts electricity in the molten and in the aqueous solution state.
(c) They are insoluble in water.
(d) They exist as oppositely charged ions even in the solid state.

Ans :

COMP 2013

Ionic compounds do not typically conduct electricity in solid state. They can conduct electricity when molten or dissolved in water because the ions can move freely.

Thus (c) is correct option.

11. Among the following compounds, identify the compound that has all three bonds (ionic, covalent and coordinate bond).

(a) Ammonia
(b) Ammonium chloride
(c) Sodium hydroxide
(d) Calcium chloride

Ans :

SQP 2000

Ammonium chloride contains ionic, covalent and coordinate bond.

Thus (b) is correct option.

12. Which of the following is not a common characteristic of an electrovalent compound ?

(a) High melting point.
(b) Conducts electricity when molten.
(c) Consists of oppositely charged ions.
(d) Ionises when dissolved in water.

Ans :

COMP 2008

Ionises when dissolved in water is not a common characteristic of an electrovalent compound.

Thus (d) is correct option.

13. Which of the following does not have a co-ordinate bond?

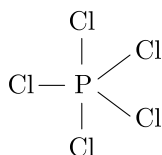
(a) PCl_5 (b) H_3O^+
(c) O_3 (d) HNO_3

Ans :

MAIN 2018

PCl_5 is made by simple covalent bonds. All other contain at least one coordinate bond.

The structure of PCl_5 is as follow :



Thus (a) is correct option.

14. Process of decomposing a compound with the help of electricity.

(a) Photosynthesis
(b) Photolysis
(c) Electrolysis
(d) None of the above

Ans :

SQP 2017

The process of breaking down a compound using electricity is called electrolysis. Electrolysis uses direct electric current (DC) to pass through a chemical compound, or electrolyte, causing a

chemical change that breaks down the compound's bonds. During electrolysis, molecules break down into ions.

Thus (c) is correct option.

15. Hydrogen without any electron is :

(a) Deuterium (b) Protium
(c) Tritium (d) None of these

Ans :

COMP 2016

A hydrogen atom without an electron is called a hydrogen ion or proton. When a hydrogen atom loses its electron, only the nucleus remains, which contains a proton. The positively charged hydrogen ion is extremely reactive and has a very short lifetime in aqueous solutions.

Thus (d) is correct option.

16. The property which is characteristic of an electrovalent compound is that :

(a) it is easily vaporized.
(b) it often exists as a liquid.
(c) it is a weak electrolyte
(d) it has a high melting point.

Ans :

MAIN 2011

The property is characteristic of an electrovalent compound is that it has a high melting point.

Thus (d) is correct option.

17. Covalent bonds are hence they show isomerism.

(a) non-directional (b) polar
(c) directional (d) non-polar

Ans :

SQP 2005

Covalent bonds are directional in nature. Therefore, they exhibit the phenomenon of isomerism. Covalent compounds majorly have a very slow rate of reactions, unlike the various ionic compounds.

Thus (c) is correct option.

18. Double covalent bond is formed by sharing electrons.

(a) One pairs of (b) four pairs of
(c) Three pairs of (d) two pairs of

Ans :

SQP 2008

A double covalent bond is formed when two pairs of electrons are shared between them. For example, in an oxygen molecule, there is a double bond between two oxygen atoms as they share two pairs of electrons i.e. 4 electrons.

Thus (d) is correct option.

19. A pair of electron which is not shared with another atom.

(a) Lone pair (b) Bond pair
(c) Ionic bond (d) Hydrogen bond

Ans :

COMP 2010

In chemistry, a pair of valence electrons that are not shared with another atom in a covalent bond is called a lone pair

Thus (a) is correct option.

20. Which of the following does not conduct electricity?

(a) Molten NaOH (b) Molten KOH
(c) Aqueous NaCl (d) Solid NaCl

Ans :

SQP 2000

As, attractive force between ions in solid state are very strong and ions are not free to move, therefore they do not conduct electricity in solid state.

NaCl (solid) is an ionic solid hence, do not conduct electricity.

Thus (d) is correct option.

21. The electronic configurations of four elements

L : $1s^2, 2s^2, 2p^4$

Q : $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

P : $1s^2, 2s^2, 2p^6, 3s^1$

R : $1s^2, 2s^2, 2p^6, 3s^2$

The formulae of ionic compounds that can be formed between them are

(a) P_2L , RL, PQ, RQ_2
(b) LP, RL, PQ, RQ
(c) L_2P , RL, PQ, R_2Q
(d) LP, R_2L , P_2Q , RQ

Ans :

MAIN 2004

Given,

L has $\rightarrow$ 6 valence electrons

Q has $\rightarrow$ 7 valence electrons

P has $\rightarrow$ 1 valence electron

R has $\rightarrow$ 2 valence electrons

Thus, the ionic compounds formed between them are P_2L , RL, PQ and RQ_2 .

Thus (a) is correct option.

22. What kind of bond is formed between the metallic and non-metallic element?

(a) Coordinate bond (b) Ionic bond
(c) Covalent bond (d) None of these

Ans :

MAIN 2015

The bond formed when a metallic element combines with a non-metallic element is called an ionic bond.

Thus (b) is correct option.

23. Negative ions are known as

(a) Cations (b) Fermions
(c) Anions (d) None of these

Ans :

SQP 2020

Ions with a negative charge are called anions.

Thus (c) is correct option.

24. A particular solution contains molecules and ions of the solute so it is a :

(a) strong acid (b) weak acid
(c) Redox (d) salt solution

Ans :

COMP 2023

A solution that contains both molecules and ions of the solute is a weak acid. Weak acids are partially dissociated and contain both unionized molecules and ions. They are also weak electrolytes, meaning they are poor conductors of electricity and only allow small amounts of current to flow through them.

Thus (b) is correct option.

25. Polarity of a molecule depends on its difference.

(a) size difference (b) electron affinity
(c) electropositivity (d) electro-negativity

Ans :

SQP 2014

Polarity of a bond depends on the difference in the electronegativity of the bonded atoms. The higher the difference in the electronegativity, the higher will be the polarity of the bond. A polar bond is formed between two atoms of different electronegativity.

Thus (d) is correct option.

26. A compound having one lone pair of electrons :

(a) Ammonia
(b) Methane
(c) Water
(d) Carbon tetrachloride

Ans :

MAIN 2017

Nitrogen in ammonia has one lone pair.

Thus (a) is correct option.

27. Sodium and chloride ions are held together by strong

- (a) Electrostatic force of Repulsion
- (b) Covalent bonds
- (c) Hydrogen bonds
- (d) Electrostatic forces of attraction

Ans :

SQP 2000

In an ionic bond, the two oppositely charged ions are held together by strong electrostatic force of attraction.

Thus (d) is correct option.

- 28.** A reaction in which oxidation and reduction takes place simultaneously.
- (a) Decomposition reaction
 - (b) Redox reaction
 - (c) Oxidation reaction
 - (d) Displacement reaction

Ans :

MAIN 2018

Those reactions in which oxidation and reduction takes place simultaneously are known as redox reactions.

Thus (b) is correct option.

- 29.** In a covalent solid, the lattice points are occupied by
- (a) ions
 - (b) atoms
 - (c) molecule
 - (d) electrons

Ans :

COMP 2011

In a covalent solid, atoms occupy the lattice points.

Thus (b) is correct option.

- 30.** Ionic compounds in general possess both
- (a) high solubility in polar and non-polar compounds
 - (b) high melting point and low boiling points
 - (c) directional bonds and low boiling points
 - (d) high melting point and non-directional bonds

Ans :

SQP 2023

Species made by ionic bonds are non-directional and of high melting point due to formation of bonds between ions (cation and anion). These bond can be made by all directions, thus are non-directional and offer strong attractive forces, thus are of high melting point.

Thus (d) is correct option.

- 31.** In the liquid state, X will :
- (a) become ionic
 - (b) not conduct electricity
 - (c) conduct electricity
 - (d) be an electrolyte

Ans :

COMP 2022

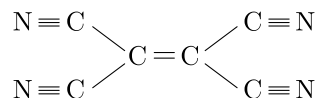
In the liquid state, X will not conduct electricity. Thus (b) is correct option.

- 32.** The total number of double and triple bonds in the structure, $(\text{CN})_2\text{C} = \text{C}(\text{CN})_2$ are
- (a) 1
 - (b) 5
 - (c) 9
 - (d) Unpredictable

Ans :

SQP 2007

Structure of $(\text{CN})_2 \cdot \text{C} = \text{C}(\text{CN})_2$ is



Thus, there are four (4) triple and one double bond is present in the given compound i.e., in total = 4 + 1 = 5

Thus (b) is correct option.

- 33.** NH_3 and BF_3 form adduct readily because they form
- (a) co-ordinate bond
 - (b) covalent bond
 - (c) ionic bond
 - (d) hydrogen bond

Ans :

COMP 2009

As, N-atom in NH_3 contain lone pair of electrons and B atom in BF_3 contain an empty orbital, thus they can form a coordinate bond to give an adduct.

Thus (a) is correct option.

- 34.** Bonding in this molecule can be understood to involve coordinate bonding.
- (a) Carbon tetrachloride
 - (b) Hydrogen
 - (c) Ammonium chloride
 - (d) Hydrogen chloride

Ans :

SQP 2010

The bond formed between the nitrogen atom in ammonia and the chloride ion is a coordinate bond.

Thus (c) is correct option.

- 35.** Compounds which do not allow electric current to pass through them.
- (a) Conductors
 - (b) Reductors
 - (c) Oxidants
 - (d) Bad Conductors or Insulators

Ans :

COMP 2015

Insulators are the substances that do not allow electricity to pass through them. Examples of

insulators are wax, wood, mud and plastic etc.
Thus (d) is correct option.

36. When a metallic atom becomes anion ?

- (a) It gains electrons and is oxidised.
- (b) It gains electrons and is reduced.
- (c) It loses electrons and is oxidised.
- (d) It loses electrons and is reduced.

Ans :

MAIN 2019

A metallic atom becomes an anion when it gains one or more electrons, giving it a negative charge. This is in contrast to metallic atoms losing electrons to form cations, which are positive ions. Thus (c) is correct option.

37. Positively charged hydrogen atom is known as

- (a) Proton
- (b) Deuterium
- (c) Neutron
- (d) Tritium

Ans :

COMP 2011

A positively charged hydrogen atom is called a proton, which is a subatomic particle with a positive electric charge. Thus (a) is correct option.

38. Cation and anion get stabilised by achieving configuration.

- (a) Inert Gas
- (b) Ionic
- (c) Similar
- (d) Stable

Ans :

MAIN 2015

Cations and anions achieve stability by attaining a noble gas configuration. This means they gain or lose electrons to get as close as possible to the electron configuration of the nearest noble gas. Thus (a) is correct option.

39. Hydrogen molecule shares pair of electron.

- (a) two
- (b) one
- (c) three
- (d) none of the above

Ans :

SQP 2017

A hydrogen molecule shares one pair of electrons with another hydrogen atom to form a single bond.

Thus (b) is correct option.

40. The bond between oxygen atoms in a molecule is

- (a) single covalent bond
- (b) ionic bond
- (c) triple covalent bond
- (d) double covalent bond

Ans :

MAIN 2009

The two oxygen atoms share two pairs of electrons,

so two covalent bonds hold the oxygen molecule together.

Thus (d) is correct option.

41. Which of the following is incorrect about a coordinate bond?

- (a) A co-ordinate bond is non-directional in nature.
- (b) A co-ordinate bond is also called a semi-polar bond.
- (c) A co-ordinate bond once formed cannot be distinguished from a covalent bond.
- (d) Due to co-ordinate bond, the formal charges on donor and acceptor atoms are positive and negative, respectively.

Ans :

COMP 2007

Coordinate bond between two atoms will form in specific direction, thus are not non-directional. Thus (a) is correct option.

42. A substance which oxidises other compounds and itself gets reduced.

- (a) Inhibitor
- (b) Reducing agent
- (c) Catalyst
- (d) Oxidising agent

Ans :

SQP 2005

A substance which oxidises itself and reduces other is known as a reducing agent.

Thus (b) is correct option.

43. Number of lone pairs present in water.

- (a) Two
- (b) One
- (c) Three
- (d) None

Ans :

MAIN 2010

A water molecule consists of two bonding pairs and two lone pairs.

Thus (a) is correct option.

44. Greater is the difference, stronger is the bond formed.

- (a) Electro-valency
- (b) Electropositivity
- (c) Electronegativity
- (d) Electron Affinity

Ans :

COMP 2015

Greater electronegativity difference results in a stronger ionic bond. The polarity of a bond is also determined by the difference in electronegativity between the bonded atoms.

Thus (c) is correct option.

45. In symbols the electrons present are represented with the help of dots.

- (a) Empirical
- (b) Lewis
- (c) Skeletal
- (d) Condensed

Ans :

MAIN 2017

Lewis symbols or Lewis dot structure represents valence electrons of an atom.

Thus (b) is correct option.

46. The property which is characteristic of an electrovalent compound is that :

- (a) it is easily vaporised
- (b) it has a high melting point
- (c) it is a weak electrolyte
- (d) it often exists as a liquid

Ans :

SQP 2006

The property is characteristic of an electrovalent compound is that it has a high melting point .

Thus (b) is correct option.

47. When a metal atom becomes an ion :

- (a) it loses electrons and is oxidised.
- (b) it gains electrons and is reduced.
- (c) it gains electrons and is oxidised.
- (d) it loses electrons and is reduced.

Ans :

COMP 2007

When a metal atom loses an electron, it becomes positively charged. Ion is an atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

Thus (a) is correct option.

ASSERTION AND REASON

48. **Assertion :** Ionic compounds have high melting points.

Reason : Ionic compounds consist of ions held together by strong electrostatic forces.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

SQP 2012

Ionic compounds have high melting points because the strong electrostatic forces between the oppositely charged ions require a significant amount of energy to break.

Thus (a) is correct option.

49. **Assertion :** Covalent compounds generally have low melting and boiling points.

Reason : Covalent compounds are made up of molecules held together by weak Van der Waals forces.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

MAIN 2015

In covalent compounds, the intermolecular forces (Van der Waals forces) are weak compared to ionic or metallic bonds, resulting in low melting and boiling points.

Thus (a) is correct option.

50. **Assertion :** Water is a polar molecule.

Reason : Water has a bent molecular shape and an unequal distribution of electrons.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

COMP 2002

Water is polar due to its bent shape and the difference in electronegativity between hydrogen and oxygen, leading to an unequal distribution of electrons.

Thus (a) is correct option.

51. **Assertion :** Hydrogen bonding leads to higher boiling points in compounds like water.

Reason : Hydrogen bonding is a type of strong dipole-dipole attraction that occurs between molecules.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

SQP 2008

Hydrogen bonds are strong dipole-dipole interactions that significantly increase the boiling points of compounds such as water.

Thus (a) is correct option.

52. Assertion : Metallic bonds are strong.

Reason : In metallic bonds, electrons are delocalized and can move freely throughout the metal lattice.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

SQP 2020

Metallic bonds are strong because the delocalized electrons create a strong attraction between the positively charged metal ions, forming a stable structure.

Thus (a) is correct option.

53. Assertion : Diamond is a good conductor of electricity.

Reason : Diamond has a three-dimensional network of covalent bonds.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

MAIN 2011

Diamond, despite having a strong three-dimensional network of covalent bonds, is not a good conductor of electricity because it lacks free electrons.

Thus (c) is correct option.

54. Assertion : Graphite is a good lubricant.

Reason : Graphite has layers of carbon atoms that can slide over each other easily.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.

- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

COMP 2015

Graphite's structure consists of layers of carbon atoms held together by weak Van der Waals forces, allowing them to slide over each other and act as a lubricant.

Thus (a) is correct option.

55. Assertion : The bond in an oxygen molecule (O_2) is a double bond.

Reason : Oxygen has six electrons in its outer shell and shares two pairs of electrons to achieve stability.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

MAIN 2017

Oxygen forms a double bond by sharing two pairs of electrons, allowing each oxygen atom to achieve a stable electronic configuration.

Thus (a) is correct option.

56. Assertion : Noble gases do not form compounds easily.

Reason : Noble gases have a complete outer shell of electrons.

- (a) Assertion and reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true
- (d) Assertion is true, but reason is false.

Ans :

COMP 2018

Noble gases have a full valence shell, making them chemically inert and unlikely to form compounds under normal conditions.

Thus (a) is correct option.

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ONE MARK QUESTIONS

DIRECTION : Name the following :

- 57.** A bond formed between two atoms by sharing of a pair of electrons, with both electrons being provided by the same atom.

Ans : COMP 2025
Coordinate bond

- 58.** The chemical bond formed by a shared pair of electrons, each bonding atom contributing one electron to the pair.

Ans : COMP 2020
Single covalent bond

- 59.** The tendency of an atom to attract electrons to itself when combined in a compound.

Ans : MAIN 2020
Electronegativity

- 60.** Formation of ions from molecules.

Ans : SQP 2014
Ionisation

- 61.** A bond formed by a shared pair of electrons with both electrons coming from the same atom.

Ans : COMP 2013
Coordinate bond

- 62.** The covalent bond in which the electrons are shared equally between the combining atoms.

Ans : COMP 2019
Non-polar covalent bond.

- 63.** Polar covalent compound which, on dissolving in water, produces ions.

Ans : COMP 2015
Hydrogen chloride gas

- 64.** The type of bonding present in metallic chlorides.

Ans : SQP 2013
Ionic or electrovalent bonding

- 65.** The type of bonding present in non-metallic chlorides.

Ans : MAIN 2015

Covalent bonding

- 66.** The bond formed by the mutual sharing of electrons.

Ans : COMP 2017
Covalent bond

- 67.** The bond formed by the transference of electrons.

Ans : SQP 2019
Ionic bond

- 68.** An ion formed by the loss of electrons from the neutral atom.

Ans : MAIN 2021
Cation

- 69.** An ion formed by the gain of electrons by the neutral atom.

Ans : SQP 2023
Anion

- 70.** Outermost shell of an atom.

Ans : COMP 2021
Valence shell

- 71.** The electrons present in the outermost shell of an atom.

Ans : MAIN 2018
Valence electrons

- 72.** Elements having eight electrons in the outermost shell.

Ans : SQP 2011
Inert gases or noble gases

- 73.** Name the bond formed by a shared pair of electrons with both electrons coming from the same atom.

Ans : MAIN 2000
Coordinate bond.

DIRECTION : Fill in the blanks from the choices given in bracket :

- 74.** Carbon tetrachloride is a (polar/non-polar) covalent molecule.

Ans : MAIN 2024
Non-polar

75. During electrolysis of acidulated water the gas liberated at the anode is (oxygen/hydrogen).

Ans : MAIN 2024

Oxygen

76. The polar covalent compound in gaseous state that does not conduct electricity is _____ (carbon tetra chloride/ammonia/methane).

Ans : SQP 2020

Ammonia.

77. In covalent compounds, the bond formed is due to the _____ (sharing/transfer) of electrons.

Ans : COMP 2014

Sharing

78. Electrovalent compounds have _____ (high/low) boiling point.

Ans : MAIN 2014

High

79. A molecule of _____ contains a triple bond. (hydrogen/ammonia/nitrogen)

Ans : COMP 2011

Nitrogen.

80. Generally ionic compounds exist in (i) _____ (solid/liquid/gas) state. Melting and boiling points of covalent compounds are generally (ii) _____ (low/high).

Ans : SQP 2009

(i) solid, (ii) low

81. Electrovalent compounds have _____ (high/low) melting points.

Ans : MAIN 2016

High.

82. Copy and complete the following table which refers to the conversion of ions to neutral particles.

Conversion	Ionic Equation	Oxidation/ Reduction
Chloride ion to chlorine molecule	(i) _____	(ii) _____
Lead (II) ion to lead	(iii) _____	(iv) _____

Ans :

MAIN 2018

Conversion	Ionic equation	Oxidation/ Reduction
Chloride ion to chlorine molecule	(i) $\text{Cl}^- - 1\text{e}^- \rightarrow \text{Cl}$ $\text{Cl} + \text{Cl} \rightarrow \text{Cl}_2$	(ii) Oxidation
Lead (II) ion to lead	(iii) $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$	(iv) Reduction

DIRECTION : Give reason for the following :

83. Carbon tetrachloride does not conduct electricity.

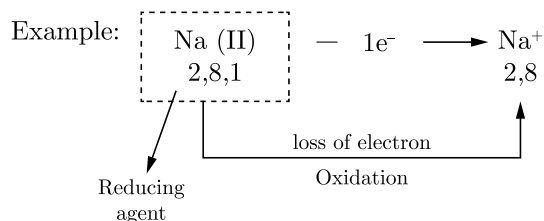
Ans : SQP 2015

Carbon tetrachloride has strong covalent bonding. It contains only molecules. Due to the absence of ions it is a bad conductor of electricity.

84. Alkali metals are good reducing agents.

Ans : MAIN 2018

Alkali metals have free electrons. They can easily lose electrons to form positive ions. The loss of electron is known as oxidation and the substance/element that loses electrons is said to be a reducing agent.



85. Ionic compounds have a high melting point.

Ans : COMP 2018

Ionic compounds have ions held strongly by electrostatic forces of attraction. These strong forces need more energy to be broken apart. Hence, they have high melting point.

86. Ionic compounds have high melting and boiling points.

Ans : SQP 2008

The constituents of ionic compounds, i.e. oppositely charged ions are held by strong electrostatic forces of attraction, therefore, more energy is required to separate them and hence, they have high melting and boiling points.

87. Inert gases do not form ions.

Ans :

SQP 2018

Inert gases do not form ions because they have completely filled octet. They are extremely stable. Hence, they neither lose, nor gain electrons.

88. Solid sodium chloride does not conduct electricity.

Ans :

COMP 2008

Solid sodium chloride does not conduct electricity because the oppositely charged ions in sodium chloride are held by strong electrostatic force of attraction and hence, they are not free to carry electric current.

89. Molten sodium chloride conducts electricity.

Ans :

SQP 2008

Molten sodium chloride conducts electricity because the electrostatic forces of attraction are overcome by heat energy. Therefore, the ions become free to carry electric current.

90. Sugar solution does not conduct electricity.

Ans :

MAIN 2008

Sugar solution, being a covalent compound, does not conduct electricity as the ions are absent and only molecules are present.

91. Bond formed in hydrogen molecule is non-polar covalent bond.

Ans :

MAIN 2008

The combining elements in hydrogen molecule are identical, i.e. they have no difference in their electro-negativities. Hence, the shared pair of electrons lies exactly at the centre of two combining atoms. Therefore, the bond formed is non-polar covalent bond.

DIRECTION : Answer the following :

92. An aqueous solution of sodium chloride conducts electricity.

Ans :

SQP 2012

An aqueous solution of sodium chloride conducts electricity because water is polar solvent and has high dielectric constant which leads to formation of sodium and chloride ions which conduct electricity.

93. Compare the compounds carbon tetra-chloride

and sodium chloride with regard to solubility in water and electrical conductivity.

Ans :

COMP 2013

The comparison between tetra-chloride and sodium chloride with regard to solubility in water and electrical conductivity

	CCl_4	NaCl
Solubility in water :	Insoluble in water.	Soluble in water.
Electrical conductivity.	Bad conductor of electricity.	Good conductor of electricity in molten or aqueous state.

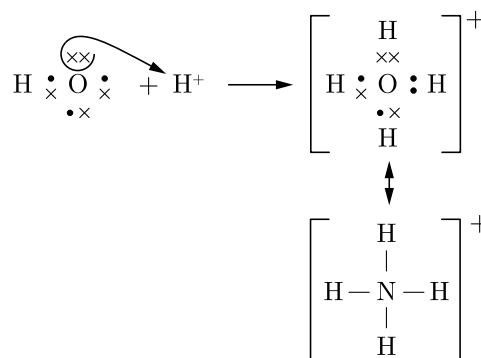
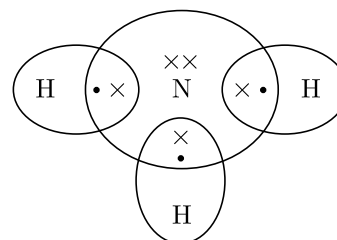
94. By drawing an electron dot diagram show the formation of Ammonium Ion [Atomic No. : N = 7 and H = 1]

Ans :

COMP 2016

$\text{N}(7) \rightarrow 2,5$

$\text{H}(1) \rightarrow 1$



95. An element L consists of molecules. What type of bonding is present in the particles that make up L ?

Ans :

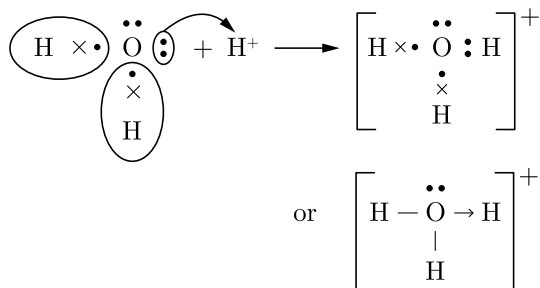
SQP 2015

Covalent bonding.

96. Draw an electron dot diagram to show the structure of hydroponic ion. State the type of bonding present in it.

Ans :

MAIN 2014



The bonding is coordinate bonding.

97. Why hydrogen chloride can be termed a polar covalent compound?

Ans :

COMP 2011

Chlorine is more electronegative than hydrogen, therefore, the shared pair of electrons lies closer to chlorine and hence the bond becomes polar.

98. Sodium chloride will conduct electricity only in fused or aqueous solution state. Give Reason.

Ans :

SQP 2016

It is because sodium chloride contains free ions in aqueous solution state to conduct electricity.

99. Why do covalent compounds exist as gases, liquids or soft solids?

Ans :

MAIN 2014

The force of attraction between the constituent particles is weak.

100. State the force which holds two or more atoms together in a stable molecule.

Ans :

SQP 2011

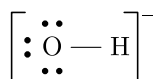
Chemical bond

101. Give the structure of hydroxyl ion.

Ans :

MAIN 2017

Hydroxyl ion has the structure.



102. Define covalent bond.

Ans :

COMP 2019

The bond formed by equal contribution and mutual sharing of electrons between two atoms so that both the atoms acquire the stable nearest

noble gas configuration i.e., get their octet complete is called covalent bond.

103. How do atoms attain noble gas configuration ?

Ans :

SQP 2020

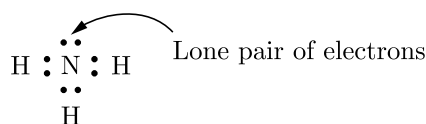
The atoms attain noble gas configuration by losing, gaining or sharing of electrons present in their valence shells.

104. What is a lone pair of electrons ?

Ans :

MAIN 2006

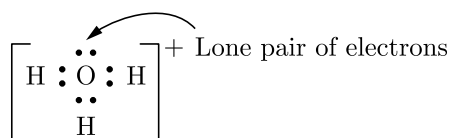
It is a pair of electrons present on an atom in a molecule which does not take part in bond formation :



105. Draw an electron dot diagram of a hydronium ion and label the lone pair of electrons.

Ans :

COMP 2006



106. Name the charged particles which attract one another to form electrovalent compounds.

Ans :

COMP 2019

Cation and anion

107. In the formation of electrovalent compounds, electrons are transferred from one element to another. How are electrons involved in the formation of a covalent compound ?

Ans :

MAIN 2020

There is a mutual sharing of electrons.

108. The electronic configuration of nitrogen is 2,5. How many electrons in the outer shell of a nitrogen atom are not involved in the formation of a nitrogen molecule ?

Ans :

SQP 2021

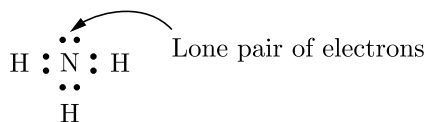
Two

109. Name a neutral covalent molecule which contains one lone pair of electrons.

Ans :

SQP 2006

Ammonia,



110. An atom is electrically neutral. Explain.

Ans :

COMP 2007

In an atom the number of electrons is equal to number of protons and hence the atom is electrically neutral.

111. In the formation of magnesium chloride (by direct combination between magnesium and chlorine), name the substance that is oxidised and the substance that is reduced.

Ans :

COMP 2023

Magnesium is oxidised and chlorine is reduced.

TWO MARKS QUESTIONS

112. Draw the electron dot structure of:

(a) Methane molecule

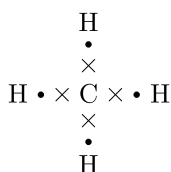
(b) Nitrogen molecule

[Atomic number: N = 7, C = 6, H = 1]

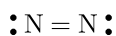
Ans :

MAIN 2024

(a) Methane molecule



(b) Nitrogen molecule



113. Give reasons for the following:

(a) Inert gases do not form ions.

(b) Covalent compounds have a low melting and boiling point.

Ans :

MAIN 2024

(a) Inert gas do not form ions because their outermost shell is completely filled and possess a stable configuration. So they are

unreactive in nature and do not form ions.

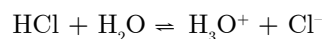
(b) The molecules that are formed by the covalent bonds are held together by weak intramolecular forces. Thus, a very small amount of energy is required to break the bonds between two or more molecules as a result they possess low melting and boiling points.

114. Draw the structure of the stable positive ion formed when an acid dissolves in water.

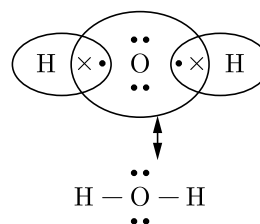
Ans :

SQP 2014

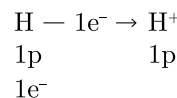
When an acid dissolves in water hydronium ion is formed.



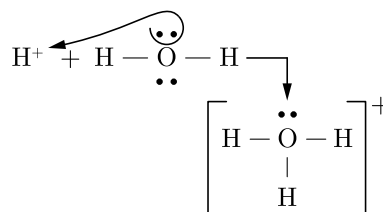
(i) Structure of water :



(ii) Formation of proton :



(iii) Structure of hydronium ion:



115. There are three elements *E*, *F* and *G* with atomic numbers 19, 8 and 17 respectively.

(i) Classify the elements as metals and non-metals.

(ii) Give the molecular formula of the compound formed between *E* and *G* and state the type of chemical bond in this compound.

Ans :

MAIN 2000

(i) Non-metal - *F*, *G*Metal - *E*(ii) *EG*, ionic bond.

116. Why do covalent compounds exist as gases, liquids or soft solids ?

Ans :

SQP 2014

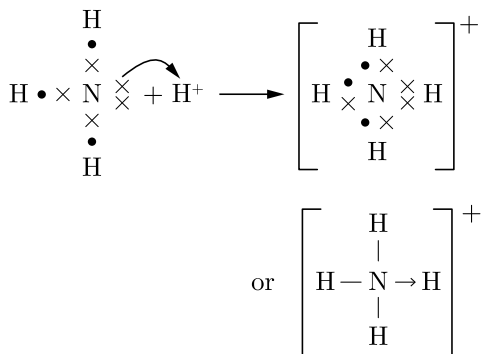
Covalent compounds are bound by weak Van der Waal forces of attraction so the molecules of the compound are loosely bound, thus due to weak forces they exist as gases, liquids or soft solids.

117. By drawing an electron dot diagram, show the formation of ammonium Ion.

[Atomic No.: N = 7 and H = 1]

Ans :

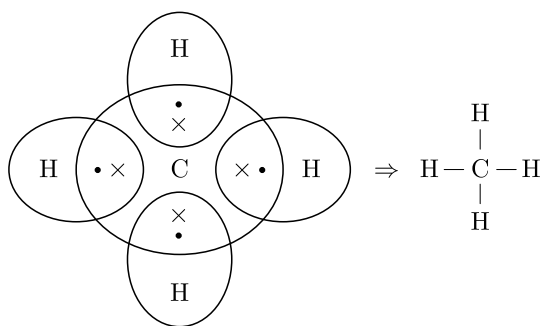
COMP 2016



118. Explain the bonding in methane molecule using electron dot structure.

Ans :

SQP 2015



119. There are three elements E, F, G with atomic numbers 19, 8 and 17 respectively.

- Classify the elements as metals and non-metals.
- Give the molecular formula of the compound formed between E and G and state the type of chemical bond in this compound.

Ans :

COMP 2000

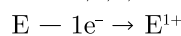
(i)

	Z	E.C.	
E	19	2,8,8,1	Metal
F	8	2,6	Non-metal

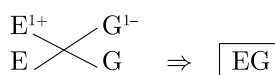
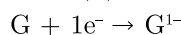
G	17	2,8,7	Non-metal
---	----	-------	-----------

- (ii) Type of bond $\Rightarrow$ Ionic bond

$$E - 2,8,8,1$$



$$G - 2,8,7$$



NODIA

120. (a) Name two compounds that are covalent when taken pure but produce ions when dissolved in water.
 (b) For each compound, give the formulae of the ions formed in aqueous solutions.

Ans :

MAIN 2014

- (a) Hydrogen chloride and Hydrogen bromide.
 (b) $HCl + H_2O \rightarrow H_3O^+ + Cl^-$
 $HBr + H_2O \rightarrow H_3O^+ + Br^-$

121. Ionic compounds do not conduct electric current in the solid state, why ?

Ans :

SQP 2018

In the solid state, there are strong electrostatic forces of attraction between the oppositely charged ions and ions cannot move, hence do not conduct electricity.

122. How many covalent bonds and co-ordinate bonds are present in ?

- Hydronium ion
- Ammonium ion

Ans :

COMP 2020

- Hydronium ion contains two covalent bonds and one co-ordinate bond.
- Ammonium ion has three covalent bonds and one co-ordinate bond.

123. An element X is a metal with valency 1. Element Y is a non-metal with valency 1.

- Write equations to show how X and Y form ions.
- If Y is a diatomic gas, write the equation for the direct combination of X and Y to form a compound.

Ans :

SQP 2023

- (i) $X - e^- \rightarrow X^{+1}$
 $Y + e^- \rightarrow Y^{-1}$

- (ii) $2X + Y_2 \rightarrow 2XY$

- 124.** What is the essential difference in the nature of compounds when two combining atoms
- differ much in their electro-negativities ?
 - don't differ much in their electro-negativities?

Ans :

COMP 2022

- Form either ionic bond or polar covalent bond.
- Form non-polar covalent bond.

- 125.** How many covalent and coordinate bonds are present in :

- Hydronium ion
- Ammonium ion.

Ans :

MAIN 2018

	Name of the ions	No. of covalent bonds	No. of coordinate bonds
(i)	Hydronium ion	Two	One
(ii)	Ammonium ion	Three	One

- 126.** What is lone pair effect ? In what kind of compound does this effect occur ?

Ans :

SQP 2017

When the unshared pair of electrons around an atom in the middle of a molecule is completely shared by another atom or an ion, it is called lone pair effect. Lone pair effect is shown by polar covalent compounds such as HCl and NH_3 .

- 127.** An element X is a metal with valency 3. Element Y is a non-metal with valency 3.

- Write equations to show how X and Y form ions.
- If Y is a diatomic gas, write the equation for the direct combination of X and Y to form a compound.

Ans :

COMP 2000

- $X - 3e^- \longrightarrow X^{3+}$ and $Y + 3e^- \longrightarrow Y^{3-}$
- $2X + Y_2 \longrightarrow 2XY$

- 128.** Name the rule on which the combination of atoms to form molecules is based. Give two limitations of this rule.

Ans :

SQP 2014

This is called Octet rule.

Limitations of Octet rule are as follows :

- It cannot explain the formation of molecules such as PF_5 , SF_6 etc., in which the central

atom has more than eight electrons in its valence shell.

- It cannot explain the formation of molecules like BeF_2 , BF_3 in which the central atom has less than 8 electrons in its valence shell.

- 129.** Why is methane molecule regarded as a non polar covalent compound ?

Ans :

SQP 2015

It has been found that a methane molecule has a three dimensional tetrahedral structure. The four carbon hydrogen bonds are directed towards the four corners of tetrahedron. In such a configuration, none of the participating atoms is more electrically charged as compared to other atoms. Hence methane molecule is a non polar covalent compound.

- 130.** Elements A, B and C have atomic number 9, 20 and 10 respectively.

- State which one is (i) a non-metal, (ii) a metal, (iii) chemically inert
- Write down the formula of the compound formed by two of the above elements ?

Ans :

COMP 2017

- (i) A, (ii) B, (iii) C
- B and A form compound BA_2 .

- 131.** Compare sodium atom and sodium ion.

Ans :

SQP 2019

The comparison sodium atom and sodium ion are as following

	Property	Sodium atom (Na)	Sodium ion (Na^+)
1.	Colour	Silvery white	Colourless
2.	Toxicity	Poisonous	Non-poisonous
3.	Action with water	Very reactive	No action with water
4.	Electrical state	Neutral	Positively charged

- 132.** What are the conditions for the formation of an electrovalent bond ?

Ans :

MAIN 2010

The condition for the formation of an electrovalent bond are as follows :

- Low ionisation energy : One of the atoms should have low ionisation energy.

2. High electron affinity : The other atom should have high electron affinity.
3. High lattice energy : The lattice energy should be high.

133. On the basis of the knowledge of electronic configuration of elements, predict the nature of bonds in each of the following molecules.



Ans :

MAIN 2008

Molecule	Nature of bond
N_2	Covalent bond
CO_2	Covalent bond
HCl	Covalent bond
$MgCl_2$	Ionic bond
CCl_4	Covalent bond
HCN	Covalent bond

134. An element A has electronic arrangement 2, 8, 2. The element B has electronic configuration 2, 8, 7. Explain what happens to A and B when they combine to form ionic compound ? Also give the formula of ionic compound.

Ans :

SQP 2005

A (2, 8, 2) loses two electrons forming A^{2+} ion (2, 8).

B (2, 8, 7) gains one electron forming B^- ion (2, 8, 8).

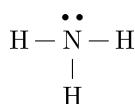
When A^{2+} and B^- ion combine, AB_2 compound is formed.

135. How many covalent bonds are present in
(a) Ammonia molecule and
(b) Methane molecule ?

Ans :

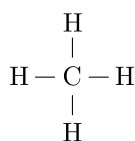
COMP 2017

(a) Ammonia molecule has the structural formula:



It has three covalent bonds.

(b) Methane molecule has the structural formula:



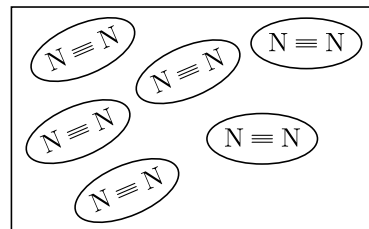
It has four covalent bonds.

136. Nitrogen and water are both covalent compounds but nitrogen is a gas and water is a liquid at room temperature. Explain.

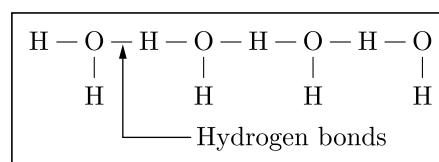
Ans :

SQP 2019

This is because water has an additional bonding known as hydrogen bonding between its molecules due to which the molecules remain closely bonded giving it a liquid state.



Nitrogen gas (Exists as independent) molecules



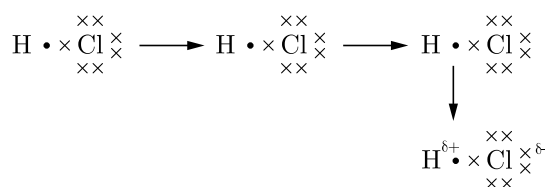
Water Molecules (Exists collectively due to strong hydrogen bonding)

THREE MARKS QUESTIONS

137. Give reasons as to why hydrogen chloride can be termed as a polar covalent compound.

Ans :

SQP 2011



Pure covalent bond exists between two elements which have similar electro-negativities. In hydrogen chloride, chlorine being more electronegative attracts the shared pair of electrons towards itself. As a result hydrogen acquires partial positive charge and chlorine gets partial negative charge. Thus, hydrogen chloride can be termed as a polar covalent compound.

- 138.** Element X is a metal with a valency 2.
Element Y is a non-metal with a valency 3.
- Write equations to show how X and Y form ions.
 - If Y is a diatomic gas, write the equation for the direct combination of X and Y to form a compound.
 - If the compound formed between X and Y is melted and an electric current passed through the molten compound, the element X will be obtained at the _____ and Y at the _____ of the electrolytic cell. (Provide the missing words)

Ans :

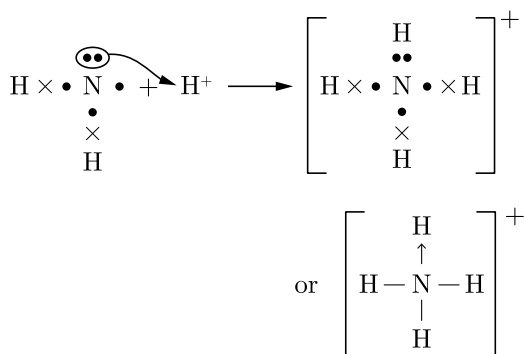
COMP 2004

- $X - 2e^- \rightarrow X^{2+}$
 $Y + 3e^- \rightarrow Y^{3-}$
- $3X + Y_2 \rightarrow X_3Y_2$
- Cathode, Anode

- 139.** By drawing an electron dot diagram, show the lone pair effect leading to the formation of ammonium ion from ammonia gas and hydrogen ion.

Ans :

SQP 2011



NH_3 has one lone pair of electrons which is donated to hydrogen atom forming a co-ordinate bond. The arrow represents a co-ordinate bond. The arrow points from donor to acceptor atom.

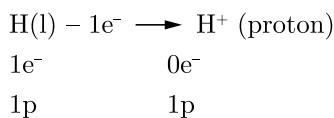
- 140.** Draw an electron dot diagram to show the structure of hydronium ion. State the type of bonding present in it.

Ans :

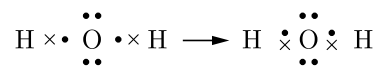
MAIN 2000

Structure of hydronium ion :

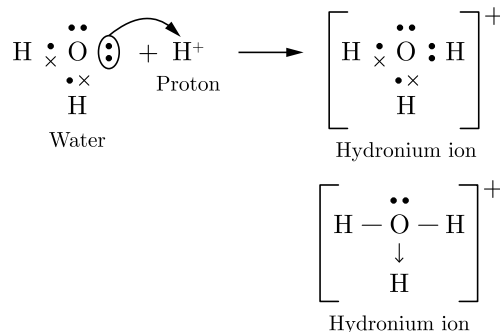
- Formation of proton:



- Structure of water :



- Formation of hydronium ion :



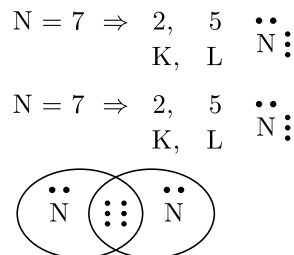
- 141.** Draw the electron dot structure of :

- Nitrogen molecule [N = 7]
- Sodium chloride [Na = 11, Cl = 17]
- Ammonium ion [N = 7, H = 1]

Ans :

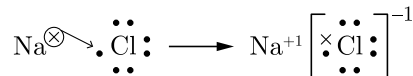
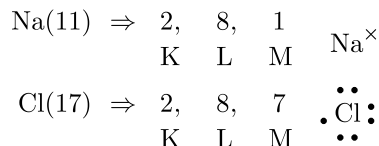
SQP 2019

- Nitrogen molecule



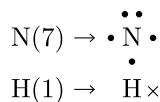
Nitrogen atom shares three electrons forming a triple covalent bond.

- Sodium chloride

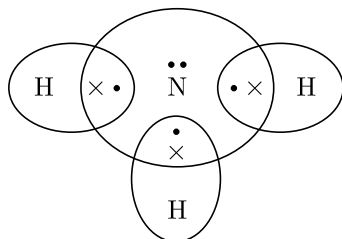


Sodium loses one electron to chlorine forming a positive ion and chlorine gains one electron forming a negative ion. These ions form an electrovalent bond and are held strongly by electrostatic forces of attraction.

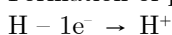
- Ammonium ion



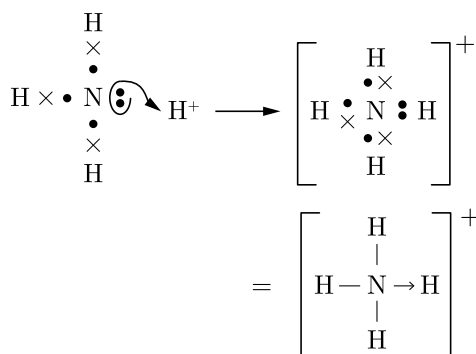
Formation of ammonia



Formation of proton



Formation of ammonium ion



Ammonia donates its lone pair to proton forming ammonium ion.

142. Match the column A with column B.

	Column A		Column B
1.	Sodium chloride	(a)	Increases
2.	Ammonium ion	(b)	Covalent bond
3.	Electro-negativity across the period	(c)	Ionic bond
4.	Non metallic character down the group	(d)	Covalent and Co-ordinate bond
5.	Carbon tetrachloride	(e)	Decreases

Answer as follows :

- correct item from B matching sodium chloride.
- correct item from B matching ammonium ion, and so on.

Ans :

SQP 2010

- Ionic bond

- Covalent and co-ordinate bond
- Increases
- Decreases
- Covalent bond.

143. What are non-polar and polar covalent bonds?

Ans :

COMP 2018

Non-polar covalent bond : When a covalent bond is formed between two identical atoms of the same element, the shared pair of electrons is attracted equally by both the bonded atoms. Such a covalent bond is called non-polar covalent bond. e.g., Cl-Cl, H-H etc.

Polar covalent bond : When a covalent bond is formed between two atoms having different electro-negativities, the shared pair of electrons is attracted more towards the atom having higher electro-negativity. This atom acquires a partial negative charge (δ^-) and other atom acquires a partial positive charge (δ^+). Such a covalent bond is called polar covalent bond e.g., $\text{H}^+ - \text{F}^-$ etc.

144. Give reasons for the following:

- Ionic compounds have high melting point.
- Ionic compounds easily dissolve in water.
- Inert gases do not form ions.

Ans :

MAIN 2014

- There are strong electrostatic forces of attraction between the oppositely charged ions of ionic compounds. Hence, they have high melting point.
- Water has the ability to reduce the forces of attraction between existing ions and hence make the ionic compound soluble.
- Inert gases have stable electronic configuration following the octet rule, hence they do not lose or gain electrons to form ions.

145. Predict the type of bonding in the following molecules :

- Oxygen
- Calcium oxide
- Water
- Methane
- Ammonium ion

Ans :

SQP 2018

- Covalent bond
- Ionic bond
- Covalent bond
- Covalent bond
- Covalent and co-ordinate bonds.

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- 146.** Match the atomic numbers 4, 14, 8, 15 and 19 with each of the following:

(a) A solid non-metal of valency 3
(b) A gas of valency 2
(c) A metal of valency 1
(d) A non-metal of valency 4

Ans :

COMP 2000

- Atomic number 15
- Atomic number 8
- Atomic number 19
- Atomic number 14

- 147.** In the formation of compound XY_2 , atom X gives one electron to each Y atom. What is the nature of bond to XY_2 ? Give four properties of XY_2 .

Ans :

MAIN 2015

The bond in XY_9 is ionic.

Properties of XY_n :

1. It is hard and brittle.
2. It is soluble in water.
3. It has high melting and boiling point.
4. It does not conduct electric current in the solid state but conducts electric current in the molten or dissolved state.

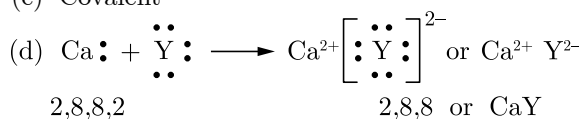
- 148.** A compound has the formula H_2Y ($Y = \text{Non-metal}$). State the following :

- the outer electronic configuration of Y.
- the valency of Y.
- the bonding present in H_2Y .
- the formula of the compound formed between calcium $\left[\begin{smallmatrix} 40 \\ 20 \end{smallmatrix} \text{Ca} \right]$ and Y.

Ans :

SQP 2018

- (a) Y has six electrons in its valence shell.
(b) 2
(c) Covalent



- 149.** State the type of bond present in :

- Non-metallic chloride
- Metallic chloride
- Chlorine molecule

Ans :

MAIN 2015

- (i) Covalent bond
- (ii) Ionic bond
- (iii) Non-polar covalent bond

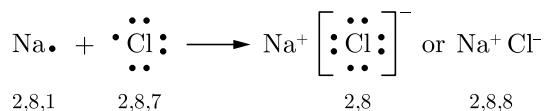
- 150.** Give the electron dot structures of :

- (i) NaCl
- (ii) MgCl_2
- (iii) CaO

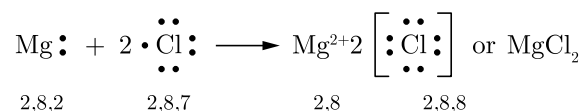
Ans :

COMP 2017

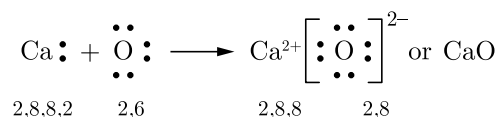
- (i) NaCl



- (ii) MgCl_2



- (iii) CaO



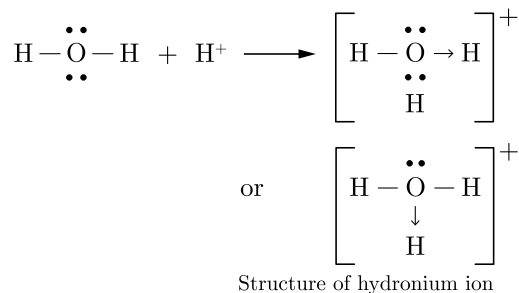
- 151.** Explain the structures of :

- (a) Hydronium ion
(b) Ammonium ion.

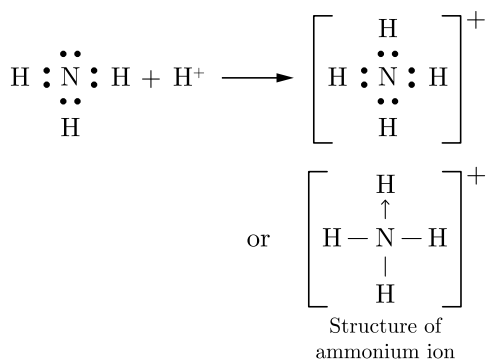
Ans :

SQP 2012

- (a) Structure of hydronium ion (H_3O^+) : Hydronium ion is produced when hydrogen (H^+) ion combines with water molecule. In this case, (H^+) ion accepts a lone pair of electrons present on O atom in H_2O forming a co-ordinate bond.



- (b) Structure of ammonium ion (NH_4^+) : Ammonium ion is produced when proton (H^+) combines with NH_3 molecule. In this case hydrogen H^+ ion accepts a lone pair of electrons present on N-atoms of NH_3 molecule forming a co-ordinate bond.



152. Predict the type of bonding in the following :

- (i) Ammonia
- (ii) Calcium oxide
- (iii) Oxygen

Ans :

MAIN 2000

- (i) Polar covalent bond
- (ii) Ionic bond
- (iii) Double covalent bond

153. Predict the type of bond (ionic or covalent) likely to be formed when pairs of elements having following atomic numbers combine :

- (a) 3 and 7
- (b) 6 and 9
- (c) 11 and 16

Ans :

SQP 2015

- (a) Ionic bond
- (b) Covalent bond
- (c) Ionic bond

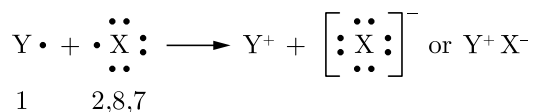
154. An atom X has 2,8,7 electrons in its shell. It combines with Y having 1 electron in its valence shell.

- (a) What type of bond will be formed between X and Y ?
- (b) Write the formula of the compound formed.
- (c) Would it be soluble in water ?

Ans :

COMP 2017

- (a) Ionic bond



- (b) Formula of the compound is YX.
- (c) Yes, because it is an ionic compound.

155. Elements X, Y and Z have atomic number 6, 9 and 12 respectively. Which one ?

- (a) forms an anion.

(b) forms a cation.

(c) has four electrons in its valence shell.

Ans :

SQP 2020

Element	Atomic No.	Electronic configuration
X	6	2, 4
Y	9	2, 7
Z	12	2, 8, 2

- (a) Y will form an anion
- (b) Z forms a cation
- (c) X has four electrons in its valence shell.

156. An atom P has 2,8,7 electrons in its orbits. It combines with Q having one electron in its valence orbit.

- (a) What type of bond will be formed between P and Q ?
- (b) Write the formula of the compound formed.
- (c) Is it soluble in water ?

Ans :

MAIN 2023

- (a) Electrovalent or ionic bond.
- (b) QP
- (c) Yes, it is soluble in water.

157. Two columns A and B are given:

	Column A	Column B
1.	Sodium chloride	Covalent bond
2.	Ammonium ion	Ionic bond
3.	Carbon tetrachloride.	Covalent and Coordinate bond

Answer as follows :

- (i) Correct item from B matching sodium chloride.
- (ii) Correct item from B matching ammonium ion.
- (iii) Correct item from B matching carbon tetrachloride.

Ans :

SQP 2011

- (i) Ionic bond
- (ii) Covalent and Coordinate bond
- (iii) Covalent bond

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FOUR MARKS QUESTIONS

158. Match the Column A with Column B:

	Column A		Column B
(a)	Water	1.	Lithium
(b)	Alkali metal	2.	Iodine
(c)	Halogen	3.	Covalent compound
(d)	Calcium oxide	4.	Acetic acid
(e)	Weak acid	5.	Ionic compound
		6.	Sulphuric acid

Ans :

MAIN 2024

	Column A		Column B
(a)	Water	3.	Covalent compound
(b)	Alkali metal	1.	Lithium
(c)	Halogen	2.	Iodine
(d)	Calcium oxide	5.	Ionic compound
(e)	Weak acid	4.	Acetic acid

159. Choose from the following the ionic compounds, the polar covalent compounds and the non-polar covalent compounds:

- NaCl
- Methane
- Oxygen molecule
- Hydrogen chloride gas
- Calcium oxide
- Ammonia

Ans :

COMP 2016

(a)	NaCl	Ionic compound
(b)	Methane	Non-polar covalent compound
(c)	Oxygen molecule	Non-polar covalent compound
(d)	Hydrogen chloride gas	Polar covalent compound
(e)	Calcium oxide	Ionic compound
(f)	Ammonia	Polar covalent compound

160. Identify the type of bond expected to be formed between the pair of elements with the following atomic numbers. Identify the elements and predict

their formula also.

- 1, 17
- 11, 9
- 6, 1
- 20, 1

Ans :

MAIN 2000

	Atomic Number	Name of element	Type of bond	Formula
(i)	1	Hydrogen	Polar covalent bond	HCl
	17	Chlorine		
(ii)	11	Sodium	Ionic bond	NaF
	9	Fluorine		
(iii)	6	Carbon	Non-polar covalent bond	CH ₄
	1	Hydrogen		
(iv)	20	Calcium	Ionic bond	CaH ₂
	1	Hydrogen		

161. The following table shows the electronic configuration of the elements W, X, Y and Z :

Element	W	X	Y	Z
Electronic configuration	2, 8, 1	2, 8, 7	2, 5, 1	1

Answer the following questions based on the table above :

- What type of bond is formed between:
 - W and X
 - Y and Z
- What is the formula of the compound formed between:
 - X and Z
 - W and X

Ans :

SQP 2017

- Electrovalent (Ionic)
 - Covalent
- ZX
 - WX

162. See the table and answer the question given below:

Element	Proton	Electron present in ion formed from element
P	9	10
Q	20	18

<i>R</i>	11	10
<i>S</i>	18	18

Using above table, answer the following :

- Identify the element which forms:
 - Cation
 - Anion
- Identify the element with complete octet.
- What type of bond is formed between *Q* and *P*?
- Give the formula of the compound formed between *Q* and *P*.

Ans :

COMP 2014

- Q* and *R*
 - P*
- S*
- Ionic bond
- QP_2

- 163.** Copy and complete the table given below and answer the following questions :

(Note : Do not identify the element)

Element	Mass No.	Atomic No.	Proton	Electronic configuration
<i>A</i>	14	7	—	—
<i>B</i>	35	17	—	—
<i>C</i>	1	1	—	—
<i>D</i>	12	6	—	—
<i>E</i>	16	8	—	—

- How many valence electrons are present in *A*, *B*, *C*, *D* and *E*?
- Choose metal, non-metal or inert gas from the above elements.
- What type of bond formation takes place between:
 - B* and *C*
 - Molecule of *A*
 - D* and *C*
 - A* and *C*?

Ans :

SQP 2016

Element	Mass No.	Atomic No.	Proton	Electronic configuration
<i>A</i>	14	7	7	2, 5
<i>B</i>	35	17	17	2, 8, 7
<i>C</i>	1	1	1	1
<i>D</i>	12	6	6	2, 4
<i>E</i>	16	8	8	2, 6

- A* - 5, *B* - 7, *C* - 1, *D* - 4, *E* - 6
- Metals — None
Non-metals — *A*, *B*, *C*, *D*, *E*
Inert gas — None
- Polar covalent bond
 - Covalent bond
 - Covalent bond
 - Polar covalent bond

- 164.** The atomic numbers of the elements *A*, *B*, *C*, *D* and *E* are 11, 17, 16, 12 and 18 respectively. With reference to the above mentioned elements, answer the following questions :

(Note: Do not identify the element).

- Give the electronic configurations of *A*, *B*, *C*, *D* and *E*.
- How many valence electrons are present in *A*, *B*, *C*, *D* and *E*?
- Name the type of ion (if formed) in *A*, *B*, *C*, *D* and *E*.
- Identify the type of element.

Ans :

COMP 2017

Element (atomic number)	Electronic configuration	No. of valence electrons	Type of ion	Type of element
<i>A</i> (11)	2, 8, 1	1	Cation	Metal
<i>B</i> (17)	2, 8, 7	7	Anion	Non-metal
<i>C</i> (16)	2, 8, 6	6	Anion	Non-metal
<i>D</i> (12)	2, 8, 2	2	Cation	Metal
<i>E</i> (18)	2, 8, 8	8	—	Inert gas

- 165.** See the table and answer the questions given below :

Element	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Electronic configuration	2, 8, 1	2, 8, 7	2, 5,	1

- What type of bond is formed between :
 - A* and *B*
 - C* and *D*
 - B* and *D*
 - Molecule of *D*
 - Molecule of *C*
 - Molecule of *B*
- What is the formula of the compound formed between :
 - A* and *B*
 - C* and *D*
 - B* and *D*

Ans :

SQP 2019

- (a) (i) Ionic bond or electrovalent bond
 (ii) Covalent bond
 (iii) Polar covalent bond
 (iv) Single covalent bond
 (v) Triple covalent bond
 (vi) Single covalent bond
- (b) (i) AB
 (ii) CD₃
 (iii) DB

166. State which of the following are oxidised or reduced.

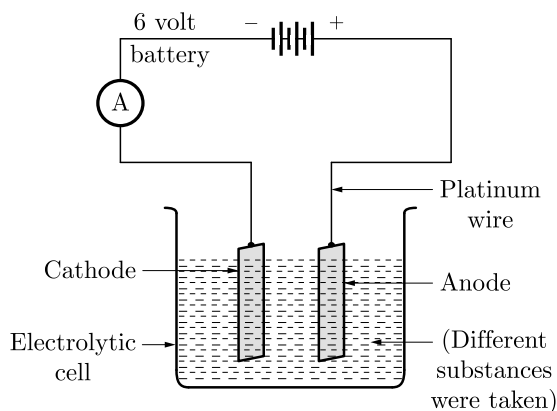
- (i) $O^{2-} \rightarrow O$
 (ii) $Zn \rightarrow Zn^{2+}$
 (iii) $Fe \rightarrow Fe^{3+}$
 (iv) $Fe^{3+} \rightarrow Fe^{2+}$
 (v) $Fe^{2+} \rightarrow Fe$

Ans :

MAIN 2020

- (i) Oxidised
 (ii) Oxidised
 (iii) Oxidised
 (iv) Reduced
 (v) Reduced

167. On the basis of the given diagram answer the following questions.



- (i) Which part shows deflection for current ?
 (Give full name)
- (ii) For which of the following deflection was observed.
 (a) Ethanol
 (b) Distilled water
 (c) Carbon tetrachloride
 (d) Copper sulphate solution
 (e) Acetic acid
- (iii) Why some substances don't show deflection ?
- (iv) Define the phenomenon shown in the above diagram.

Ans :

COMP 2023

- (i) A — Ammeter
- (ii) (a) Ethanol — no deflection
 (b) Distilled water — no deflection
 (c) Carbon tetrachloride — no deflection
 (d) Copper sulphate solution — deflection shown
 (e) Acetic acid — deflection shown
- (iii) Some substances don't show deflection because they do not form ions and hence do not conduct electricity. Only the substances which conduct electricity show deflection.
- (iv) Electrolysis It is defined as the process of chemical decomposition of an electrolyte present in the molten or dissolved state, by passing electric current through it.

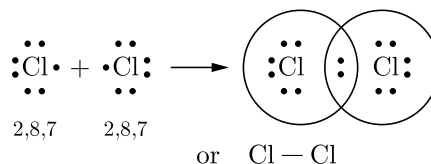
168. Give electron dot representation of :

- (a) Cl₂ (b) H₂O
 (c) NH₃ (d) CCl₄
 (e) CH₄

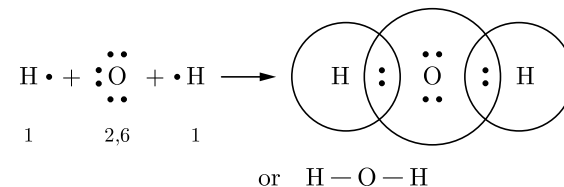
Ans :

MAIN 2017

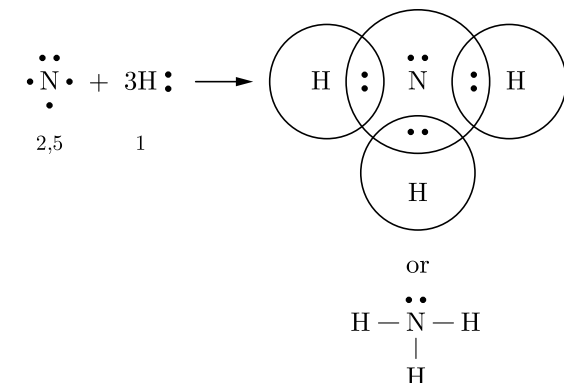
- (a) Cl₂

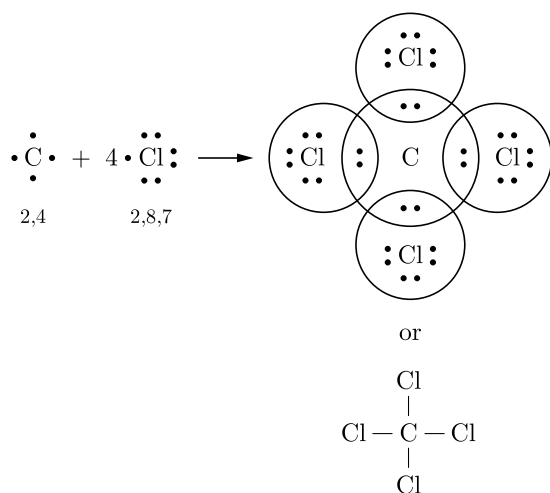
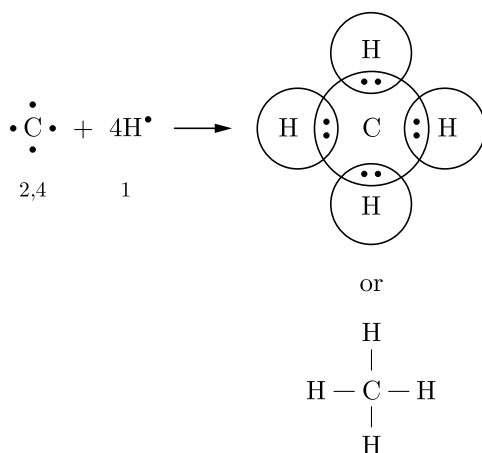


- (b) H₂O



- (c) NH₃



(d) CCl_4 (e) CH_4 

169. Five atoms labelled A to E have mass numbers and atomic numbers as given below:

Atoms	Mass number	Atomic number
A	40	20
B	19	9
C	7	3
D	16	8
E	14	7

- (a) Which one of these atoms contains 7 protons?
 (b) Which has an electronic configuration 2, 7?
 (c) Write down the formula of compound formed between C and D.
 (d) Predict which are (i) metals, (ii) non-metals?

Ans :

SQP 2020

- (a) E contains 7 protons.
 (b) B has the electronic configuration = 2, 7

- (c) C has the electronic configuration = 2, 1
 D has the electronic configuration = 2, 6
 The formula of the compound between C and D is C_2D .
 (d) (i) A and C are metals.
 (ii) B, D and E are non-metals.

170. State which of the following are oxidised or reduced.

- (i) $\text{S} \rightarrow \text{S}^{2-}$
 (ii) $\text{N} \rightarrow \text{N}^{3-}$
 (iii) $\text{Cl}^- \rightarrow \text{Cl}_2$
 (iv) $\text{Cu} \rightarrow \text{Cu}^{2+}$
 (v) $\text{Cr} \rightarrow \text{Cr}^{3+}$

Ans :

SQP 2021

- (i) Reduced
 (ii) Reduced
 (iii) Oxidised
 (iv) Oxidised
 (v) Oxidised

CASE BASED QUESTION

171. Potassium bromide (KBr) forms when potassium donates an electron to bromine, resulting in the formation of an ionic bond. This compound is known for conducting electricity when molten, making it useful in various electrochemical processes. Potassium becomes a positively charged cation, while bromine becomes a negatively charged anion. This strong ionic bond contributes to the high melting point of KBr.

- (i) What type of bond is in Potassium bromide?
 (ii) Which ion does potassium form?
 (iii) What charge does bromine gain?
 (iv) Is KBr's bond strong or weak?

Ans :

- (i) Ionic
 (ii) Cation
 (iii) Negative
 (iv) Strong

172. Carbon dioxide (CO_2) forms when carbon atoms share electrons with oxygen atoms, creating a covalent bond. This molecule is crucial for life on Earth as it plays a vital role in photosynthesis. In CO_2 , the shared electrons between carbon and oxygen result in a stable, nonpolar molecule. Despite being a greenhouse gas, CO_2 is essential

for the carbon cycle and maintaining Earth's temperature balance.

- (i) What type of bond is in Carbon dioxide?
- (ii) What do carbon and oxygen share?
- (iii) Is CO_2 a polar or nonpolar molecule?
- (iv) Is CO_2 organic or inorganic?

Ans :

- (i) Covalent
- (ii) Electrons
- (iii) Nonpolar
- (iv) Inorganic

- 173.** Hydrogen chloride (HCl) forms when hydrogen shares its electron with chlorine, leading to a polar covalent bond. This bond arises because chlorine, being more electronegative, attracts the shared electron more strongly. HCl is commonly found in hydrochloric acid, which is used in various industrial and laboratory applications. The polar nature of HCl allows it to dissolve easily in water, forming an acidic solution.

- (i) What type of bond is in Hydrogen chloride?
- (ii) Which element in HCl is more electronegative?
- (iii) Is HCl polar or nonpolar?
- (iv) Does HCl dissolve in water?

Ans :

- (i) Covalent
- (ii) Chlorine
- (iii) Polar
- (iv) Yes

- 174.** Calcium oxide (CaO) forms when calcium atoms transfer electrons to oxygen atoms, resulting in the formation of an ionic bond. This compound, also known as quicklime, is widely used in the construction industry, particularly in the production of cement. The transfer of electrons from calcium to oxygen forms strong electrostatic forces, giving CaO a high melting point and basic nature, making it effective in neutralizing acids.

- (i) What type of bond is in Calcium oxide?
- (ii) What ion does calcium form?
- (iii) Is CaO acidic or basic?
- (iv) Does CaO conduct electricity?

Ans :

- (i) Ionic
- (ii) Cation
- (iii) Basic
- (iv) Yes

- 175.** Ammonia (NH_3) is a compound formed when nitrogen shares its electrons with hydrogen atoms, resulting in a covalent bond. This molecule is widely used in agriculture as a key ingredient in fertilizers. The lone pair of electrons on nitrogen makes NH_3 a polar molecule, which allows it to dissolve well in water. Ammonia's ability to donate a pair of electrons also makes it a useful reagent in many chemical reactions.

- (i) What type of bond is in Ammonia?
- (ii) How many hydrogen atoms bond with nitrogen?
- (iii) Is NH_3 polar or nonpolar?
- (iv) What is NH_3 used as?

Ans :

- (i) Covalent
- (ii) Three
- (iii) Polar
- (iv) Fertilizer

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CHAPTER 3

STUDY OF ACIDS, BASES AND SALTS

SUMMARY

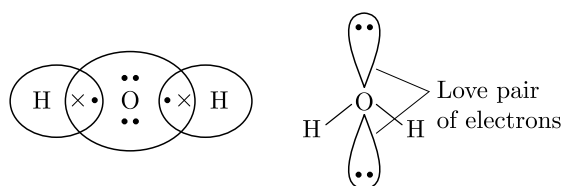
1. ACIDS

The chemical compounds which on dissolving in water produce hydrogen ions or hydronium ions as the only positively charged ions. All acids essentially contain hydrogen.

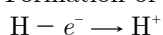
2. HYDRONIUM ION

Hydronium ion is hydrated hydrogen ion. When hydrogen ion combines with water molecule, it forms hydrated hydrogen ion called as hydronium ion. The formation of hydronium ion takes place by the coordinate bond formation. In water molecule, oxygen atom has two lone pairs of electrons. It shares one of its lone pair of electrons with hydrogen ion to complete its dublet thereby hydronium ion forming.

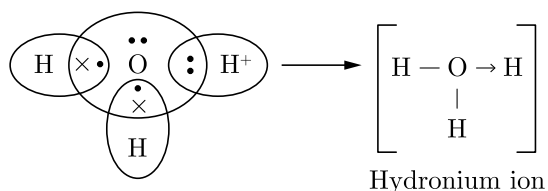
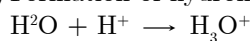
(i) Formation of Water molecule



(ii) Formation of hydrogen ion (H^+)



(iii) Formation of hydronium ion



3. CLASSIFICATION OF ACID

Acids can be classified on the basis of

(i) Strength

- (ii) Basicity
- (iii) Concentration
- (iv) Source
- (v) Composition
- (vi) Volatility.

The number of hydronium ions present in an aqueous solution of the acid is known as the strength of the acid. The greater the concentration of hydronium ions, stronger is the acid.

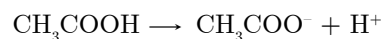
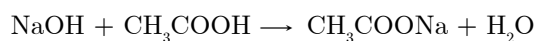
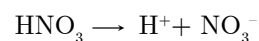
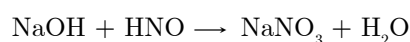
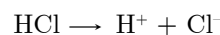
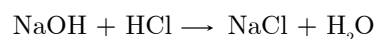
Strong acids are those which are almost completely ionised in their aqueous solutions. The solution of strong acid contains mostly ions. e.g. hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3).

Weak acids are those which are partially or incompletely ionised in their aqueous solutions. The solution of weak acid contains ions as well as molecules, e.g. acetic acid (CH_3COOH), sulphurous acid (H_2SO_3), carbonic acid (H_2CO_3). Basicity of an acid is defined as the number of replaceable hydrogen ions present per molecule of an acid on complete ionisation.

3.1 Monobasic Acids

Acids which contain only one replaceable hydrogen ion per molecule on complete ionisation. e.g. HCl , HNO_3 , CH_3COOH .

Monobasic acids form single salts or normal salts.



The names of the salts formed by some monobasic acids are given below.

	Monobasic acids	Salts
(i)	Nitric acid	Nitrate
(ii)	Nitrous acid	Nitrite

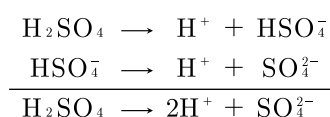
(iii)	Hydrochloric acid	Chloride
(iv)	Acetic acid	Acetate
(v)	Hydrobromic acid	Bromide
(vi)	Hydrofluoric acid	Fluoride

3.2 Dibasic Acids

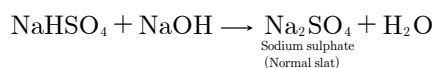
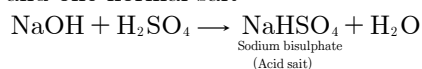
Dibasic acids are those acids which contain two replaceable hydrogen ions per molecule on complete ionisation. e.g. H_2SO_4 , H_2SO_3 , H_2CO_3 , etc.

For example :

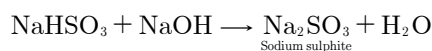
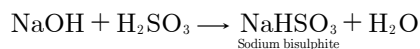
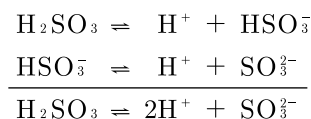
(i) Ionisation of sulphuric acid



Dibasic acids form two series of salts, one acid salt and one normal salt



(ii) The ionisation/dissociation of sulphurous acid



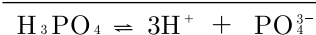
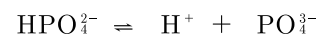
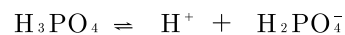
The names of the salts formed by some dibasic acids are given below :

	Di-basic acids	Salts
(i)	Sulphuric acid	Bisulphate and sulphate
(ii)	Sulphurous acid	Bisulphite and sulphite
(iii)	Carbonic acid	Bicarbonate and carbonate
(iv)	Hydrogen sulphide	Bisulphide and sulphide

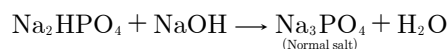
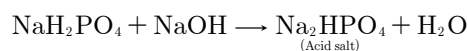
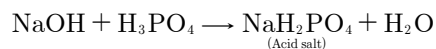
3.3 Tri-basic Acids

Tri-basic acids are those which contain three replaceable hydrogen ions per molecule on complete ionisation, e.g. H_3PO_4 .

Ionization of Phosphoric acid



Tribasic acids form two different acid salts and one normal salt.

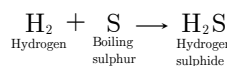
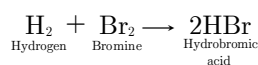
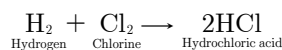


1. Concentration of an acid is the measure of the amount of water present in the acid.
2. Concentrated acid contains very less or negligible quantity of water.
3. Dilute acid contains more quantity of water and less quantity of acid.
4. Strong acid will remain strong even if is dilute because it produces high concentration of H^+ ions and weak acid will remain weak even if it is concentrated because it does not produce high concentration of H^+ ions.

3.4 Methods of Preparation of Acids

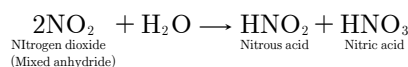
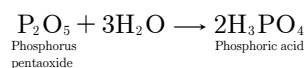
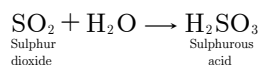
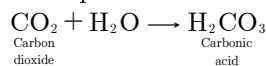
Acids are generally prepared by the following methods.

(a) By synthesis or direct combination :



(b) By dissolving acidic oxide or acid anhydride in water :

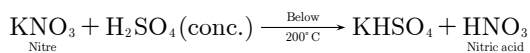
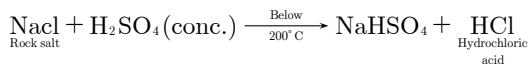
Acidic oxides are also called as acid anhydrides. Acidic oxides on dissolving in water produce acids.



(c) By the reaction of non-volatile acid with the salts to liberate more volatile acids :

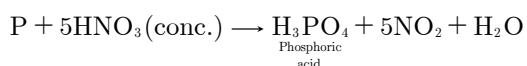
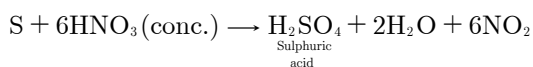
Concentrated sulphuric acid is the non-volatile or least volatile acid which reacts with metallic nitrates and metallic chlorides

to form nitric acid and hydrochloric acid respectively.



(d) By the oxidation of non-metals :

Non-metals on reaction with concentrated acids get oxidised to respective oxyacids.



3.5 Physical Properties

The physical properties of an acid are as follows

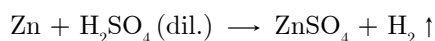
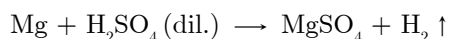
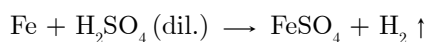
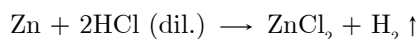
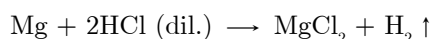
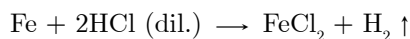
- They are sour in taste.
- Most of them are corrosive in nature.
- They conduct electricity in solution.
- They show characteristic colour change with indicators.

	Indicator	Colour change
1.	Blue litmus	Blue to red
2.	Phenolphthalein	Colourless to colourless
3.	Methyl orange	Orange to red or pink

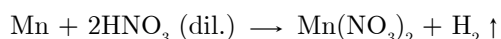
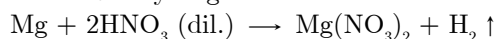
3.6 Chemical Properties

The typical chemical properties of a dilute acid are :

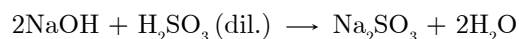
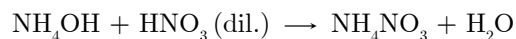
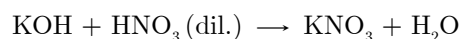
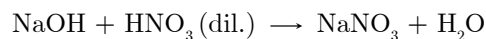
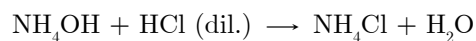
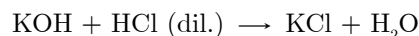
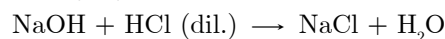
- (a) **Reaction with active metals:** Dilute acids (except dilute nitric acid) on reaction with active metals produce a colourless and odourless gas which burns with a popping sound.



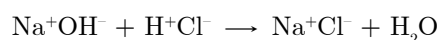
Nitric acid on reaction with metals produce oxides of nitrogen and water as it is a strong oxidising agent. Only magnesium and manganese react with very dilute nitric acid to liberate hydrogen.



- (b) **Reaction with bases :** Dilute acids react with bases to form salt and water as the only products and the reaction is called as neutralisation.



Ionic equation :

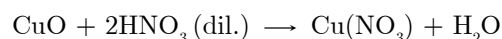
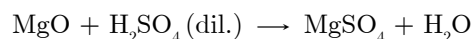
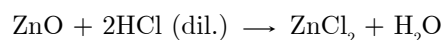
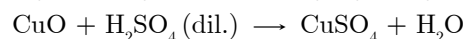


Deleting the spectator ions :

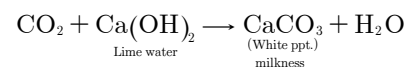
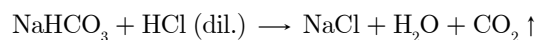
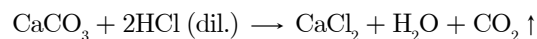
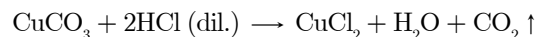
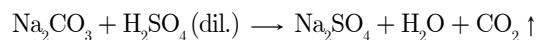
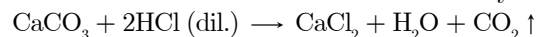


In neutralisation reaction, hydroxyl ion derived from the base and hydrogen ion derived from the acid combine to form unionised water molecule.

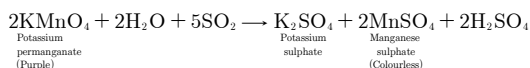
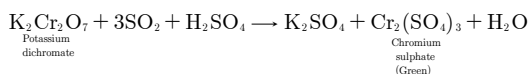
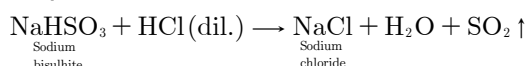
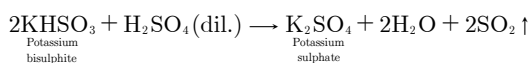
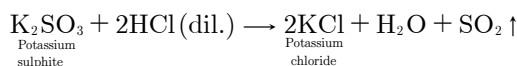
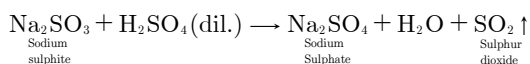
- (c) **Reaction with metallic oxides :** Metallic oxides react with acids to form salt and water.



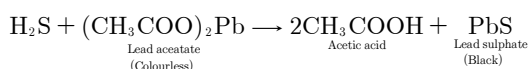
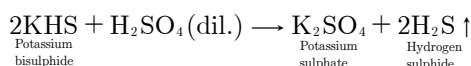
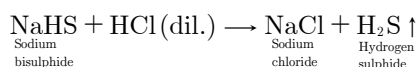
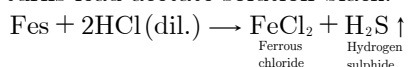
- (d) **Reaction with metallic carbonates and bicarbonates:** Dilute acids react with metallic carbonates and bicarbonates to liberate a colourless, odourless gas with brisk effervescence which turns lime water milky.



- (e) **Reaction with metallic sulphites and bisulphites:** Dilute acids react with metallic sulphites and bisulphites to liberate a colourless gas having burnt sulphur smell which turns acidified potassium dichromate from orange to green and potassium permanganate solution from purple to colourless, i.e. it decolourises.



- (f) Reaction with metallic sulphides and bisulphides: Dilute acids combine with metallic sulphides and bisulphides to form a colourless gas having rotten egg smell which turns lead acetate solution black.



4. BASE

A chemical compound which accepts protons $[\text{H}^+]$ to form salt and water as the only products.

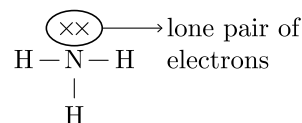
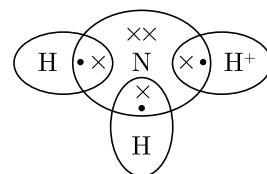
The metallic hydroxides and metallic oxides are called bases. The general formula of metallic hydroxide is $\text{M}(\text{OH})_x$, where x is the valency of metal.

- Alkalies :** These are the water soluble bases which in aqueous solution produce hydroxyl ions as the only negatively charged particles. NaOH , KOH , NH_4OH and $\text{Ca}(\text{OH})_2$. $\text{Ca}(\text{OH})_2$ is sparingly soluble.

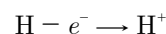


- Ammonium ion :** The ammonium ion is formed between ammonia molecule and hydrogen ion. In ammonia; there are three single covalent bonds between nitrogen and hydrogen and one lone pair of electrons on nitrogen atom. The hydrogen ion shares the lone pair of electrons from nitrogen atom to complete its dublet by a coordinate bond thereby leading to the formation of an ammonium ion.

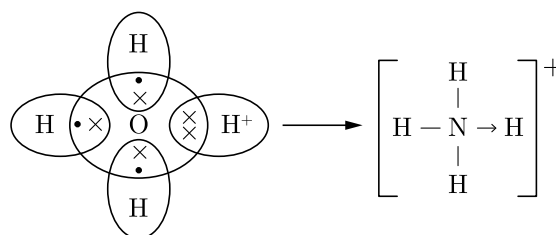
- (i) Formation of ammonia molecule



- (ii) Formation of hydrogen ion



- (iii) Formation of ammonium ion



5. CLASSIFICATION OF BASES

Bases are classified on the basis of their strength, acidity and concentration.

5.1 Strong Bases

The bases which almost completely ionise in their aqueous solutions are called strong bases. The solution of a strong base contains high concentration of hydroxyl ions $[\text{OH}^-]$, e.g. NaOH , KOH etc.

5.2 Weak Bases

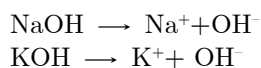
The bases which incompletely or partially ionise in their aqueous solutions are called weak bases. The solution of a weak base contains low concentration of hydroxyl ions $[\text{OH}^-]$ and molecules, e.g. NH_4OH , $\text{Cu}(\text{OH})_2$ etc.

Acidity of a base :

The number of replaceable hydroxyl ions present per molecule of a base on complete ionisation in its aqueous solution is called acidity of a base. In case of water insoluble bases, acidity is equal to the number of hydroxyl ions present per molecule of a base.

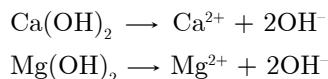
5.3 Mono-acidic Bases

The bases which contain only one hydroxyl ion per molecule of a base.



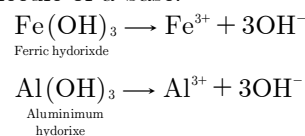
5.4 Diacidic Bases

The bases which contain two hydroxyl ions per molecule of a base.



5.5 Triacidic Bases

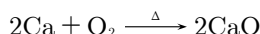
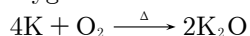
The bases which contain three hydroxyl ions per molecule of a base.



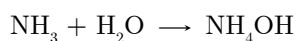
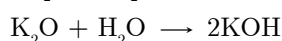
5.6 Methods of Preparation of Bases

Bases are generally prepared by the following methods.

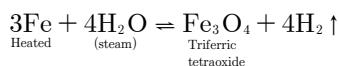
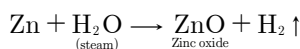
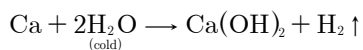
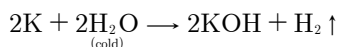
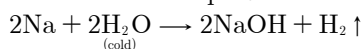
- (a) By reaction of metals with oxygen : Metals like sodium, potassium and calcium burn in oxygen to form their respective oxides.



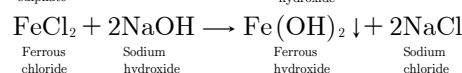
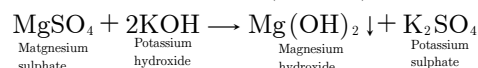
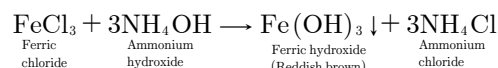
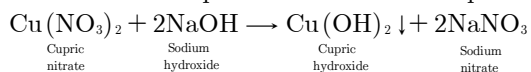
- (b) By the reaction of water with soluble metallic oxides and ammonia: Soluble basic oxides and ammonia on dissolving in water produces soluble bases.



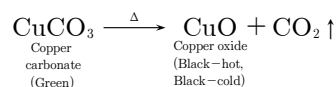
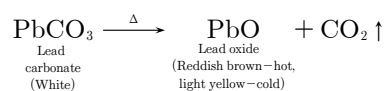
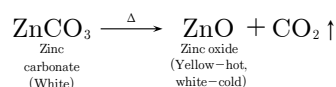
- (c) By the action of water on metals: Active metals react with water to displace hydrogen and form metallic hydroxide or metallic oxide depending on the nature of metal and the conditions of temperature.



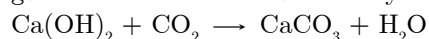
- (d) By the precipitation of metallic hydroxides from their soluble salts: In this case, interchange of radicals in solution takes place, i.e. double decomposition reaction takes place.



- (e) By thermal decomposition of metallic carbonates: Metallic carbonates on heating give their respective metallic oxides and carbon dioxide gas is evolved.

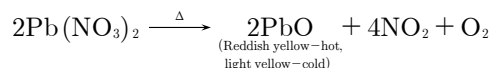


Carbon dioxide is a colourless and odourless gas which turns lime water milky.

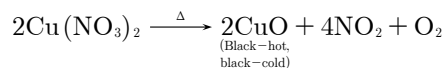
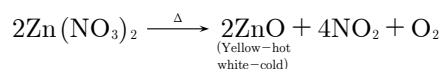


Sodium carbonate and potassium carbonate are stable towards heat.

- (f) Thermal decomposition of metallic nitrates: Metallic nitrates such as lead nitrates on heating decompose, melt to give off reddish brown coloured gas having pungent suffocating smell. A residue is left behind which sticks to the glass tube. The residue is reddish brown or reddish yellow when hot, and light yellow when cold.



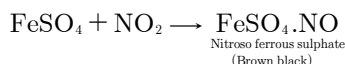
Similarly,



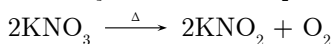
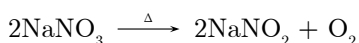
The colour of the residues are summarised in the table given below.

	Name of the residue	Colour of the residue	
		Hot	Cold
1.	Lead monoxide	Reddish brown/Reddish yellow	Light yellow
2.	Zinc oxide	Yellow	White
3.	Copper oxide	Black	Black

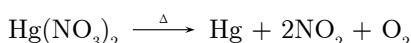
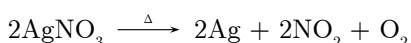
Nitrogen dioxide turns freshly prepared acidified ferrous sulphate solution brown black.



Sodium nitrate and potassium nitrate on heating forms their respective nitrite with the liberation of oxygen.



Silver nitrate and mercury nitrate on heating give their respective metal, nitrogen dioxide and oxygen.



5.7 Physical Properties

The physical properties of bases are :

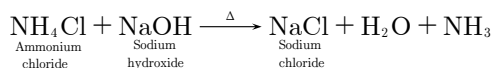
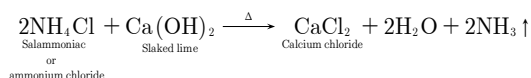
- They are bitter in taste.
- They have a soapy touch which gives slippery feel.
- Soluble bases show characteristic colour change with indicators.

	Indicator	Colour change
1.	Red litmus	Red to blue
2.	Phenolphthalein	Colourless to pink
3.	Methyl orange	Orange to yellow

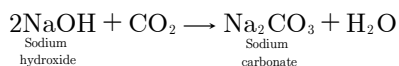
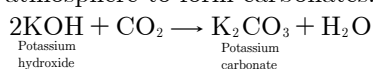
5.8 Chemical Properties

The chemical properties of bases are :

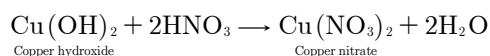
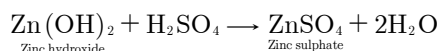
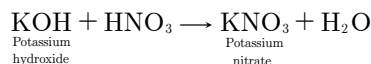
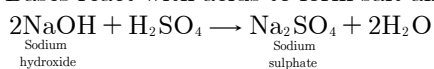
- Alkalies react with ammonium salts to liberate a colourless gas having pungent, irritating smell which turns Nessler's reagent brown and give dense white fumes with concentrated HCl.



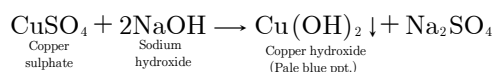
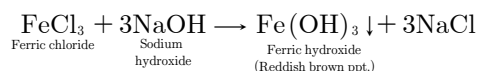
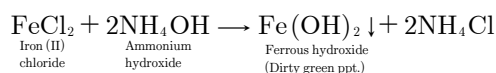
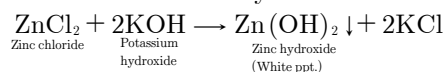
- Alkalies readily absorb carbon dioxide from atmosphere to form carbonates.



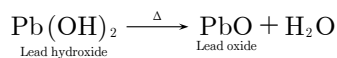
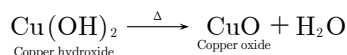
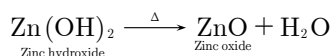
- Bases react with acids to form salt and water.



- Alkalies, i.e. soluble bases precipitate different coloured insoluble bases from the soluble metallic salts of heavy metals.

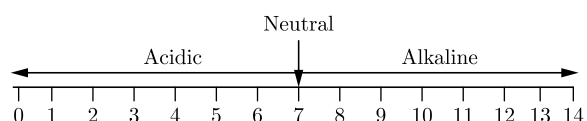


- Insoluble bases decompose on heating to form their respective metallic oxides and water.



6. PH SCALE

pH scale tells us whether the given solution is acidic, alkaline or neutral.



pH of pure water is equal to 7.

At

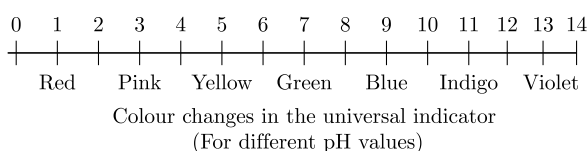
pH = 7, solution is neutral.

pH > 7, solution is alkaline.

pH < 7, solution is acidic.

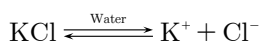
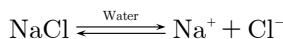
7. UNIVERSAL INDICATOR

Universal indicator is a mixture of several organic dyes. It not only tells whether the given solution is acidic or alkaline but it also predicts the strength of the given solution. It gives different colours with solutions of different pH.



8. SALTS

These are the chemical compounds which on dissolving in water produce positively charged particle other than hydrogen ions and negatively charged particles other than hydroxyl ions on dissociation.

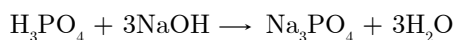
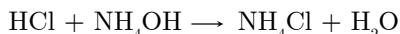
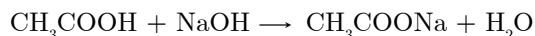
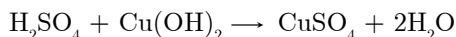
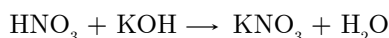
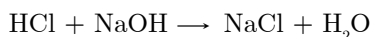
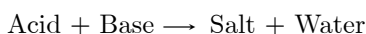


8.1 Classification of Salt

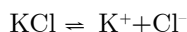
Salts can be classified as :

- (a) **Normal salt** : A salt formed by complete replacement of replaceable hydrogen ions of an acid by a basic radical, or metallic ion. Some examples of normal salt are sodium chloride (NaCl), potassium nitrate (KNO_3), copper sulphate (CuSO_4), sodium acetate (CH_3COONa), ammonium chloride (NH_4Cl) and sodium phosphate (Na_3PO_4).

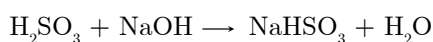
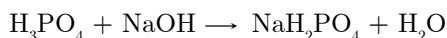
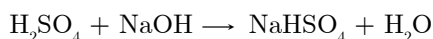
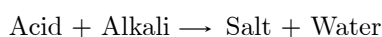
The formation of the above mentioned salts are shown below :



These salts on dissolving in water dissociate into their constituent ions.



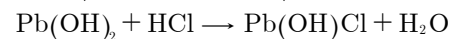
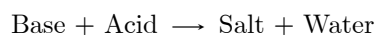
- (b) **Acid salt** : A salt formed by incomplete or partial replacement of replaceable hydrogen ions of an acid by a basic radical or metallic ion. Some examples of acid salt are sodium hydrogen sulphate (NaHSO_4), potassium bisulphate (KHSO_4), sodium dihydrogen phosphate (NaH_2PO_4) and sodium hydrogen sulphite (NaHSO_3). The formation of the above mentioned salts can be shown below :



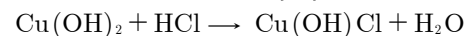
Acid salts are formed when the basicity of the acid taken is more than the acidity of a base. In aqueous solutions, acid salts furnish hydrogen ion or hydronium ion (H_3O^+). Hence, the aqueous solution of acid salt exhibits all the properties of an acid. The acid salt contains a cation obtained from the base and one or more hydrogen atoms of the acid attached to the anion obtained from the acid.

- (c) **Basic salt** : A salt formed by the partial or incomplete replacement of replaceable hydroxyl ions of diacidic or triacidic base by an acid radical. Some examples of basic salt are basic lead chloride (Pb(OH)Cl), basic copper chloride (Cu(OH)Cl), basic magnesium chloride (Mg(OH)Cl), basic lead nitrate (Pb(OH)NO_3), basic copper nitrate (Cu(OH)NO_3).

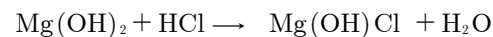
The formation of the above mentioned salts are shown below :



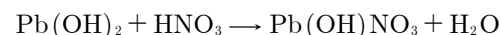
Basic lead chloride
or
Lead hydroxy chloride



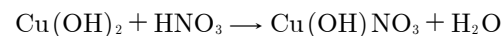
Basic copper chloride
or
Copper hydroxy chloride



Basic magnesium chloride
or
Magnesium hydroxy chloride



Basic lead nitrate
or
Lead hydroxy nitrate



Basic copper nitrate
or
Copper hydroxy nitrate

It is to be noted that basic salts are formed only when the acidity of the base taken is more than the basicity of the acid taken. The basic salts contain a metallic cation, a hydroxyl ion from the base and an anion obtained from the acid.

- (d) **Double salt** : A double salt is formed from two simple salts when they crystallise out from their a mixture of saturated solutions.

Example :

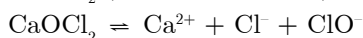
$\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$	–	Potash alum
$\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	–	Mohr's salt
$\text{K}_2\text{SO}_4 \cdot \text{Cr}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$	–	Chrome alum
$(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$	–	Ferric alum

The aqueous solution of a double salt furnishes the ions of its constituent salts.

- (e) **Mixed salt** : It contains more than one acid or basic radical.

Examples :

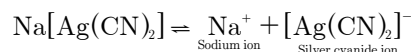
CaOCl_2 (Bleaching powder)



NaKCO_3 (Sodium potassium carbonate)

- (f) **Complex salt** : It gives one complex ion and one simple ion on dissolving in water.

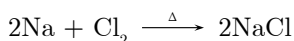
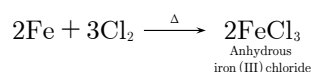
Examples :



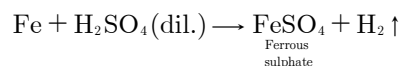
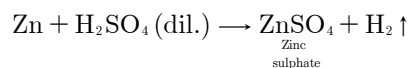
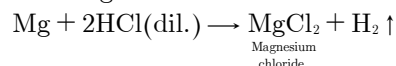
8.2 Soluble Salt Preparation

Soluble salts are generally prepared by the following methods :

- (a) **By synthesis** : Several soluble salts are prepared by heating the constituent elements together.

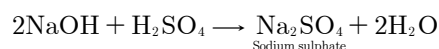
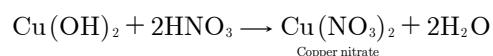
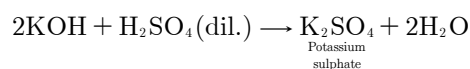
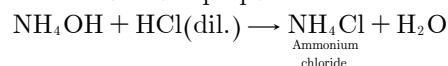


- (b) **By simple displacement** : Soluble salts of active metals like Mg, Zn, Fe, etc. can be prepared by the simple displacement reactions involving active metal and dilute acid.

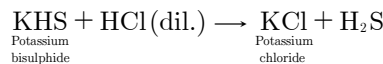
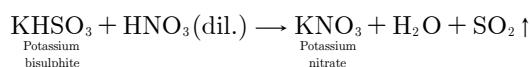
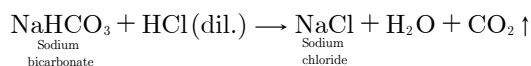
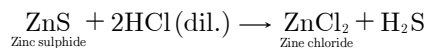
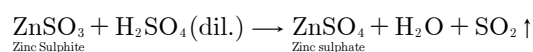
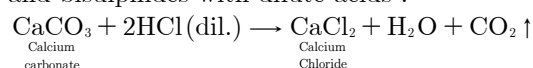


- (c) By double decomposition (neutralisation reaction) :

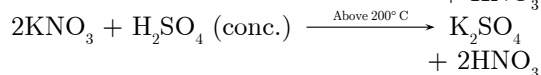
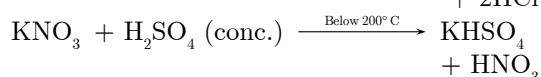
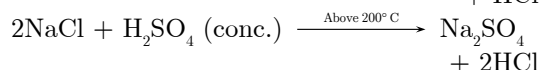
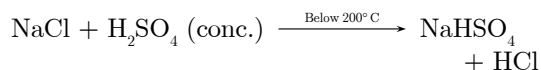
Insoluble or soluble bases react with acids to form salt and water. By this reaction, only soluble salts are prepared.



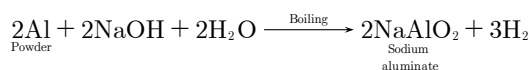
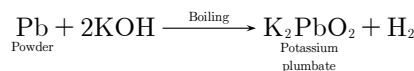
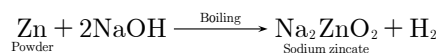
- (d) By the reaction of metallic carbonates, bicarbonates, sulphites, bisulphites, sulphides and bisulphides with dilute acids :



- (e) By the reaction of chlorides and nitrates with concentrated sulphuric acid :



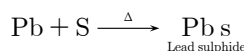
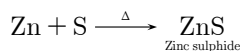
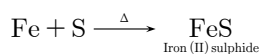
- (f) By the reaction of metals with alkalis :



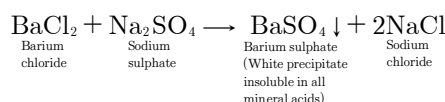
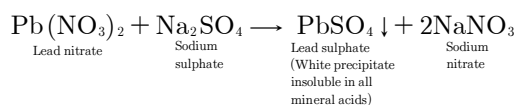
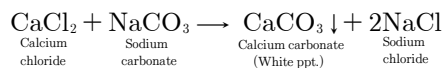
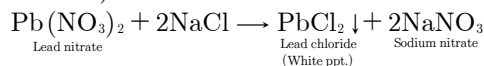
8.3 Insoluble Salts Preparation

Insoluble salts are prepared by the following methods:

- (a) **By synthesis** : Several insoluble salts are prepared by heating the constituent elements together.



- (b) Double decomposition (precipitation reaction):

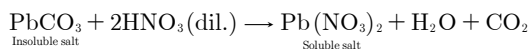


- (c) Insoluble salts cannot be directly prepared from another insoluble salt.

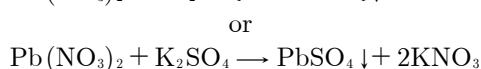
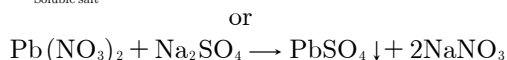
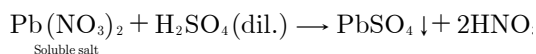
These salts are prepared by two steps.

For example conversion of lead carbonate to lead sulphate :

Step I : Conversion of insoluble salt to a soluble salt : By the reaction of insoluble salt with dilute nitric acid.



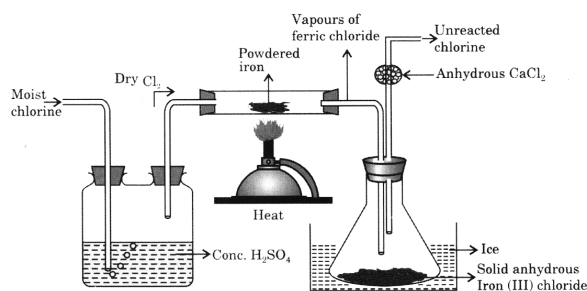
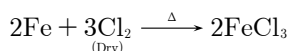
Step II : Soluble salt undergoes reaction with either dilute acid or another soluble salt (precipitation).



9. THE LABORATORY PREPARATION OF SOME NORMAL AND ACID SALTS ARE BRIEFLY GIVEN BELOW

1. Iron (III) chloride or anhydrous ferric chloride (By synthesis)

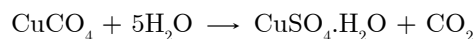
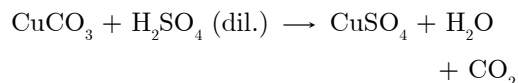
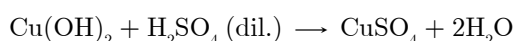
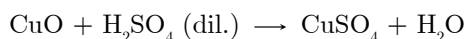
During the laboratory preparation of anhydrous ferric chloride, dry chlorine is passed over heated iron. The iron (III) chloride formed volatilises as its formation is exothermic and it condenses in the receiver as brown scales. As iron (III) chloride is highly deliquescent in nature, therefore it is kept dry in the receiver with the help of anhydrous calcium chloride which does not allow the moisture to enter into the receiver.



Experimental set-up for laboratory preparation of anhydrous iron (III) chloride

2. Copper (II) sulphate (By decomposition)

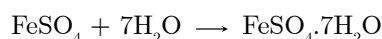
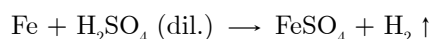
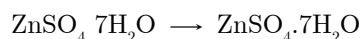
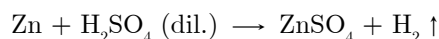
Copper sulphate can be prepared by the reaction of copper oxide, copper hydroxide or copper carbonate with dilute sulphuric acid.



Add copper oxide or copper hydroxide or copper carbonate to heated dilute sulphuric acid in small quantities with constant straining till no more compound gets dissolved in the acid and the unreacted compound gets settled to the bottom. Filter the hot solution and the filtrate is collected in a china dish. Evaporate the filtrate slowly by heating to the point of crystallisation and then allow it to cool. Bright blue crystals of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (blue vitrio-id) are formed which are further dried. The other salts prepared by this method are lead nitrate, copper nitrate, calcium chloride, etc.

3. Zinc sulphate (By displacement)

Salts like zinc sulphate, iron (II) sulphate can be prepared by the reaction of metals with dilute sulphuric acid. Metals like iron and zinc can displace hydrogen from dilute acids as they are lying above hydrogen in the metal activity series.



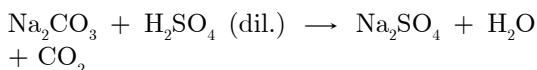
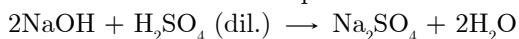
The following steps are involved in the preparation of zinc sulphate:

- (i) Dilute sulphuric acid is taken in a beaker and zinc pieces in little quantity are added to it with constant stirring till no further reaction takes place.
- (ii) Effervescence is observed during the liberation of hydrogen. When effervescence stops, it indicates the completion of reaction, i.e. all the acid has been used up.
- (iii) The above hot solution is filtered and the excess of zinc (unreacted) is removed.
- (iv) The filtrate is collected in a china dish and allowed to evaporate to get the crystals.
- (v) The crystals of $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ (white vitriol) obtained are filtered, washed and dried between the folds of filter paper.

4. Sodium sulphate (By neutralisation)

Sodium sulphate can be prepared by the neutralisation of sodium hydroxide or sodium

carbonate with dilute sulphuric acid.



For the preparation of sodium sulphate initially the process of titration is conducted as both the reactants and the products are soluble in water. So as to know the volumes of alkali and acid used up for the completion of reaction. The following steps are involved in the process of titration.

- (i) 5 cm³ of sodium hydroxide solution is measured and transferred in a titration flask. A drop of phenolphthalein is added. The solution turns pink. If Na₂CO₃ solution is taken then methyl orange is added.
- (ii) Now, rinse and fill the burette with dilute sulphuric acid. Note the initial reading of the burette. Now add acid drop by drop into the flask containing sodium hydroxide by constant shaking till the last drop de-colourises the solution (end point is completion of reaction). Now note the final reading of the burette and calculate the difference. The difference will give the volume of dilute sulphuric acid required to neutralise 5 cm³ of sodium hydroxide.
- (iii) The acid and alkali are mixed in the same ratio by volume (as determined by titration) in the evaporating dish. The solution contains sodium sulphate and water.
- (iv) On evaporating the solution, the crystals of Na₂SO₄·10H₂O are obtained.

10. PROPERTIES OF SALT

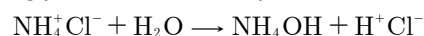
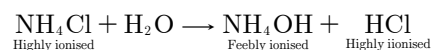
The properties of salts are as follows :

- (a) **Efflorescence** : Certain hydrated salts, when left exposed to atmosphere, lose their water of crystallisation and crumble into powder. Such salts are called efflorescent salts and the property is called efflorescence.
Examples : Na₂CO₃·10H₂O, Na₂SO₄·10H₂O and MgSO₄·7H₂O
- (b) **Deliquescence** : Certain water soluble salts, when left exposed to atmosphere, absorb moisture and get converted into their saturated solutions. Such salts are called deliquescent salts and the property is called deliquescence.
Examples : Ferric chloride, magnesium

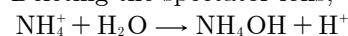
chloride, etc.

- (c) **Hygroscopy** : Certain substances, when left exposed to atmosphere, absorb moisture and become wet. Such substances are called hygroscopic substances and the property is called hygroscopy. Hygroscopic substances are called as drying agents.
Examples : Anhydrous calcium chloride, calcium oxide, concentrated sulphuric acid.
- (d) **Hydrolysis** : It is the phenomenon due to which salt of strong acid and weak base, or weak acid and strong base on dissolving in water reacts with it to form parent acid and alkali thereby rendering the solution either acidic or alkaline in nature.
 - (i) **Ammonium chloride** : It is a salt of strong acid and weak base.

Strong acid	Weak base
Hydrochloric acid (HCl)	Ammonium hydroxide (NH ₄ OH)



Deleting the spectator ions,



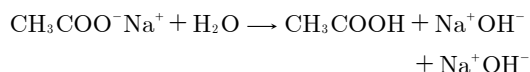
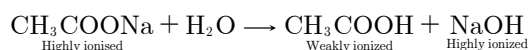
The presence of hydrogen ion render the solution acidic.

In general, a salt solution of strong acid and weak base is acidic in nature.

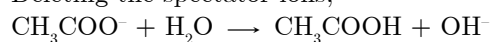
Other examples are ferric chloride, copper sulphate, ammonium sulphate, ammonium nitrate and aluminium chloride.

- (ii) **Sodium acetate** : It is a salt of strong base, i.e. NaOH and weak acid, i.e. CH₃COOH.

Strong base	Weak acid
Sodium hydroxide (NaOH)	Acetic acid (CH ₃ COOH)



Deleting the spectator ions,



The presence of hydroxyl ion renders the solution alkaline.

In general, a salt solution of weak acid and strong base is alkaline in nature and examples are potassium acetate, sodium

sulphide and sodium sulphite.

- (iii) **Sodium chloride** : It is a salt of strong acid (HCl) and strong base (NaOH). In general, the salts of a strong acid and a strong base do not hydrolyse and the solutions formed are neutral.

Other examples are KCl, KNO₃, NaNO₃, etc.

- (iv) **Ammonium acetate** : It is a salt of weak acid (CH₃COOH) acid a weak base (NH₄OH).

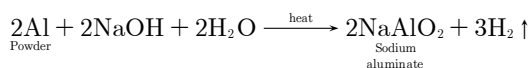
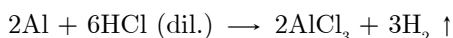
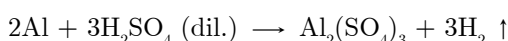
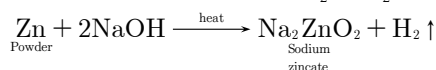
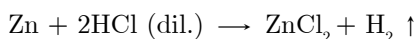
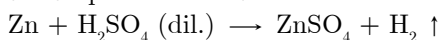
The salts of a strong acid and a strong base do not hydrolyse and the solution formed is neutral.

11. WATER OF CRYSTALLISATION

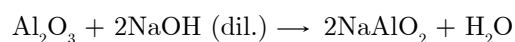
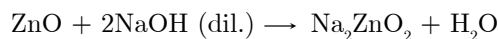
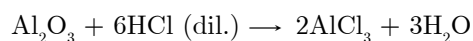
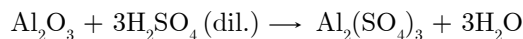
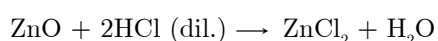
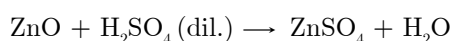
- The definite number of water molecules which enter into loose chemical combination with the salt when it crystallises out of its saturated solution.
- Hydrated salts (salts with water of crystallisation) on heating lose their water of crystallisation, i.e. lose their crystalline shape and the colour fades. For example if hydrated copper sulphate is heated, its colour changes from blue to white and crystalline shape becomes amorphous.



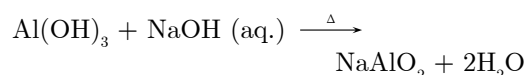
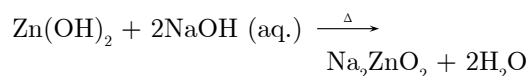
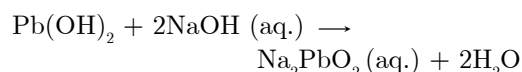
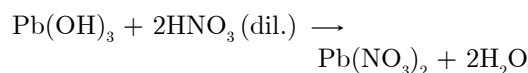
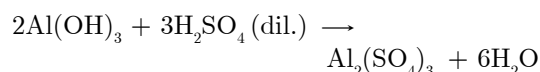
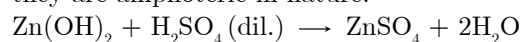
- Hydrated salts on heating become anhydrous. The substance that removes water molecules from a compound or other substances is called a dehydrating agent, e.g. H₂SO₄.
- Zinc and aluminium displace hydrogen from the acids as well as alkalies, therefore, they are amphoteric in nature.



- The oxides of Zinc and Aluminium react with acids as well as alkalies to form salt and water as the only products, therefore, they are amphoteric in nature.



- The hydroxides of Zinc, Aluminium and lead react with acids as well as alkalies to form salt and water as the only products, therefore, they are amphoteric in nature.



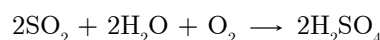
12. SOLUBILITY TABLE OF SALTS

- All salts of sodium, potassium and ammonium are soluble in water.
- All nitrates and nitrites are soluble in water.
- All sulphates are soluble in water.
Except : CaSO₄, PbSO₄, BaSO₄
- All chlorides are soluble in water.
Except : Hg₂Cl₂, AgCl and PbCl₂ (soluble in hot water)
- All sulphites are insoluble in water.
Except : Na₂SO₃, K₂SO₃ and (NH₄)₂SO₃
- All sulphides are insoluble in water.
Except : Na₂S, K₂S and (NH₄)₂S
- All carbonates are insoluble in water.
Except : Na₂CO₃, K₂CO₃ and (NH₄)₂CO₃

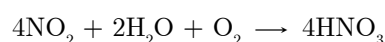
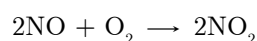
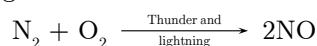
13. EQUATION FOR THE ACID RAIN

The oxides of sulphur (released from oil refineries) and the oxides of nitrogen (released by automobiles exhaust) produce acid rain.

Sulphur dioxide combines with oxygen and water to form sulphuric acid.



Nitrogen dioxide form nitric acid.



MULTIPLE CHOICE QUESTION

1. A compound *P* is heated in a test tube with sodium hydroxide solution. A red litmus paper held at the mouth of the test tube turns blue. Which of the following could compound *P* be?
- (a) zinc sulphate (b) copper sulphate
(c) ferrous sulphate (d) ammonium sulphate

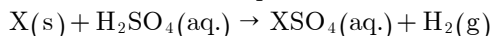
Ans :

SQP 2025

Ammonium sulphate reacts with sodium hydroxide to produce sodium sulphate, ammonia gas, and water. The red litmus turns blue due to the basic ammonia gas.

Thus (d) is correct option.

2. The equation below shows the reaction between element 'X' and dilute sulphuric acid.



Which particles are responsible for conducting electricity in dilute sulphuric acid and compound XSO_4 ?

- (a) Electrons
(b) Only positive ions
(c) Only negative ions
(d) Both positive and negative ions

Ans :

SQP 2025

Thus (d) is correct option.

3. Which of the following about oxides is correct?
- (a) A basic oxide is an oxide of a non-metal
(b) Acidic oxides contain ionic bonds
(c) Amphoteric oxides contain a metal
(d) Basic oxides are always gases

Ans :

SQP 2025

Thus (c) is correct option.

4. The metal hydroxide which reacts with both acids and alkalis to form salt and water is:
- (a) Calcium hydroxide
(b) Magnesium hydroxide
(c) Aluminium hydroxide
(d) Ferric hydroxide

Ans :

MAIN 2024

Amphoteric hydroxides react with both alkalis and acids. Aluminium hydroxide is an amphoteric in nature.

Thus (c) is correct option.

5. On passing ammonia gas over heated copper oxide for some time, a reddish-brown residue

is left behind. What property of ammonia is demonstrated here?

- (a) Basic property
(b) Oxidising property
(c) Reducing property
(d) Acidic property

Ans :

MAIN 2024

When ammonia gas (NH_3) is passed over heated copper oxide (CuO) and a brown color residue is left, it indicates the reducing property of ammonia.

Thus (c) is correct option.

6. If the pH of a solution is '2', then the solution is a
- (a) strong acid (b) strong alkali
(c) weak acid (d) weak alkali

Ans :

COMP 2021

Lower pH values of solutions represent more acidic in nature, So pH with value 2 is a strong acid.

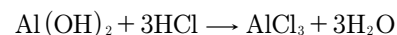
Thus (a) is correct option.

7. The acidity of aluminium hydroxide is
- (a) 3 (b) 1
(c) 4 (d) 2

Ans :

SQP 2021

The chemical formula of Aluminium hydroxide is $Al(OH)_3$. When it reacts with any acid.



It requires 3 acidic H^+ ions to neutralize therefore its acidity is 3.

Thus (a) is correct option.

8. Which of the following is a tribasic acid?
- (a) H_2SO_4 (b) $Al(OH)_3$
(c) H_3PO_4 (d) $Ca(OH)_2$

Ans :

MAIN 2021

Phosphoric acid (H_3PO_4) is a tribasic acid because it has three hydrogen ions that can be donated to a base in a neutralization reaction. When it decomposes, phosphoric acid forms three hydrogen ions, which are attached to oxygen.

Thus (c) is correct option.

The products formed when an acid reacts with a base is

- (a) salt and hydrogen
(b) salt and oxygen
(c) salt and water
(d) salt and carbon dioxide

Ans :

COMP 2021

Acid and bases react to form salt and water. This is an example of neutralization reaction.
Thus (c) is correct option.

10. Hydracids are those acids which contain
(a) hydrogen with any meal
(b) hydrogen, a non-metal and oxygen
(c) hydrogen and a non-metal other than oxygen
(d) hydrogen and oxygen only

Ans : MAIN 2021

Acids that contain Hydrogen and other non-metallic elements, except Oxygen, are called Hydracids.
Thus (c) is correct option.

11. Hydroxide of this metal is soluble in sodium hydroxide solution :
(a) Magnesium (b) Lead
(c) Silver (d) Copper

Ans : SQP 2011

Hydroxide of this metal is soluble in sodium hydroxide solution is Lead.
Thus (b) is correct option.

12. Which one of the following will not produce an acid when made to react with water?
(a) Carbon monoxide (b) Carbon dioxide
(c) Nitrogen dioxide (d) Sulphur trioxide

Ans : COMP 2013

Carbon monoxide does not react with water to form an acid.
Thus (a) is correct option.

13. To increase the pH value of neutral solution, we should add
(a) an alkali (b) an acid salt
(c) an acid (d) a salt

Ans : SQP 2016

Acidic nature is represented by the lower range of the pH scale (1 to 6) and alkaline nature is represented by the upper range of the pH scale (8 to 14). As a result, we should use an alkali to raise the pH of a neutral solution ($\text{pH} = 7$).
Thus (a) is correct option.

14. The salt in which the solution gives a pale green precipitate with sodium hydroxide solution and a white precipitate with barium chloride solution is
(a) iron (III) sulphate (b) iron (II) sulphate
(c) iron (II) chloride (d) iron (III) chloride

Ans : COMP 2008

Iron (III) sulphate is a salt that produces a pale green precipitate in sodium hydroxide solution and a white precipitate in barium chloride solution.
Thus (b) is correct option.

15. Dilute sulphuric acid will produce a white precipitate when added to a solution of
(a) copper nitrate (b) zinc nitrate
(c) lead nitrate (d) sodium nitrate

Ans : SQP 2008

According to the solubility rule for sulphates, lead sulphate is not soluble in water and thus, lead sulphate precipitates out. Thus, dilute sulphuric acid produces white precipitate when added to the solution of lead nitrate.
Thus (c) is correct option.

16. An electrolyte which completely dissociates into ions is :
(a) Alcohol (b) Carbonic acid
(c) Sucrose (d) Sodium hydroxide

Ans : MAIN 2019

Sodium hydroxide (NaOH) is an example of an electrolyte that completely dissociates into ions. In fact, strong electrolytes, like strong acids and strong bases, completely dissociate into ions when dissolved in water.
Thus (d) is correct option.

17. When dilute sulphuric acid reacts with iron sulphide, the gas evolved is
(a) hydrogen sulphide
(b) sulphur dioxide
(c) sulphur trioxide
(d) vapour of sulphuric acid

Ans : COMP 2011

When dilute sulfuric acid (H_2SO_4) reacts with iron sulfide (FeS), the gas evolved is hydrogen sulfide (H_2S).
Thus (a) is correct option.

18. Anhydrous iron (III) chloride is prepared by
(a) direct combination
(b) simple displacement
(c) decomposition
(d) neutralisation reaction

Ans : SQP 2017

Anhydrous iron (III) chloride, also known as ferric chloride, is prepared by directly combining iron metal with dry chlorine gas. This process is called direct combination, where two reactants combine

to form a product.

Thus (a) is correct option.

19. A particular solution contains molecules and ions of the solute so it is a :

(a) Weak acid (b) Strong acid
(c) Strong base (d) Salt solution

Ans :

MAIN 2016

A solution that contains both molecules and ions of a solute is a weak acid. Weak acids are poor conductors of electricity and only allow small amounts of current to pass through them. They also contain undissociated molecules in addition to ions.

Thus (a) is correct option.

20. An organic weak acid is :

(a) Formic acid (b) Sulphuric acid
(c) Nitric acid (d) Hydrochloric acid

Ans :

COMP 2010

A weak organic acid is an acid that only partially dissociates in an aqueous solution, producing relatively few hydrogen ions.

Thus (a) is correct option.

21. Select the acid which contains four hydrogen atoms in it.

(a) Formic acid (b) Sulphuric acid
(c) Nitric acid (d) Acetic acid

Ans :

MAIN 2009

Acetic acid is the acid that contains four hydrogen atoms.

Thus (d) is correct option.

22. The aqueous solution of the following compounds which contains both ions and molecules is :

(a) Sulphuric acid (b) Hydrochloric acid
(c) Nitric acid (d) Acetic acid

Ans :

COMP 2009

The aqueous solution of the compound which contains both ions and molecules is hydrochloric acid.

Thus (d) is correct option.

23. The metal oxide which can react with acid as well as alkali is :

(a) Silver oxide (b) Copper (II) oxide
(c) Aluminium oxide (d) Calcium oxide

Ans :

SQP 2009

Aluminium oxide is a metal oxide that can react with both acids and alkalis, also known as bases.

Metal oxides that react with both acids and bases are called amphoteric oxides.

Thus (c) is correct option.

24. Which one of the following will not produce an acid when made to react with water ?

(a) Carbon monoxide (b) Carbon dioxide
(c) Nitrogen dioxide (d) Sulphur trioxide

Ans :

MAIN 2013

Carbon monoxide does not react with water to form an acid.

Thus (a) is correct option.

25. Lime juice has a sour taste while lime water is slightly bitter. Why ?

(a) Lime water is alkaline
(b) Lime juice contains citric acid
(c) Both (a) and (b) are correct
(d) None of the above

Ans :

COMP 2013

Lime juice contains citric acid which imparts a sour taste to it while lime water is alkaline and hence bitter to taste.

Thus (c) is correct option.

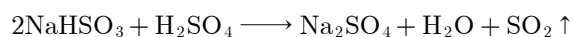
26. The gas liberated when sodium sulphite reacts with dilute sulphuric acid:

(a) Carbon dioxide
(b) Hydrogen
(c) Sulphur dioxide
(d) Hydrogen sulphide

Ans :

MAIN 2017

Acids react with sulphites to liberate sulphur dioxide gas.



Thus (c) is correct option.

27. An organic weak acid is :

(a) Nitric acid (b) Sulphuric acid
(c) Formic acid (d) Hydrochloric acid

Ans :

SQP 2011

Organic acids, in general, are weak acids that do not entirely dissociate in water, whereas strong mineral acids do.

Thus (c) is correct option.

28. The metal oxide which can react with acid as well as alkali is :

(a) Silver oxide (b) Aluminium oxide
(c) Copper(II) oxide (d) Calcium oxide

Ans :

COMP 2018

Aluminium oxide is a metal oxide that can react with both acid and alkali. It is an amphoteric oxide that reacts with both acid and base (alkali). Thus (b) is correct option.

29. The acid which can produce carbon from cane sugar, is :

(a) Concentrated Hydrochloric acid
(b) Concentrated Sulphuric acid
(c) Concentrated Nitric acid
(d) Concentrated Acetic acid

Ans :

SQP 2020

H_2SO_4 has a high attraction to water. It can remove water from the compound if it is concentrated, that is, if there is a higher concentration of sulphuric acid present. However, because a substantial amount of water is already present around it when it is diluted, it will not work as a dehydrating agent.

Thus (b) is correct option.

30. When copper oxide and dilute hydrochloric acid react, colour changes to:

(a) white (b) black
(c) blue-black (d) bluish-green

Ans :

MAIN 2023

A blue – green solution is produced when copper oxide and weak hydrochloric acid are combined

Thus (d) is correct option.

31. Which of the given is a strong base?

(a) Potassium hydroxide
(b) Magnesium hydroxide
(c) Ammonium hydroxide
(d) Calcium hydroxide

Ans :

SQP 2022

Because KOH is a strong base ($\text{KOH} = \text{K}^+ + \text{OH}^-$), it dissociates fully in water into negative (hydroxide ion, OH^-) and positive ions.

Thus (a) is correct option.

32. A strong acid:

(a) Do not get ionized in water
(b) Partially gets ionized in water
(c) completely gets ionized in water
(d) All the these

Ans :

COMP 2010

In an aqueous Solutions a strong acid is fully dissociated or ionised into ions.

Thus (c) is correct option.

33. What is formed when zinc reacts with sodium hydroxide?

(a) Zinc hydroxide and sodium
(b) Sodium zincate and water
(c) Sodium zinc-oxide and hydrogen gas
(d) Sodium zincate and hydrogen gas

Ans :

COMP 2010

Excess sodium hydroxide reacts with zinc to generate sodium zincate (Na_2ZnO_2) and hydrogen gas.

Thus (d) is correct option.

34. The salt prepared by the method of direct combination is

(a) iron (III) Sulphide
(b) iron (III) Chloride
(c) iron (III) Sulphide
(d) None of the above

Ans :

MAIN 2013

A chemical process in which two or more simple chemicals combine to generate a more complex result is known as a direct combination reaction. The reactants might be either elements or compounds, and the final result is invariably a compound.

Thus (b) is correct option.

35. When a metallic oxide is dissolved in water, the solution formed has high concentration of ions.

(a) OH^- (b) H^+
(c) H_2O_2^- (d) None of the above

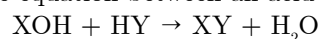
Ans :

SQP 2018

When a metallic oxide is dissolved in water, the resulting solution contains a large amount of hydroxide ion. These are the most fundamental solutions. Let's look at an example. Sodium hydroxide is formed when sodium oxide is dissolved with water. The solution is basic and a huge quantity of hydroxide ions are released.

Thus (a) is correct option.

36. The equation between an acid and a base is



In the given equation, which specie act as a cation?

(a) Y (b) OH
(c) H (d) X

Ans :

COMP 2019

When an acid reacts with a base, salt and water is formed.

In the given question 'XOH' is the base which gives OH^- ions and 'HY' is the acid (which gives H^+ ions)

Hence 'X' acts as a cation.

Thus (d) is correct option.

37. As the pH of solution increases, the strength of the solution progressively decreases.
 (a) Acidic (b) Atomic
 (c) Basic (d) None of these

Ans :

SQP 2017

We know that $[\text{H}^+]$ increases, the pH value decreases and acidity increases. As the pH value increases, $[\text{H}^+]$ decreases and basicity increases.

Thus (a) is correct option.

38. Vinegar contains acid.
 (a) Phenol (b) Hydrochloric
 (c) Sulphuric (d) Acetic

Ans :

MAIN 2011

Vinegar is an aqueous solution of acetic acid which is produced by fermentation.

Thus (d) is correct option.

39. An acid is a compound which when dissolved in water gives ions as the only ions.
 (a) Hydronium, negative
 (b) Peroxide, negative
 (c) Hydronium, positive
 (d) Peroxide, positive

Ans :

COMP 2000

An acid is a compound which when dissolved in water to give hydronium (H_3O^+) ions which carry positive charges.

Thus (c) is correct option.

40. $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ is:
 (a) bleaching powder (b) baking soda
 (c) washing soda (d) tartaric acid

Ans :

SQP 2010

Sodium carbonate decahydrate $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ is also known as washing soda.

Thus (c) is correct option.

41. The reaction, which involves the formation of salts is
 (a) neutralisation reaction
 (b) redox reaction
 (c) decomposition reaction
 (d) combination reaction

Ans :

MAIN 2008

A neutralization reaction is when an acid and a base react to form water and a salt.

Thus (a) is correct option.

42. Absorption of moisture when exposed to atmosphere.
 (a) Hydrophobic
 (b) Hygroscopic substances
 (c) Hydrolytic substances
 (d) None of these

Ans :

SQP 2005

Hygroscopic substance absorb moisture from the atmosphere when exposed to it but unlike deliquescent substances do not change their state after absorption of moisture.

Thus (b) is correct option.

43. The product of $[\text{H}^+]_{(\text{aq})}$ and $[\text{OH}^-]_{(\text{aq})}$ is called the
 (a) Covalent compound
 (b) Molecular compound
 (c) The Ionic product
 (d) Metallic compound

Ans :

COMP 2000

Thus (c) is correct option.

44. A reaction in which proton combines with hydroxyl ions to form water.
 (a) Precipitation reaction
 (b) acidification reaction
 (c) neutralisation reaction
 (d) amphoteric reaction

Ans :

SQP 2008

The reaction between a proton (H^+) and a hydroxyl ion (OH^-) is called neutralization and produces water.

Thus (c) is correct option.

45. A base having a relatively low percentage of base in its aqueous solution
 (a) Dilute acid
 (b) Concentrated acid
 (c) Concentrated base
 (d) Dilute base

Ans :

MAIN 2004

An aqueous solution which has a relatively low percentage of the base is a dilute base. For e.g. dilute sodium hydroxide, diluted potassium hydroxide, dilute ammonium hydroxide, etc.

Thus (d) is correct option.

46. A strong, non-volatile acid
(a) Sulphuric acid (H_2SO_4)
(b) Nitric Acid (HNO_3)
(c) Acetic Acid (CH_3COOH)
(d) Hydrochloric Acid (HCl)

Ans :

COMP 2007

Sulphuric acid (H_2SO_4) is a strong but non-volatile mineral acid.

Thus (d) is correct option.

47. The acid anhydride of sulphuric acid is :
(a) Sulphur trioxide
(b) Sulphur dioxide
(c) Sulphur monochloride
(d) None of these

Ans :

SQP 2010

Sulphur trioxide (SO_3) is the acidic anhydride form of sulphuric acid (H_2SO_4).

Thus (a) is correct option.

48. The aqueous solution of the following compounds which contains both ions and molecules is:
(a) Sulphuric acid (b) Acetic acid
(c) Nitric acid (d) Hydrochloric acid

Ans :

COMP 2011

Because acetic acid is a weak electrolyte, it dissociates slowly and produces few ions, resulting in a solution that contains both molecules and ions.

Because all of the others are strong electrolytes, they completely dissociate and form ions.

Thus (b) is correct option.

49. Why zinc chloride is stored in air-tight bottles ?
(a) Because it is highly basic substance.
(b) Because it is highly reactive substance.
(c) Because it is highly acidic substance.
(d) Because it is a deliquescent substance.

Ans :

COMP 2022

Zinc chloride absorbs moisture from the atmosphere and turns into solution because it is a deliquescent substance. In order to prevent this, it is stored in air tight bottles.

Thus (d) is correct option.

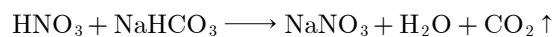
50. Which gas is evolved when HNO_3 react with sodium bicarbonate?
(a) CO_2 (b) SO_2
(c) H_2 (d) H_2S

Ans :

COMP 2021

HNO_3 reacts with sodium bicarbonate to liberate

carbon dioxide gas.



Thus (a) is correct option.

51. Which one of the following will not produce an acid when made to react with water ?
(a) Nitrogen dioxide (b) Carbon dioxide
(c) Carbon monoxide (d) Sulphur trioxide

Ans :

SQP 2018

Acid rain is caused when carbon dioxide combines with water to form carbonic acid. So, only carbon monoxide does not generate an acid when it comes into contact with water.

Thus (c) is correct option.

52. Which one of the following salts does not contain water of crystallisation?
(a) Blue vitriol (b) Gypsum
(c) Washing soda (d) Baking soda

Ans :

MAIN 2009

Baking soda is sodium bicarbonate in anhydrous form, meaning it doesn't include any water throughout the crystallisation process.

Thus (d) is correct option.

53. Rain is called acid rain when its:
(a) pH falls below 5.6 (b) pH falls below 6
(c) pH falls below 7 (d) pH is above 7

Ans :

COMP 2010

Rainwater has a pH of 5-6, which is somewhat acidic. Acid rain occurs when the pH level of rainwater goes below this range.

Thus (a) is correct option.

54. Which gas is evolved when HCl react with calcium carbonate?
(a) CO_2 (b) H_2
(c) SO_2 (d) H_2S

Ans :

MAIN 2015

HCl reacts with calcium carbonate to liberate carbon dioxide gas



Thus (a) is correct option.

55. Sodium carbonate is a basic salt because it is a salt of a:
(a) strong acid and strong base
(b) weak acid and strong base
(c) strong acid and weak base
(d) weak acid and weak base

Ans :

SQP 2018

Sodium carbonate is a basic salt because it is derived from a weak acid (carbonic acid) and strong base (sodium hydroxide).

Thus (b) is correct option.

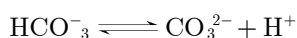
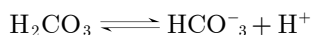
56. Carbonic acid is a dibasic acid. Why ?

- (a) Because it has double electron at its valence cell
- (b) Because it has two replaceable hydrogen atoms
- (c) Both (a) and (b) are correct
- (d) None of the above

Ans :

COMP 2002

Carbonic acid (H_2CO_3) is a dibasic acid because it has two replaceable hydrogen atoms and hence it combines with two hydroxyl groups of the bases to form two kinds of salt and water.



Thus (b) is correct option.

57. The salt of the acid HNO_2 are called and those of the acid HNO_3 are called

- (a) nitrates, nitrites
- (b) nitrites, nitrous
- (c) nitrous, nitrates
- (d) nitrites, nitrates

Ans :

MAIN 2005

The salt of the acid HNO_2 are called nitrites and those of the acid HNO_3 are called nitrates. Some examples of nitrite salts are ammonium nitrite, calcium nitrite, sodium nitrite etc. Some example of nitrate salts are ammonium nitrate (NH_4NO_3), sodium nitrate (NaNO_3) and potassium nitrate (KNO_3).

Thus (d) is correct option.

58. The acid which cannot act as an oxidizing agent is

- (a) conc. HCl
- (b) conc. HNO_3
- (c) conc. H_2SO_4
- (d) none of the above

Ans :

SQP 2007

Although hydrochloric acid is not an oxidising agent, it can be oxidised by extremely powerful oxidising agents, releasing chlorine gas. Hydrogen chloride is almost entirely decomposed into hydrogen and chloride ions in dilute acid solutions. Thus (a) is correct option.

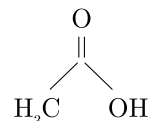
59. The basicity of acetic acid is

- (a) 4
- (b) 2
- (c) 3
- (d) 1

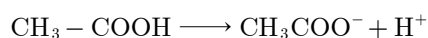
Ans :

MAIN 2009

Acetic acid has a chemical structure with 4 hydrogen atoms, 2 carbon atoms, and the functional group oxygen/ as shown below.



The following is the dissociation formula for acetic acid:



Although the molecule of Acetic Acid has four hydrogen atoms, it only contains one replaceable hydrogen ion. As a result, there is just one ionizable H^+ ion and its basicity is 1.

Thus (d) is correct option.

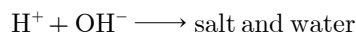
60. A chemical reaction between hydronium ions of an acid and OH^- ions of a base to form unionised water is called

- (a) Formation
- (b) Galvanisation
- (c) Alkalisiation
- (d) Neutralisation

Ans :

COMP 2010

A chemical reaction between hydronium ions of an acid and OH^- ions of a base to form unionised water is called neutralisation reaction.



These salts are extremely harmful to human health.

Thus (d) is correct option.

61. Which one of the given is the pH value of pure water?

- (a) 0
- (b) 1
- (c) 8
- (d) 7

Ans :

SQP 2020

Pure water is neither acidic nor basic. It is neutral. pH value changes with temperature.

Thus (d) is correct option.

62. 10^{-6}M HCl is divided to 100 times its pH will be

- (a) 6.0
- (b) 8.0
- (c) 9.5
- (d) 6.95

Ans :

MAIN 2023

Given,

$$\text{Concentration of HCl} = 10^{-6} \text{ M}$$

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After dilution conc. of $\text{HCl} = \frac{10^{-6}}{100} = 10^{-8} \text{ M}$

$$\text{pH} = -\log [\text{H}^+]$$

Hence,
$$\text{pH} = -\log [10^{-8}]$$

$$= 8$$

But this is not true because an acidic solution cannot have pH greater than 7. In this case, $[\text{H}^+]$ ions of water molecule cannot be neglected. Thus,

$$[\text{H}^+] = [\text{H}^+]_{\text{HCl}} + [\text{H}^+]_{\text{H}_2\text{O}} \quad \dots(i)$$

As we know, ionic product

$$[\text{H}^+][\text{OH}^-] = 10^{-14}$$

Hence,
$$[\text{H}^+] = 10^{-7}$$

$$\begin{aligned} [\text{H}^+]_{\text{total}} &= 10^{-8} + 10^{-7} \quad (\text{from Eq. (i)}) \\ &= 10^{-8}(1 + 10) \\ &= 11 \times 10^{-8} \end{aligned}$$

Now from,
$$\text{pH} = -\log [\text{H}^+]$$

$$= -\log (11 \times 10^{-8})$$

$$= -\log 11 - \log 10^{-8} = 6.957$$

Thus (d) is correct option.

- 63.** A blue litmus paper was first dipped in dil. HCl and then in dil. NaOH solution. It was observed that the colour of the litmus paper
- changed to red
 - remain blue in both the solution
 - changed blue to colourless
 - changed first to red and then to blue

Ans : SQP 2016

Blue litmus paper when dipped in dil. HCl (acidic solution), it changes to red but when dipped in dil. NaOH (alkaline solution), it changes to blue. Thus (d) is correct option.

- 64.** NaHSO_3 is an example of which type of salts?
- Complex salts
 - Basic salts
 - Normal salts
 - Acidic salts

Ans : COMP 2012

NaHSO_3 is an acidic salt. Acid salt is a chemical compound, formed when a dibasic or tribasic acid was neutralized to some degree. Despite being a salt, the replaceable hydrogen remains. It acts like an acid, because when the acid salt is ionized, it yields a H^+ ion which demonstrates the acidic properties.

Thus (d) is correct option.

- 65.** Identify the metallic oxide which is amphoteric in nature:
- Calcium oxide
 - Zinc oxide
 - Barium oxide
 - Copper(II) oxide

Ans : MAIN 2010

Zinc oxide is an amphoteric oxide as it reacts with both acids and alkalis to give salt and water.

Thus (b) is correct option.

- 66.** For pure water hydroxyl ion concentration is equal to concentration.
- Hydrogen ions (H^+)
 - Hydroxide ions (OH^-)
 - Nitrate ions (NO_3^-)
 - Bicarbonate ions (HCO_3^-)

Ans : COMP 2013

In pure water at 25°C , the concentration of hydroxide ions is equal to the concentration of hydronium ions.

Thus (a) is correct option.

- 67.** Which of the following hydroxides is not an alkali?
- copper hydroxide
 - calcium hydroxide
 - ammonium hydroxide
 - sodium hydroxide

Ans : SQP 2015

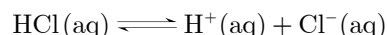
Copper hydroxide is basic but it is not soluble in water. So, it is not an alkali.

Thus (a) is correct option.

- 68.** Hydrochloric acid is considered as a strong acid whereas acetic acid is a weak acid. Why ?
- Because it dissociates partially when dissolved in water.
 - Because it dissociates completely in water.
 - Both (a) and (b) are correct
 - None of the above

Ans : MAIN 2017

Hydrochloric acid is considered as a strong acid because it dissociates correctively in water.



Acetic acid is a weak acid as it dissociates partially when dissolved in water. Most of its molecules remain in molecular form in the solution.



Thus (a) is correct option.

69. An alkali which on dissociation produces a high concentration of hydroxyl ions
 (a) Calcium Hydroxide $[\text{Ca}(\text{OH})_2]$
 (b) Potassium Hydroxide (KOH)
 (c) Sodium Hydroxide (NaOH)
 (d) Caesium Hydroxide (CsOH)

Ans :

COMP 2019

A strong alkali is an alkali that dissociates almost completely in water to produce a high concentration of hydroxide ions. Examples of strong alkalis include sodium hydroxide (NaOH) and potassium hydroxide.

Thus (c) is correct option.

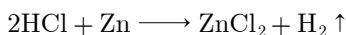
70. Which the gas evolved when the following reactions takes place?

- (a) CO_2 (b) H_2
 (c) SO_2 (d) H_2S

Ans :

SQP 2013

Dilute acids react with active metals such as Zn to liberate hydrogen gas



Thus (b) is correct option.

71. A compound used as an antacid
 (a) Sodium Hydroxide (NaOH)
 (b) Magnesium hydroxide $(\text{Mg}[\text{OH}]_2)$
 (c) Hydrogen Sulfide (H_2S)
 (d) Potassium Hydroxide (KOH)

Ans :

COMP 2018

A compound used as an antacid also known as milk of magnesia, this antacid is non-toxic and works by neutralizing stomach acids.

Thus (b) is correct option.

72. Hydrated copper sulphate on heating changes to :
 (a) Blue and crystalline
 (b) White and amorphous
 (c) Blue and amorphous
 (d) White and crystalline

Ans :

MAIN 2011

When hydrated copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) is heated, it changes color from blue to white and its crystalline form changes to amorphous. This is because the compound loses its water of crystallization and breaks apart to form anhydrous CuSO_4 and H_2O .

Thus (b) is correct option.

73. An acid which contains four hydrogens but is monobasic.

- (a) Sulphuric acid (H_2SO_4)
 (b) Hydrochloric Acid (HCl)
 (c) Nitric Acid (HNO_3)
 (d) Acetic Acid (CH_3COOH)

Ans :

SQP 2008

Acetic acid is monobasic though it contains four H atoms.

Thus (d) is correct option.

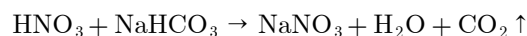
74. Which gas is evolved when HNO_3 react with sodium bicarbonate?

- (a) H_2 (b) SO_2
 (c) CO_2 (d) H_2S

Ans :

COMP 2011

HNO_3 reacts with sodium bicarbonate to liberate carbon dioxide gas



Thus (c) is correct option.

75. A solution whose pH is greater than 7, then the solution is in nature.

- (a) acidic (b) neutral
 (c) basic (d) None of these

Ans :

MAIN 2013

A pH of 7 is neutral. A pH less than 7 is acidic. A pH greater than 7 is basic.

Thus (c) is correct option.

76. Match the following columns and choose the correct option:

	Column A		Column B
A.	Acid salt	(i)	Ferrous ammonium sulphate.
B.	Double salt	(ii)	Contains only ions.
C.	Ammonium hydroxide solution	(iii)	sodium hydrogen sulphate.
D.	Dilute hydrochloric	(iv)	Contains only ions acid.
E.	Carbon tetrachloride	(v)	contains ions and molecules.

- (a) B-i, C-iv, D-ii, E-iv
 (b) A-v, B-i, C-ii, D-iv, E-iii
 (c) A-i, B-iv, C-ii, D-v, E-iii
 (d) A-ii, B-iv, C-i, D-v, E-iii

Ans :

COMP 2018

The correct combination of column A and column B as follows

B-i, C-iv, D-ii, E-iv

Thus (a) is correct option.

77. The salt which in solution gives a pale green precipitate with sodium hydroxide solution and a white precipitate with barium chloride solution is:

- (a) Iron (II) sulphate
(b) Iron (III) sulphate
(c) Iron (II) chloride
(d) Iron (III) chloride

Ans :

SQP 2016

Iron (III) sulphate is a salt that produces a pale green precipitate in sodium hydroxide solution and a white precipitate in barium chloride solution.

Thus (a) is correct option.

78. Alkalis are:

- (a) bases, which are soluble in water.
(b) acids, which are insoluble in water.
(c) bases, which are insoluble in water.
(d) acids, which are soluble in water.

Ans :

MAIN 2000

Alkali is a base. It's a type of base that may be dissolved in water. Although not all bases are alkali, all alkali are bases.

Thus (a) is correct option.

79. Sodium hydroxide turns phenolphthalein solution.

- (a) orange (b) yellow
(c) colourless (d) pink

Ans :

COMP 2011

In an alkaline solution, phenolphthalein produces a pink hue as an indication of the reaction's endpoint when it interacts with the base's hydroxide ions.

Thus (d) is correct option.

80. An alkali which completely dissociates into ions is

- (a) calcium hydroxide
(b) ammonium hydroxide
(c) barium hydroxide
(d) None of the above

Ans :

MAIN 2015

When calcium hydroxide is dissolved in water, it separates into calcium ions and hydroxide ions. Antimicrobial properties are conferred to a solution by the presence of hydroxide ions.

Thus (a) is correct option.

81. Ammonium hydroxide is a base.

- (a) Weak (b) Strong
(c) does not change (d) None of the above

Ans :

SQP 2019

Because it is soluble in water and the pH of ammonium hydroxide is in between 7-10, it is considered as a weak base.

Thus (a) is correct option.

82. Which of the following statement is correct?

- (a) Bases are sour in taste.
(b) Anion can be used as an oil factory indicator to check acid or base.
(c) Bases turn blue litmus solution to red.
(d) pOH is defined as the logarithm of $[\text{OH}^-]$ ions.

Ans :

COMP 2023

Bases are sour in taste. They do not turn blue litmus to red and their strength is given by

$$p(\text{OH}) = -\log[\text{OH}^-]$$

Thus (a) is correct option.

83. Which one of the following will not produce an acid when made to react with water ?

- (a) Nitrogen dioxide (b) Carbon dioxide
(c) Carbon monoxide (d) Sulphur trioxide

Ans :

SQP 2019

Carbon monoxide is the only option that doesn't produce an acid when it reacts with water. In fact, carbon monoxide doesn't contribute to acid rain, while other gases like sulfur dioxide, carbon dioxide, and nitrogen oxides do.

Thus (c) is correct option.

84. A salt is dissolved in water. The pH of this salt solution was found to be 7 by measuring the pH with a universal indicator paper. The salt is most likely to be

- (a) Na_2CO_3 (b) NH_4Cl
(c) KCl (d) CH_3COONa

Ans :

COMP 2011

NH_4Cl will give an acidic solution because it is made up of a strong acid and weak base.

Thus (c) is correct option.

85. A base having three hydroxyl ions in its molecule

- (a) $\text{Fe}(\text{OH})_3$ (b) H_3PO_4
(c) H_2SO_4 (d) $\text{Cu}(\text{OH})_2$

Ans :

SQP 2013

Base that contains three hydroxyl ions and combines with three hydrogen ions is called triacidic base.

Thus (a) is correct option.

86. Identify the metallic oxide which is amphoteric in nature

- (a) Zinc oxide (b) Barium oxide
(c) Calcium oxide (d) Copper (II) oxide.

Ans :

MAIN 2015

Zinc oxide (ZnO) is an amphoteric metallic oxide that reacts with both acids and alkalis to produce salts and water.

Thus (a) is correct option.

87. What happens when a solution of an acid is mixed with a solution of a base in a test tube?

- (a) Temperature of the solution increases.
(b) Temperature of the solution decreases.
(c) Temperature of the solution remains the same
(d) None of the above

Ans :

MAIN 2009

Salt and water are made by combining acid and base. This process is exothermic in nature, releasing heat known as heat of neutralisation causing a temperature increase. When acid is added to any base, the temperature of the acid-base reaction rises.

Thus (a) is correct option.

88. Sodium hydroxide is used:

- (a) as an antacid
(b) as a cleansing agent
(c) in manufacture of soap
(d) in alkaline batteries

Ans :

COMP 2000

Soaps, rayon, paper, explosives, dyestuffs, and petroleum products are all made with sodium hydroxide.

Thus (c) is correct option.

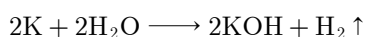
89. Which gas is liberated when metals like sodium, potassium and calcium react with cold water?

- (a) H_2S (b) CO_2
(c) SO_2 (d) H_2

Ans :

MAIN 2001

Metals like sodium, potassium and calcium react with cold water and form their corresponding hydroxides along with the liberation of H_2 gas.



Thus (d) is correct option.

90. An acid used to remove ink stains

- (a) Acetic acid (CH_3COOH)
(b) Hydrochloric acid (HCl)
(c) Oxalic acid [$H_2C_2O_4$]
(d) Nitric acid (HNO_3)

Ans :

SQP 2009

Oxalic acid is used to remove ink stains from clothes because it converts most insoluble iron compounds into a soluble complex ion.

Thus (c) is correct option.

91. Why fused calcium chloride is used in the preparation of $FeCl_3$?

- (a) $FeCl_3$ is highly deliquescent
(b) $FeCl_3$ is highly basic
(c) $FeCl_3$ is highly reactive
(d) $FeCl_3$ is highly acidic

Ans :

COMP 2013

$FeCl_3$ is highly deliquescent, so it is kept dry with the help of fused calcium chloride and is used in the preparation of $FeCl_3$.

Thus (a) is correct option.

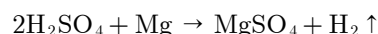
92. Which gas is evolved when dilute $MgSO_4$ react with active metals such as Mg?

- (a) CO_2 (b) H_2
(c) SO_2 (d) H_2S

Ans :

COMP 2017

Dilute acids react with active metals such as Mg to liberate hydrogen gas.



Thus (b) is correct option.

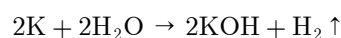
93. Which gas is liberated when metals like sodium, potassium and calcium react with cold water?

- (a) CO_2 (b) H_2
(c) SO_2 (d) H_2S

Ans :

MAIN 2020

Metals like sodium, potassium and calcium react with cold water and form their corresponding hydroxides along with the liberation of H_2 gas.



Thus (b) is correct option.

94. Choose oxyacid from the following acids:

- (a) Nitric acid (b) Hydroiodic acid
(c) Hydrochloric acid (d) Hydrofluoric acid.

Ans :

COMP 2023

Phosphoric acid, Sulfuric acid, and nitric acid are all examples of oxyacids.

Thus (a) is correct option.

95. Universal indicators impact colour in neutral solution.

- (a) Red (b) Green
(c) Yellow (d) Blue

Ans :

MAIN 2015

A neutral solution turns a universal indicator green, which corresponds to a pH of 7. The universal indicator contains a spectrum of dyes, including water, propan-1-ol, phenolphthalein sodium salt, sodium hydroxide, methyl red, bromothymol blue monosodium salt and thymol blue monosodium salt.

Thus (b) is correct option.

96. A black colour solid, which on reaction with dilute sulphuric acid forms a blue coloured solution. It is

- (a) carbon
(b) copper (II) oxide
(c) lead (II) oxide
(d) manganese (IV) Oxide

Ans :

COMP 2018

Copper (II) oxide forms a blue-colored solution with dilute sulphuric acid.

Thus (b) is correct option.

97. An aqueous solution turns red litmus solution blue. Excess addition of which of the following solution would reverse the change?

- (a) Baking powder
(b) Hydrochloric acid
(c) Ammonium hydroxide solution
(d) Lime

Ans :

SQP 2012

If an aqueous solution turns red litmus blue, hydrochloric acid can reverse the change. Hydrochloric acid is an acid, and acids reverse the effects of bases.

Thus (b) is correct option.

98. Sodium acetate hydroxide and

- (a) benzene (b) cytosine
(c) acetic acid (d) glycerol

Ans :

COMP 2014

When sodium acetate is dissolved in water, it splits into sodium and acetate ions rather quickly. The sodium ions react only slightly with

the hydroxyl ions already present in the water to generate sodium hydroxide molecules because sodium hydroxide is a strong base.

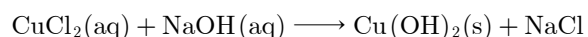
Thus (c) is correct option.

99. Copper (II) chloride reacts with sodium hydroxide to form copper hydroxide and sodium chloride.

- (a) Does not react
(b) Insoluble
(c) Soluble
(d) Depends on the catalyst

Ans :

MAIN 2005



Aqueous copper chloride is a blue-colour solution, whereas aqueous sodium hydroxide is colourless. As a result of their reaction, blue colour precipitate, copper hydroxide, and colourless sodium chloride solution are produced.

Thus (b) is correct option.

100. Methyl orange is:

- (a) Pink in acidic medium, colourless in basic medium
(b) Yellow in acidic medium, pink in basic medium
(c) Colourless in acidic medium, pink in basic medium
(d) Pink in acidic medium, yellow in basic medium

Ans :

COMP 2011

Because of its clear and distinct colour variance at different pH values, methyl orange is an often used pH indicator in titration. It turns pink in acidic medium and yellow in basic medium.

Thus (d) is correct option.

101. An aqueous solution turns red litmus solution blue. Excess addition of which of the following solution would reverse the change?

- (a) Baking powder
(b) Lime
(c) Hydrochloric acid
(d) Ammonium hydroxide solution

Ans :

SQP 2014

Because it turns red litmus solution blue, the aqueous solution is a base. The alteration might be reversed using an acidic solution like hydrochloric acid. Hydrochloric acid, on the other hand, would turn blue litmus solution red.

Thus (c) is correct option.

- 102.** To increase the pH value of neutral solution, we should add :

(a) An acid (b) An acid salt
(c) A salt (d) An alkali

Ans :

COMP 2004

The lower range of the pH scale (1 to 6) denotes acidic nature, and the upper range (8 to 14) denotes alkaline nature. As a result, we should use an alkali to raise the pH of a neutral solution (pH = 7).

Thus (d) is correct option.

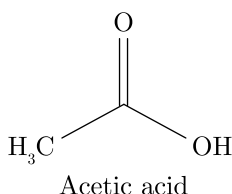
- 103.** Select the acid which contains four hydrogen atoms in it :

(a) Acetic acid (b) Sulphuric acid
(c) Nitric acid (d) Formic acid

Ans :

MAIN 2006

Acetic acid is a four hydrogenatom compound. Structure of acetic acid:



Thus (a) is correct option.

- 104.** The solution with the lowest concentration of H^+ ion is

(a) pH = 8.6 (b) pH = 7
(c) pH = 2.0 (d) pH = 6.7

Ans :

COMP 2005

We know that, $pH = -\log[H^+]$, means more be the value of pH, lesser be the concentration of H^+ ions.

Thus (a) is correct option.

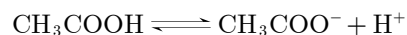
- 105.** Acetic acid is mono basic. Why ?

(a) Because it has single electron at its valence cell.
(b) Because it has one ionisable hydrogen ion and combines with one hydroxyl ion.
(c) Both (a) and (b) are correct.
(d) None of the above.

Ans :

SQP 2011

Acetic acid is mono-basic because it has one ionisable hydrogen ion and combines with one hydroxyl ion of the base to give a single salt and water.



Thus (b) is correct option.

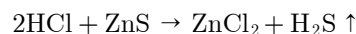
- 106.** Which gas is evolved when HCl react with zinc sulphide?

(a) H_2S (b) CO_2
(c) SO_2 (d) H_2

Ans :

COMP 2017

HCl reacts with zinc sulphide to liberate hydrogen sulphide gas.



Thus (a) is correct option.

- 107.** Nitrogen oxide is a :

(a) Greenish yellow coloured gas
(b) Reddish brown coloured gas
(c) Colourless and odourless gas
(d) None of these.

Ans :

SQP 2020

The nitrogen gas at higher temperature is a reddish brown gas. The nitrogen dioxide is paramagnetic in nature. Thus, the oxides of nitrogen is a colored gas is nitrogen dioxide.

Thus (b) is correct option.

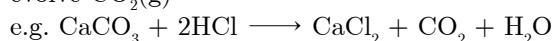
- 108.** Which gas is evolved when acids react with metal carbonates?

(a) NH_3 (b) H_2
(c) CO_2 (d) O_2

Ans :

COMP 2011

When metal carbonates react with acids, they evolve $CO_2(g)$



Thus (c) is correct option.

- 109.** A basic gas extremely soluble in water

(a) Ammonia (NH_3)
(b) Helium (He)
(c) Hydrogen Sulfide (H_2S)
(d) Hydrogen (H_2)

Ans :

MAIN 2010

Ammonia is highly soluble because there is hydrogen bonding possible between ammonia and water molecules.

Thus (a) is correct option.

- 110.** Concentration of H^+ ions in water is

(a) 10^{-5} (b) 10^{-4}
(c) 10^{-9} (d) 10^{-7}

Ans :

COMP 2017

In pure water, hydrogen ion concentration is 10^{-7} . Pure water is neutral, with a pH value of 7.0. When chemicals are mixed with water, the mixture may begin to be acidic or basic.

Thus (d) is correct option.

111. To increase the pH value of a neutral solution, we should add

(a) an alkali (b) an acid salt
(c) an acid (d) a salt

Ans :

SQP 2019

To increase the pH value of neutral solution we should add an alkali.

Thus (a) is correct option.

112. Methyl orange turns in acidic solution.

(a) Yellow (b) Blue
(c) Pink (d) Red

Ans :

COMP 2011

Alkaline and neutral water will become yellow when exposed to methyl orange. When water gets acidig it instantly becomes red.

Thus (d) is correct option.

113. The divalent metal whose oxide is reduced to metal by electrolysis of its fused salt is

(a) Mg (b) Al
(c) Ca (d) Ag

Ans :

MAIN 2006

The valency of a divalent or bivalent ion or atom is two. For magnesium to achieve its octet, it must shed two valence electrons. As a result, it is ambivalent. Magnesium is a highly reactive alkaline earth metal in nature. Magnesium is one of nature's most abundant metals.

Thus (a) is correct option.

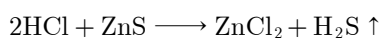
114. Which gas is evolved when HCl react with zinc sulphide?

(a) H_2 (b) H_2S
(c) SO_2 (d) CO_2

Ans :

COMP 2001

HCl reacts with zinc sulphide to liberate hydrogen sulphide gas



Thus (b) is correct option.

115. Which of the following statements is correct about an aqueous solution of an acid and of a base?

(i) Higher the pH, stronger the acid

(ii) Higher the pH, weaker the acid
(iii) Lower the pH, stronger the base
(iv) Lower the pH, weaker the base
(a) (i) and (iii) (b) (ii) and (iii)
(c) (ii) and (iv) (d) (i) and (iv)

Ans :

MAIN 2021

Acids are those with a pH below 7; the lower the pH, the stronger the acid; similarly, bases are those with a pH greater than 7. The higher the pH the more acidic it will be.

Thus (c) is correct option.

116. In terms of acidic strength, which one of the following is in the correct increasing order?

(a) Acetic acid < Water < Hydrochloric acid
(b) Water < Hydrochloric acid < Acetic acid
(c) Water < Acetic acid < Hydrochloric acid
(d) Hydrochloric acid < Water < Acetic acid

Ans :

SQP 2000

Because it is a strong acid, HCl has the maximum acidic strength and entirely or 100 percent ionises into its ions. Acetic acid partially dissociates into its ions and both the ions, acetate and hydrogen ions, are present at equilibrium. Both have a lower acidic strength than HCl. Water is the weakest of all the elements.

Thus (a) is correct option.

117. You are supplied with five solutions : A, B, C, D and E with pH values as follows:

A = 1.8 , B = 7 , C = 8.5 , D = 13 and E = 5

(a) A is neutral (b) A is strong base
(c) A is strong acid (d) cannot say

Ans :

COMP 2002

A solution having low pH has high concentration of H^+ ion. Thus a solution with low pH and high H^+ ion concentration is considered as a strong acid.

Thus (c) is correct option.

118. What is the pH value of sodium chloride?

(a) more than 7 (b) 7
(c) less than 7 (d) zero

Ans :

SQP 2004

The pH of a sodium chloride solution remains 7 due to the extremely weak basicity of the Cl^- ion which is the conjugate base of the strong acid HCl.

Thus (b) is correct option.

- 119.** The pH values of three solutions, A, B and C are given in the table. Answer the following questions:

Solution	pH value
A	12
B	2
C	7

- (i) Which solution will have no effect on litmus solution ?
 (a) A (b) B
 (c) C (d) None of these

Ans :

MAIN 2010

Solution C would have no effect on litmus solution as its pH is 7 and hence it is neutral.
 Thus (c) is correct option.

- (ii) Which solution will liberate CO_2 when reacted with sodium carbonate ?
 (a) B (b) C
 (c) A (d) None of these

Ans :

COMP 2013

Solution B would liberate CO_2 when reacted with sodium carbonate as it is acidic solution and has pH 2.

Thus (a) is correct option.

- (iii) Which solution will turn red litmus solution blue?
 (a) B (b) C
 (c) A (d) None of these

Ans :

SQP 2017

Solution A would turn red litmus solution blue as it is basic in nature and has pH 12.

Thus (b) is correct option.

- 120.** An organic weak acid is:
 (a) Sulphuric acid (b) Formic acid
 (c) Nitric acid (d) Hydrochloric acid

Ans :

MAIN 2000

A weak organic acid is an acid that only partially dissociates in an aqueous solution, producing relatively few hydrogen ions.

Thus (b) is correct option.

- 121.** Ion Liberated when acid reacts with water
 (a) Bicarbonate (HCO_3)
 (b) Hydronium ion (H_3O^+)
 (c) Hydroxide (OH^-)
 (d) Sulfate (SO_4^{2-})

Ans :

COMP 2015

When an acid is dissolved in water, it furnishes hydrogen ions, and consequently, the concentration of hydrogen ions increases in the solution.

Thus (b) is correct option.

- 122.** If few drops of a concentrated acid accidentally spills over the hand of a student, what should be done?
 (a) Wash the hand immediately with plenty of water and apply a paste of sodium hydrogen carbonate.
 (b) Wash the hand with saline solution.
 (c) After washing with plenty of water apply solution of sodium hydroxide on the hand.
 (d) Neutralise the acid with a strong alkali.

Ans :

MAIN 2015

Wash the hand immediately with plenty of water to wash away most of the acid and then apply a paste of baking soda (NaHCO_3) to neutralise the effect of any acid left. A strong alkali cannot be used since it is as corrosive as a strong acid.

Thus (a) is correct option.

- 123.** The interaction of a salt with water to give acidic, basic or neutral solution.
 (a) Hydrolysis (b) Electrolysis
 (c) Sublimation (d) None of these

Ans :

COMP 2017

The cations or anions formed during the ionisation of salts either exist as hydrated ions in aqueous solutions or interact with water to regenerate the acids and bases. The process of interaction between cations or anions of salts and water is known as hydrolysis of salts.

Thus (a) is correct option.

- 124.** When hydrogen reacts with non-metals, the formation of takes place.
 (a) base (b) acid
 (c) salt (d) hydronium ions

Ans :

MAIN 2014

When hydrogen reacts with non-metals, the formation of acid takes place.

Thus (b) is correct option.

- 125.** On diluting solution to pH of 4, its pH will
 (a) increase
 (b) remain same
 (c) decrease
 (d) None of these

Ans :

COMP 2016

Given, $\text{pH} = 4$

On dilution, the concentration of H^+ ions decreases, that results in increase in the pH value, as $\text{pH} = -\log[\text{H}^+]$

Thus (a) is correct option.

- 126.** A acid undergoes almost complete dissociation on dissolving in water.

(a) Weak (b) strong
(c) Normal (d) None of the above

Ans :

COMP 2018

Strong acids are those that totally dissociate in water, while weak acids are those that partially dissociate in water.

Thus (b) is correct option.

- 127.** A salt which absorbs moisture from the air, but does not change in physical state is called salt.

(a) Microscopic (b) Acidic
(c) Alkaline (d) hygroscopic

Ans :

SQP 2011

Hygroscopic refers to a substance that absorbs moisture from the air but not to the point of disintegration. The deliquescence of calcined calcium chloride makes it good at settling road dust.

Thus (d) is correct option.

- 128.** Higher the pH value of a solution, the more it is.

(a) Evaporative (b) Alkaline
(c) Basic (d) None of the above

Ans :

COMP 2021

The lesser the pH value, more acidic is the solution and higher the pH value more alkaline is the solution. At pH below 7 solutions are acidic in nature and above 7 solutions are alkaline in nature.

Thus (b) is correct option.

- 129.** Some fruits like mango, lemon, raw grapes, orange, etc., have a sour taste due to the presence of:

(a) Citric acid (b) Acetic acid
(c) Lactic acid (d) Oxalic acid

Ans :

SQP 2012

Citric acid is one of the several types of acids. It is a weak organic acid found in fruits like lemony orange, etc.

Thus (a) is correct option.

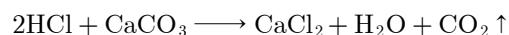
- 130.** Which gas is evolved when HCl react with calcium carbonate?

(a) H_2 (b) H_2S
(c) SO_2 (d) CO_2

Ans :

MAIN 2003

HCl reacts with calcium carbonate to liberate carbon dioxide gas.



Thus (d) is correct option.

- 131.** An example of mineral acid is

(a) HCl (b) H_2O_2
(c) ATP (d) CaCO_3

Ans :

COMP 2007

Sulphuric acid, hydrochloric acid, and nitric acid are the most often utilised mineral acids (they are also known as bench acids). Mineral acids range in strength from superacids (perchloric acid) to mild acids (potassium hydroxide).

Thus (a) is correct option.

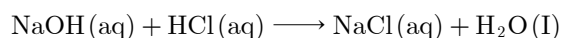
- 132.** Sodium hydroxide is a mono-acidic base. Why ?

(a) Because it has double electron at its valence cell
(b) Because it has single electron at its valence cell
(c) It combines with only one hydrogen ion
(d) None of the above

Ans :

SQP 2000

Sodium hydroxide is a mono-acidic base as it combines with only one hydrogen ion



Thus (c) is correct option.

- 133.** Which of the following gives the correct increasing order of acid strength?

(a) hydrochloric acid < water < acetic acid
(b) Water < hydrochloric acid < acetic acid
(c) Acetic acid < water < hydrochloric acid
(d) Water < acetic acid < hydrochloric acid

Ans :

COMP 2000

The increasing order of acidic strength can be represented by Water < Acetic acid < Hydrochloric acid.

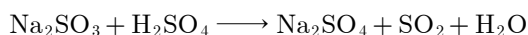
Thus (d) is correct option.

- 134.** Sodium sulphite reacts with dilute sulphuric acid to form sodium sulphate, gas and water.

(a) HO_2 (b) H_2SO_4
(c) SO_2 (d) HNO_3

Ans :

MAIN 2005



Thus (c) is correct option.

135. Which one among the given is a weak base?

- (a) Sodium hydroxide
(b) Ammonium hydroxide
(c) Potassium hydroxide
(d) All the these

Ans :

SQP 2010

Ammonium hydroxide (NH_4OH) is referred to as a weak alkali because it is soluble in water and has a pH of 7-10 indicating that it is not fully dissociated into ions.

Thus (b) is correct option.

136. An acid which is not a hydracid is :

- (a) H_2S (b) H_2SO_3
(c) HCl (d) HBr

Ans :

MAIN 2010

Acids that contain hydrogen but no oxygen are known as hydracids. HCl (Hydrochloric Acid), HBr , and HF are just a few examples. Oxyacids, on the other hand, are acids that contain both hydrogen and oxygen atoms.

Thus (c) is correct option.

137. Sodium hydrogen sulphate is salt.

- (a) Neutral (b) Basic
(c) Acidic (d) Depends

Ans :

SQP 2011

Sodium hydrogen sulphate [NaHSO_4] is an acid salt. The $[\text{H}^+]$ atom in NaHSO_4 makes it behave like an acid.

Thus (c) is correct option.

138. When the salts do not have a definite shape.

- (a) Anhydrous (b) Aqueous
(c) Amorphous (d) None of these

Ans :

COMP 2013

An amorphous solid is a type of solid material that lacks a definite shape and has a disordered arrangement of particles.

Thus (c) is correct option.

139. pH of blood is slightly

- (a) acidic (b) basic
(c) neutral (d) none of these

Ans :

COMP 2005

Blood is normally slightly basic, with a normal pH range of 7.35 to 7.45.

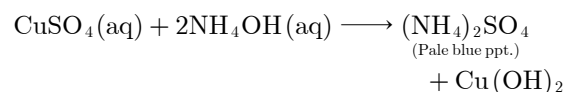
Thus (b) is correct option.

140. Aqueous solution of copper sulphate reacts with aqueous ammonium hydroxide solution to give

- (a) brown ppt. (b) white ppt.
(c) pale blue ppt. (d) green ppt.

Ans :

SQP 2010



Thus (c) is correct option.

141. Gastric juices secreted in our stomach are in nature.

- (a) Acidic (b) Basic
(c) Neutral (d) None of these

Ans :

COMP 2011

Gastric juice is a variable mixture of water, hydrochloric acid, electrolytes (sodium, potassium, calcium, phosphate, sulfate, and bicarbonate), and organic substances (mucus, pepsins, and protein). This juice is highly acidic because of its hydrochloric acid content, and it is rich in enzymes.

Thus (a) is correct option.

142. Brine is an:

- (a) aqueous solution of sodium hydroxide
(b) aqueous solution of sodium carbonate
(c) aqueous solution of sodium bicarbonate
(d) aqueous solution of sodium chloride a

Ans :

SQP 2013

Brine or salt water is a highly concentrated solution of common salt in water (sodium chloride).

Thus (d) is correct option.

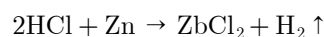
143. Which gas is evolved when dilute HCl react with active metals such as Zn ?

- (a) H_2S (b) CO_2
(c) SO_2 (d) H_2

Ans :

COMP 2018

Dilute acids react with active metals such as Zn to liberate hydrogen gas.



Thus (d) is correct option.

- 144.** A basic solution which does not contain a metallic element
 (a) Ammonium Hydroxide (NH_4OH)
 (b) Nitrite (NO_2^-)
 (c) Nitrate (NO_3^-)
 (d) Caesium Hydroxide (CsOH)

Ans :

COMP 2019

Ammonium hydroxide is the only commonly used base which does not have a metal in its molecule. Thus (a) is correct option.

- 145.** Which gas is evolved when dilute MgSO_4 react with active metals such as Mg?
 (a) SO_2 (b) CO_2
 (c) H_2 (d) H_2S

Ans :

MAIN 2011

Dilute acids react with active metals such as Mg to liberate hydrogen gas.



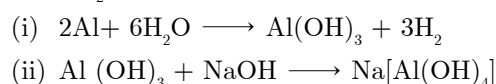
Thus (c) is correct option.

- 146.** Which of the following metals can displace hydrogen from the aqueous solution of NaOH ?
 (a) Hg (b) Al
 (c) Cu (d) Ag

Ans :

SQP 2018

Aluminium (Al) metal when react with NaOH, it gives $\text{H}_2(\text{g})$ as follows.



Thus (b) is correct option.

- 147.** Match the columns:

	Column A		Column B
A.	Acid salt	(i)	Sodium potassium carbonate
B.	Mixed salt	(ii)	Alum
C.	Complex salt	(iii)	Sodium carbonate
D.	Double salt	(iv)	Sodium zincate
E.	Normal salt	(v)	Sodium hydrogen carbonate

- (a) A-i, B-iv, C-ii, D-v, E-iii
 (b) B-i, C-ii, D-v, E-iv
 (c) A-iv, B-v, C-i, D-ii, E-iii
 (d) A-v, B-i, C-iv, D-ii, E-iii

Ans :

COMP 2011

Thus (d) is correct option.

- 148.** Universal indicator is a mixture of organic
 (a) Compounds (b) Materials
 (c) Fungi (d) Dyes

Ans :

SQP 2012

A universal indicator is a mixture of organic dyes and compounds that change color at different pH levels to indicate whether a substance is acidic or basic.

Thus (d) is correct option.

- 149.** As the pH of solution decreases, its acidic strength progressively
 (a) Does not change
 (b) Decreases
 (c) Increases
 (d) Depends on the quantity of solution

Ans :

COMP 2015

We know that, $[\text{H}^+]$ increases, the pH value decreases and acidity increases. As the pH value increases, $[\text{H}^+]$ decreases and basicity increases.

Thus (c) is correct option.

- 150.** During ionization metals lose electrons, this change can be called :
 (a) Displacement (b) Reduction
 (c) Redox (d) Oxidation

Ans :

SQP 2000

A molecule, atom, or ion undergoes oxidation when it loses electrons or increases its oxidation state.

Thus (d) is correct option.

- 151.** An example of a deliquescent salt is
 (a) CaCO_3 (b) anhydrous CaCl_2
 (c) DDT (d) KCN

Ans :

COMP 2001

Sodium hydroxide, potassium hydroxide, ammonium chloride, gold (III) chloride, sodium nitrate, and calcium chloride are all examples of deliquescent salt.

Thus (b) is correct option.

- 152.** A base used as a foaming agent in fire extinguishers
 (a) $\text{Al}(\text{OH})_3$ (b) $\text{Fe}(\text{OH})_2$
 (c) $\text{Ba}(\text{OH})_2$ (d) $\text{Zn}(\text{OH})_2$

Ans :

MAIN 2007

Aluminum hydroxide is a base that is used as a foaming agent in some foam-based fire extinguishers. When mixed with sodium bicarbonate in separate chambers of a foam fire

extinguisher, aluminum hydroxide is created through a chemical reaction that produces carbon dioxide and foam. The foam then comes out of the extinguisher's nozzle.

Thus (a) is correct option.

- 153.** The acidic or basic strength of a solution is measured by

- (a) celsius scale (b) acidic scale
(c) neutral scale (d) pH scale

Ans :

SQP 2010

The strength of acids and bases is measured on a scale called the pH scale.

Thus (d) is correct option.

- 154.** How many water molecules does hydrated calcium sulphate contain?

- (a) 2 (b) 10
(c) 7 (d) 5

Ans :

COMP 2015

Chemical formula of hydrated calcium sulphate or gypsum is $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

Thus (a) is correct option.

- 155.** Loss of water of crystallisation on being heated.

- (a) Amorphous (b) Anhydrous
(c) Aqueous (d) None of these

Ans :

SQP 2018

Some crystals have water molecules attached to them via chemical bonds. These water molecules are known as the water of crystallization. The substances are known to be hydrated. On heating, the molecules lose their water of crystallization and become anhydrous.

Thus (b) is correct option.

- 156.** Sodium hydroxide is a:

- (a) weak base (b) weak acid
(c) strong acid (d) strong base

Ans :

MAIN 2020

Sodium hydroxide is an ionic compound that contains both sodium and hydroxide ions. Because of the hydroxide ion, sodium hydroxide is a strong base.

Thus (d) is correct option.

- 157.** A particular solution contains molecules and ions of the solute so it is a :

- (a) Strong base (b) Strong acid
(c) Weak acid (d) Salt solution

Ans :

COMP 2023

Weak acids include both unionised molecules and ions because they are partially dissociated.

Thus (c) is correct option.

ASSERTION AND REASON

- 158. Assertion:** Solutions of compounds like alcohol and glucose do not show acidic character.

Reason: They do not show acidic character because they do not dissociate into ions.

- (a) Assertion is true, but reason is false.
(b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
(d) Assertion is false, but reason is true.

Ans :

SQP 2000

Solutions of compounds like alcohol and glucose do not show acidic character because like acids such as HCl which dissociates into H^+ and Cl^- ion these solutions do not dissociate into ions. Thus, both assertion and reason are true and reason is the correct explanation of the assertion. Thus (c) is correct option.

- 159. Assertion:** Dry HCl gas does not change the colour of the dry litmus paper.

Reason: It is because dry HCl does not contain the OH^- ions.

- (a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
(b) Assertion is true, but reason is false.
(c) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
(d) Assertion is false, but reason is true.

Ans :

COMP 2013

Colour of the litmus paper is changed by the hydrogen ions. Dry HCl gas does not contain H^+ ions. Acids give hydrogen ions only in the presence of ions. In case of dry litmus paper and dry HCl, water is not present. Therefore, the colour of the litmus paper does not change. Thus, assertion is true but reason is false.

Thus (b) is correct option.

160. Assertion: Tap water conducts electricity but distilled water does not conduct electricity.

Reason: Tap water conducts electricity as it contains ions whereas distilled water does not contain ions.

- (a) Assertion is false, but reason is true.
- (b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.

Ans :

MAIN 2011

Tap water conducts electricity as it contains ions whereas distilled water does not contain ions. Thus, both assertion and reason are true and reason is the correct explanation of the assertion. Thus (d) is correct option.

161. Assertion: All metals give hydrogen while reacting with nitric acid.

Reason: Nitric acid is a strong oxidising agent.

- (a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true.
- (d) Assertion is true, but reason is false.

Ans :

MAIN 2001

Nitric acid is a strong oxidising agent. Hydrogen produced during the reaction is oxidised to water and nitric acid itself gets reduced to nitrogen oxide. Thus, assertion is false but reason is true. Thus (c) is correct option.

162. Assertion: Calcium starts floating when added in water.

Reason: Calcium starts floating because the bubbles of oxygen gas which are formed during the reaction stick to the surface of the metal.

- (a) Assertion and Reason both are correct statements and reason is the correct explanation of the assertion.
- (b) Assertion and Reason both are correct statements, but reason is not the correct explanation of the assertion.
- (c) Assertion is false, but reason is true.
- (d) Assertion is true, but reason is false.

Ans :

SQP 2017

Hydrogen gas is released when calcium reacts with water. Calcium starts floating because the bubbles of hydrogen gas which are formed during the reaction stick to the surface of the metal. As a result, calcium starts floating on water. Thus, assertion is true, but reason is false.

Thus (d) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name of the following :

163. A salt formed by the complete neutralization of an acid by a base.

Ans :

SQP 2025

Normal salt

164. The gas evolved on reaction of aluminium with boiling concentrated caustic alkali solution.

Ans :

MAIN 2000

Hydrogen

165. An acid which is present in vinegar.

Ans :

COMP 2013

Acetic acid

166. Name the aqueous salt solution used for testing sulphate radical.

Ans :

SQP 2011

Barium chloride solution.

167. The gas produced on reaction of dilute sulphuric acid with a metallic sulphide.

Ans :

MAIN 2012

Hydrogen sulphide

168. Any one organic acid.

Ans :

COMP 2020

acetic acid

169. Any one normal salt

Ans :

COMP 2001

Potassium chloride

170. Any one acidic salt.

- Ans :** SQP 2005
Sodium bicarbonate
- 171.** Any one basic salt.
Ans : MAIN 2010
Basic copper chloride [Cu (OH) Cl]
- 172.** Any one hydra acid
Ans : SQP 2021
hydrochloric acid
- 173.** Any one anhydrous salt.
Ans : COMP 2012
sodium chloride
- 174.** Any oxide which is black in colour.
Ans : SQP 2014
copper oxide (CuO)
- 175.** Any one oxyacid.
Ans : MAIN 2012
nitric acid
- 176.** Iron salt formed by synthesis reaction.
Ans : COMP 2017
ferric chloride
- 177.** A liquid hygroscopic substance.
Ans : MAIN 2019
conc. sulphuric acid
- 178.** Any one monobasic acid.
Ans : SQP 2000
hydrochloric acid
- 179.** The property of spontaneously giving up water of crystallisation.
Ans : SQP 2020
efflorescence
- 180.** A strong but non-volatile mineral acid.
Ans : COMP 2023
sulphuric acid
- 181.** An acid which has strong oxidising power.
Ans : SQP 2001
nitric acid
- 182.** A basic solution which does not contain a metallic element.
Ans : MAIN 2004
Ammonium hydroxide
- 183.** An alkali which on dissociation produces a high concentration of hydroxyl ions.
Ans : COMP 2010
Sodium hydroxide
- 184.** A complex salt solution used for testing a basic gas lighter than air.
Ans : SQP 2015
Nessler's reagent, K_2HgI_4
- 185.** A base which reacts with hydrochloric acid to give a salt which on hydrolysis gives a slightly acidic solution.
Ans : MAIN 2017
Copper hydroxide
- 186.** An ion which combines with a polar covalent molecule to form ammonium ion.
Ans : COMP 2019
Hydrogen ion (H^+)
- DIRECTION : Fill in the blanks from the choices given in bracket :**
- 187.** [sulphuric acid/hydrochloric acid] does not form an acid salt.
Ans : SQP 2025
hydrochloric acid
- 188.** A [reddish brown/dirty green] coloured precipitate is formed when ammonium hydroxide is added to a solution of ferrous chloride.
Ans : SQP 2025
dirty green
- 189.** An [alkaline/acidic] solution will turn methyl orange solution pink or red.
Ans : SQP 2025
acidic
- 190.** A salt prepared by displacement reaction is _____ (ferric chloride/ferrous chloride/silver chloride).

Ans :

MAIN 2020

Ferrous chloride

191. The salt prepared by the method of direct combination is _____ (iron (II) chloride/iron (III) chloride).

Ans :

COMP 2018

Iron (III) chloride

192. The basicity of Acetic Acid is _____ (3/1/4).

Ans :

SQP 2014

1

193. Higher the pH value of a solution, the more _____ (acidic/alkaline) it is.

Ans :

MAIN 2016

Alkaline

194. pH of acetic acid is greater than dilute sulphuric acid. So acetic acid contains _____ concentration of H^+ ions. (greater/same/low).

Ans :

COMP 2020

low

195. The indicator which does not change colour on passage of HCl gas is _____ (methyl orange/moist blue litmus/phenolphthalein)

Ans :

SQP 2020

phenolphthalein

196. The acid which cannot act as an oxidizing agent is _____ (conc. H_2SO_4 /conc. HNO_3 /conc. HCl).

Ans :

MAIN 2008

conc. H_2SO_4

197. When a metallic oxide is dissolved in water, the solution formed has a high concentration of _____ ions. (H^+ , H_3O^+ , OH^-)

Ans :

COMP 2017

 OH^-

198. Potassium sulphite on reacting with hydrochloric acid releases _____ gas (Cl_2 , SO_2 , H_2S).

Ans :

SQP 2017

 SO_2

199. An element X is in the powdered state. It burns in oxygen and the product of combustion is soluble

in water. The solution of the product in water is tested with litmus solution. Write down one word only to correctly complete the sentences below :

- If X is a metal, then litmus solution will turn _____.
- If X is a non-metal, then litmus solution will turn _____.
- If X is an active metal, then _____ will be evolved, when X reacts with dilute sulphuric acid.
- If X is an active metal, then it will form basic oxide, which on dissolving in water will form _____.
- If X is a non-metal, it will not conduct electricity, unless it is carbon in the form of _____.

Ans :

MAIN 2012

- blue
- red
- hydrogen gas
- an alkali
- graphite.

200. From the list given below, select the word(s) required to correctly complete blanks (i) to (v) in the following passage :

ammonia, ammonium carbonate, carbon dioxide, hydrogen, hydronium, hydroxide, precipitate, salt, water.

A solution X turns blue litmus red, so it must contain:

- _____ ions. Another solution Y turns red litmus blue and therefore, must contain (ii) _____ ions. When solutions X and Y are mixed together, the products will be a (iii) _____ and (iv) _____. If a piece of magnesium was put into solution X, (v) _____ gas would be evolved.

(Note : Words chosen from the list are to be used only once. Write the answers as (i), (ii), (iii) and so on. Do not copy the passage.)

Ans :

MAIN 2023

- hydronium
- hydroxide
- salt
- water
- hydrogen

201. An acid is a compound which when dissolved in water forms hydronium ions as the only (1) _____ ions. A base is a compound which if soluble in water contains (2) _____ ions. A

base reacts with an acid to form a (3)_____ and water only. This type of reaction is known as (4)_____.

Ans :

COMP 2003

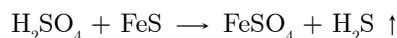
- (1) Positive
- (2) Hydroxyl
- (3) Salt
- (4) Neutralisation

DIRECTION : Write balanced equations to satisfy each statement :

202. Acid + Sulphide → Salt + Hydrogen sulphide

Ans :

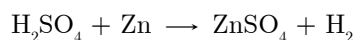
MAIN 2010



203. Acid + Active metal → Salt + Hydrogen

Ans :

COMP 2012



204. Acid + Base → Salt + Water

Ans :

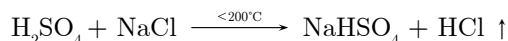
MAIN 2018



205. Acid + Chloride → Salt + Hydrochloric acid gas

Ans :

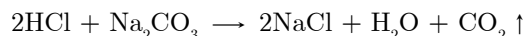
COMP 2015



206. Acid + Carbonate → Salt + Water + Carbon dioxide

Ans :

MAIN 2002



207. Acid + Sulphite → Salt + Water + Sulphur dioxide

Ans :

COMP 2020



DIRECTION : Write a balanced chemical equation for the following reaction :

208. Zinc oxide is treated with sodium hydroxide solution.

Ans :

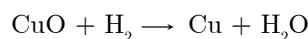
SQP 2010



209. Reduction of copper (II) oxide by hydrogen.

Ans :

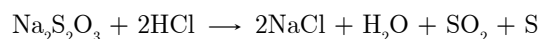
SQP 2019



210. Sodium thiosulphate is reacted with dilute hydrochloric acid.

Ans :

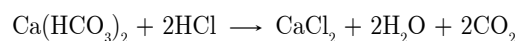
MAIN 2012



211. Calcium bicarbonate reacts with dilute hydrochloric acid.

Ans :

COMP 2016



212. Dilute sulphuric acid is poured over sodium sulphite.

Ans :

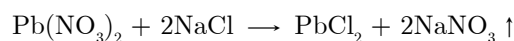
SQP 2010



213. Lead nitrate solution is added to sodium chloride solution.

Ans :

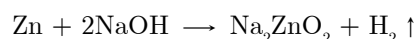
MAIN 2018



214. Zinc is heated with sodium hydroxide solution.

Ans :

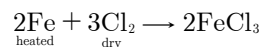
COMP 2011



215. Chlorine is passed over heated iron.

Ans :

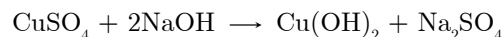
SQP 2008



216. Copper sulphate solution is added to sodium hydroxide solution.

Ans :

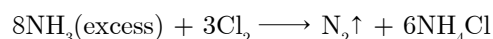
SQP 2012



217. Chlorine reacts with excess of ammonia.

Ans :

MAIN 2005



218. Ferric hydroxide reacts with nitric acid.

Ans :

COMP 2008



219. Zinc oxide dissolves in sodium hydroxide.

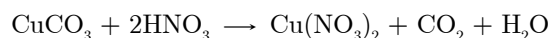
Ans :

SQP 2011



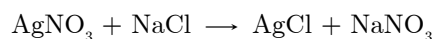
- 220.** Dilute nitric acid and copper carbonate.

Ans : MAIN 2016



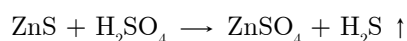
- 221.** Silver nitrate solution and sodium chloride solution.

Ans : COMP 2007



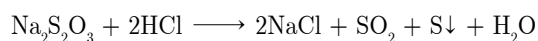
- 222.** Zinc sulphide and dilute sulphuric acid.

Ans : SQP 2012



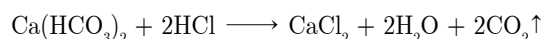
- 223.** Sodium thiosulphate is reacted with dilute hydrochloric acid.

Ans : COMP 2017



- 224.** Calcium bicarbonate reacts with dilute hydrochloric acid.

Ans : SQP 2004



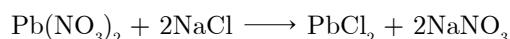
- 225.** Dilute sulphuric acid is poured over sodium sulphite.

Ans : MAIN 2009



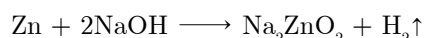
- 226.** Lead nitrate solution is added to sodium chloride solution.

Ans : COMP 2017



- 227.** Zinc is heated with sodium hydroxide solution.

Ans : COMP 2011



DIRECTION : Correct the statement and rewrite the following :

- 228.** Magnesium reacts with nitric acid to liberate hydrogen gas.

Ans : COMP 2012

Magnesium reacts with very dilute nitric acid to liberate hydrogen gas.

- 229.** Give a reason for each of the following :

Conductivity of dilute hydrochloric acid is greater than that of acetic acid.

Ans : SQP 2018

Hydrochloric acid is a strong acid. It splits to give more hydrogen ions as compared to acetic acid. Hence conductivity of dilute hydrochloric acid is more than that of acetic acid.

DIRECTION : Answers the following :

- 230.** Differentiate between the following pair based on the information given in the bracket.
Acid and Alkali (formation of type of ions)

Ans : COMP 2020

Acid	Alkali
Acids are the compounds which when dissolved in water furnish hydrogen/hydronium ions as the only positively charged ions. $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$	Alkalis are the compounds which when dissolved in water furnish hydroxyl ions as the only negatively charged ions. $\text{NH}_4\text{OH} \rightarrow \text{NH}_4^+ + \text{OH}^-$

- 231.** Match the following columns :

	Column A		Column B
1.	Acid salt	A.	Sodium potassium carbonate
2.	Mixed salt	B.	Sodium carbonate
3.	Normal salt	C.	Sodium hydrogen carbonate

Ans : MAIN 2007

- Acid salt $\longrightarrow$ Sodium hydrogen carbonate
- Mixed salt $\longrightarrow$ Sodium potassium carbonate
- Normal salt $\longrightarrow$ Sodium carbonate

- 232.** What happens to the crystals of washing soda when exposed to air? Name the phenomenon exhibited.

Ans : COMP 2011

Washing soda crystals lose their water of crystallisation when exposed to air and crumble down to form powder. The phenomenon exhibited is efflorescence.

- 233.** State your observation for the following case :
Paper soaked in potassium permanganate solution is introduced into a gas jar of sulphur dioxide.

Ans : MAIN 2010
It decolourises purple colour of KMnO_4 .

- 234.** State the inference drawn from the following observations : pH of liquid R is 10. What kind of substance is R ?

Ans : COMP 2014
R is a basic substance as its pH is greater.

- 235.** From the following list of substances, choose those which meet the description given below.
Ammonium chloride, ammonium nitrate, chlorine, dilute hydrochloric acid, iron, lead nitrate, manganese (IV) oxide, silver nitrate, sodium nitrate sulphur.
Two compounds whose aqueous solution gives white precipitate with dilute hydrochloric acid.

Ans : SQP 2019
Silver nitrate solution and lead nitrate solution.

- 236.** State your observation with an equation on mixing a solution of CaCl_2 with a solution of Na_2CO_3 .

Ans : MAIN 2015
A white milkiness is seen :
$$\text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 \downarrow + 2\text{NaCl}$$

Insoluble CaCO_3 causes milkiness.

- 237.** Give the name and formula of acid salt which gives sodium ions and sulphate ions.

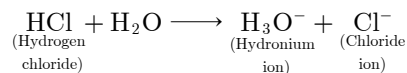
Ans : COMP 2012
Sodium hydrogen sulphate – NaHSO_4

- 238.** Two solutions X and Y have pH values of 3 and 9 respectively. Which one of these two will give a pink colour with phenolphthalein indicator ?

Ans : SQP 2011
Y, because it is basic in nature.

- 239.** Anhydrous hydrogen chloride is not an acid but its aqueous solution is a strong acid. Explain.

Ans : COMP 2002
Anhydrous hydrogen chloride is covalent compound, therefore, it is not an acid but in aqueous solution it ionises completely to give hydronium ions. Hence, it behaves as a strong acid.

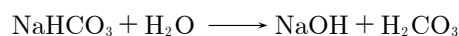


- 240.** The pH value of pure water is 7. Compare the pH values of sulphur dioxide solution and ammonia solution with that of pure water.

Ans : MAIN 2019
Sulphur dioxide solution is acidic and has $\text{pH} < 7$. Ammonia solution is alkaline and has $\text{pH} > 7$.

- 241.** What is observed when, neutral litmus solution is added to sodium hydrogen carbonate solution ?

Ans : MAIN 2005
It will turn blue.



Strong base formed will turn neutral litmus blue.

- 242.** What do you see when barium chloride solution is added to dilute sulphuric acid?

Ans : SQP 2010
A white precipitate is formed which is insoluble in all the mineral acids.

- 243.** Name the ions furnished by an acid.

Ans : COMP 2015
It gives hydronium ions (H_3O^+) in water.
e.g., $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{Cl}^-$

- 244.** Name two crystalline substances which don't contain water of crystallisation.

Ans : MAIN 2016
(i) Common salt (NaCl)
(ii) Sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)

- 245.** Write the ionisation of sulphuric acid showing the formation of hydronium ion.

Ans : SQP 2020
$$\text{H}_2\text{SO}_4 + 2\text{H}_2\text{O} \rightleftharpoons 2\text{H}_3\text{O}^+ + \text{SO}_4^{2-}$$

- 246.** Name a substance which changes the blue colour of copper sulphate crystals to white.

Ans : COMP 2023
Concentrated sulphuric acid.

- 247.** Give two examples of hygroscopic substances.

Ans : SQP 2000
(a) Concentrated sulphuric acid
(b) Quick lime.

- 248.** Give the name and formula of the acid salt which gives sodium ions and sulphate ions in solution.

Ans :

SQP 2015

Sodium hydrogen sulphate, NaHSO_4



- 249.** What is the pH of pure water ?

Ans :

COMP 2017

The pH of pure water is 7.

- 250.** What is the purpose of pH scale ?

Ans :

SQP 2019

It is used to determine the acidic, alkaline or neutral nature of an aqueous solution.

TWO MARKS QUESTIONS

- 251.** Rewrite the following statements by adding the correct word as shown in the example:

Example:

Given Statement: Ammonia changes moist red litmus to blue.

Correct statement: Aqueous ammonia changes moist red litmus to blue.

- (a) Sulphuric acid acts as a dehydrating agent.
(b) Ammonia reacts with chlorine to give ammonium chloride and nitrogen.

Ans :

MAIN 2024

- (a) Concentrated sulphuric acid acts as a dehydrating agent.
(b) Ammonia reacts with chlorine to give hydrogen chloride and nitrogen.

- 252.** Choose the most appropriate answer from the following list of oxides which fit the description. Each answer may be used only once : $[\text{SO}_2, \text{SiO}_2, \text{Al}_2\text{O}_3, \text{MgO}, \text{CO}, \text{Na}_2\text{O}]$

- (i) A basic oxide.
(ii) An oxide which dissolves in water forming an acid.

Ans :

COMP 2015

- (i) Na_2O
(ii) SO_2

- 253.** (a) Classify the solutions of the following as acids, bases or salts : Ammonium hydroxide, barium chloride, sodium chloride, sodium hydroxide, H_2SO_4 and HNO_3 .
(b) Explain how a reagent chosen from those above enables you to distinguish between the two acids mentioned therein.

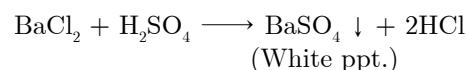
Ans :

COMP 2001

(a)

Ammonium hydroxide	Base
Barium chloride	Salt
Sodium chloride	Salt
Sodium hydroxide	Base
H_2SO_4	Acid
HNO_3	Acid

- (b) Barium chloride gives white precipitates with H_2SO_4 but not with HNO_3 .



- 254.** What are the terms defined below?

- (i) A salt containing a metal ion surrounded by other ions or molecules.
(ii) A base which is soluble in water.

Ans :

SQP 2008

- (i) Soluble salts
(ii) Alkali

- 255.** How will you distinguish between dilute hydrochloric acid and dilute sulphuric acid using lead nitrate solution ?

Ans :

SQP 2019

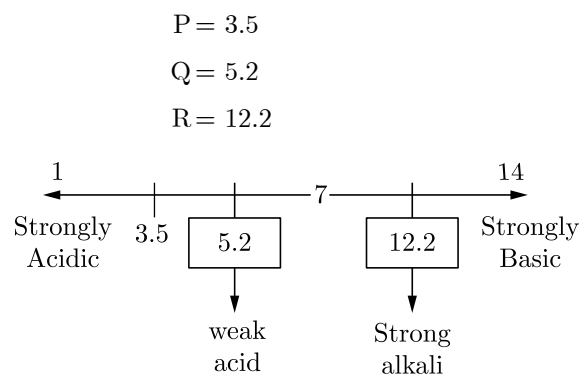
HCl acid	Dil H_2SO_4
On adding lead nitrate to dilute hydrochloric acid it will form a white precipitate which will dissolve on heating the solution. $\text{Pb}(\text{NO}_3)_2 + \text{HCl} \longrightarrow \text{PbCl}_2(\text{ppt}) + \text{H}_2\text{O} + \text{NO}_4$	Whereas on reacting with dilute sulphuric acid it will form a precipitate which will not dissolve on heating. $\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{PbSO}_4(\text{ppt.}) + \text{H}_2\text{O} + \text{NO}_2$

- 256.** Three solutions P, Q and R have pH value of 3.5, 5.2 and 12.2 respectively. Which one of these is a :

- (i) Weak acid ?
(ii) Strong alkali ?

Ans :

MAIN 2018



- (i) Weak acid = Q
(ii) Strong alkali = R

- 257.** (i) What is an alkali?
(ii) Explain the meaning of the term acid salt.

Ans :

SQP 2012

- (i) A water soluble base called an alkali.
(ii) The salt formed by the incomplete replacement of replaceable hydrogen ions of an acid by a basic radical or metallic ion.

- 258.** What do you understand by an alkali ? Give two examples of (a) Strong alkalies, (b) Weak alkalies.

Ans :

COMP 2010

Alkali - Metallic oxides or hydroxides which when dissolved in water produces hydroxyl ions (OH^-) as the only negatively charged ions. e.g., NaOH , KOH etc. or alkalies are water soluble bases

- (a) Strong alkalis - NaOH , KOH
(b) Weak alkalis - NH_4OH , $\text{Ca}(\text{OH})_2$

- 259.** State what would you observe when :

- (i) Washing soda crystals are exposed to the atmosphere.
(ii) The salt ferric chloride is exposed to the atmosphere.

Ans :

MAIN 2006

- (i) They lose their water of crystallisation and become amorphous.
(ii) It absorbs moisture from the atmosphere and forms a solution.

- 260.** What is the pH of the following solutions?

- (i) Ferric chloride
(ii) Sodium acetate

Ans :

SQP 2009

- (i) Less than 7
(ii) More than 7

- 261.** Define or explain the meaning of the following terms :

- (a) Acid
(b) pH scale.

Ans :

COMP 2010

- (a) **Acid** : An acid is a chemical compound which contain hydrogen and on dissolving in water, produces hydrogen ions or hydronium ions as the only positively charged particles.
(b) **pH scale** : The scale used for determining the acidic or alkaline or neutral character of a solution.

- 262.** Write the equations for the laboratory preparation of the following salts using sulphuric acid :

- (i) Iron (II) sulphate from iron
(ii) Sodium sulphate from sodium carbonate

Ans :

SQP 2014

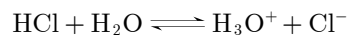
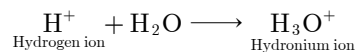
- (i) $\text{Fe} + \text{H}_2\text{SO}_4 (\text{dil.}) \longrightarrow \text{FeSO}_4 + \text{H}_2 \uparrow$
(ii) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$

- 263.** What is hydronium ion ? Write the ionisation of hydrochloric acid showing the formation of hydronium ion.

Ans :

MAIN 2015

Hydronium ion is H_3O^+ . It is formed by the combination of H^+ with H_2O .

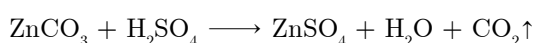
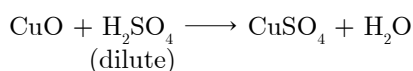
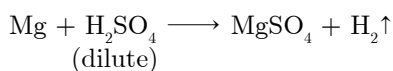


- 264.** Name three classes of substances that can react with an acid to form a salt. Give an example of each class, writing the equation that describes its reaction with suitable acid.

Ans :

COMP 2019

Metal, metallic (basic) oxide and metallic carbonates react with acid to form a salt.

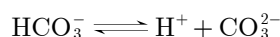
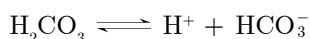


- 265.** Carbonic acid gives an acid salt but hydrochloric acid does not. Explain.

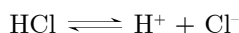
Ans :

MAIN 2011

This is because carbonic acid is a dibasic acid whereas hydrochloric acid is a mono-basic acid.
Carbonic acid :



Hydrochloric acid :



- 266.** Match the following column and choose the correction option:

	Column-I		Column-II
(i)	Ferric chloride	(a)	Precipitation
(ii)	Sodium chloride	(b)	Simple displacement
(iii)	Magnesium sulphate	(c)	Metal oxide and dilute acid
(iv)	Lead chloride	(d)	Synthesis
(v)	Copper sulphate	(e)	Neutralisation

Ans :

SQP 2012

(i) (d), (ii) (e), (iii) (c), (iv) (a), (v) (b)

- 267.** Solution A has a pH of 12, solution B has a pH of 5 and solution C has a pH of 3.

Which solution ?

- (a) will liberate ammonia from ammonium sulphate on heating ?
(b) is a strong acid.
(c) contains molecules as well as ions.

Ans :

COMP 2015

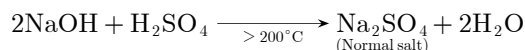
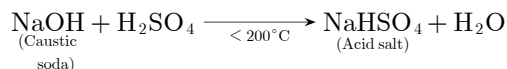
(a) A, (b) C, (c) B

- 268.** (a) What do you understand by dibasic acid? Give an example.
(b) How many types of salts does dibasic acid produce when it reacts with caustic soda solution ? Give equations.

Ans :

MAIN 2014

- (a) Dibasic acid ionises in water to give two hydronium ions (H_3O^+) per molecule.
For example : Sulphuric acid (H_2SO_4)
(b) It forms two types of salts i.e., acid salt and normal salt.
For example :



- 269.** Find the odd one out and explain your choice (note: valency is not a criterion)

- (i) $\text{Al}(\text{OH})_3$, $\text{Pb}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$, $\text{Zn}(\text{OH})_2$
(ii) Formic acid, Nitric acid, Acetic acid, Propanoic acid.

Ans :

COMP 2019

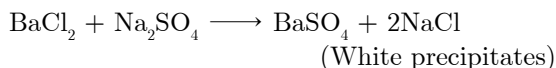
- (i) $\text{Mg}(\text{OH})_2$ [Because all others are amphoteric hydroxides]
(ii) Nitric acid [This is the only inorganic acid rest all are organic acids]

- 270.** State your observation when :

Barium chloride solution is mixed with Sodium Sulphate Solution.

Ans :

SQP 2002



When sodium sulphate is mixed with barium chloride. White coloured precipitates of barium sulphate are formed.

- 271.** Define the term neutralisation.

Ans :

MAIN 2005

The reaction in which an acid reacts with a base to form salt and water is known as neutralisation.



THREE MARKS QUESTIONS

- 272.** Mohan has three solutions P, Q and R having a pH of 13, 5 and 2 respectively. Which of the above solutions is P, Q or R:

- (a) will react with Magnesium to liberate hydrogen gas?
(b) will liberate ammonia gas when it reacts with ammonium chloride?
(c) will contain molecules as well as ions?

Ans :

MAIN 2024

- (a) Among the solutions P, Q and R, the solution with pH 2 that is R will react with magnesium to liberate hydrogen gas as metal when reacts with acid gives hydrogen gas.

- (b) Ammonia gas will be liberated from ammonium salts like ammonium chloride on addition of an alkaline solution. Therefore, solution P is used.
- (c) A solution which contains both molecules and ions is nearly neutral with pH 7. Solution Q, with a pH of 5, is closest to such the pH value of 7.

273. Hydrogen chloride gas is prepared in the laboratory by the action of concentrated sulphuric acid on sodium chloride.

- (a) Give balanced chemical equation for the above reaction.
- (b) State the method of collection of the gas formed above.
- (c) What is property of sulphuric acid that makes it a suitable reagent for the reaction.

Ans :

MAIN 2024

- (a) The chemical reaction can be shown as
- $$\text{Conc. H}_2\text{SO}_4(\text{l}) + 2\text{NaCl}(\text{s}) \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}(\text{g})$$
- (b) Hydrogen chloride gas is collected by downward delivery technique (upward displacement of air).
- (c) The sulphuric acid acts as an oxidising agent and possesses non-volatile nature and high boiling point.

274. The pH values of three solutions A, B and C are given in the table. Answer the following questions:

Solution	pH value
A	12
B	2
C	7

- (i) Which solution will have no effect on litmus solution ?
- (ii) Which solution will liberate CO_2 when reacted with sodium carbonate?
- (iii) Which solution will turn red litmus solution blue ?

Ans :

COMP 2019

- (i) C (Because pH 7 is neutral)
- (ii) B (Because acids liberate CO_2 gas when treated with carbonates and acids have pH less than 7)
- (iii) A (Bases turn red litmus blue and they have pH more than 7)

275. Solution A is a sodium hydroxide solution. Solution B is a weak acid. Solution C is dilute sulphuric acid. Which solution will ?

- (i) liberate sulphur dioxide from sodium sulphite.
- (ii) give a white precipitate with zinc sulphate solution.
- (iii) contain solute molecules and ions.

Ans :

MAIN 2010

- (i) Solution C
- (ii) Solution A
- (iii) Solution B

276. The preparation of lead sulphate from lead carbonate is a two-steps process. (Lead sulphate cannot be prepared by adding dilute sulphuric acid to lead carbonate)

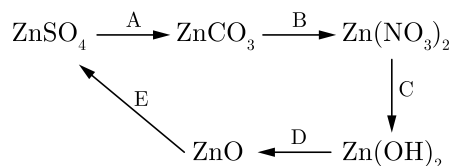
- (i) What is the first step that is required to prepare lead sulphate from lead carbonate ?
- (ii) Write the equation for the reaction that will take place when this first step is carried out.
- (iii) Why is the direct addition of dilute sulphuric acid to lead carbonate is impractical method of preparing lead sulphate ?

Ans :

COMP 2005

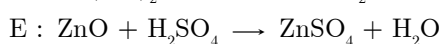
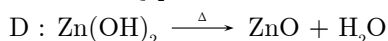
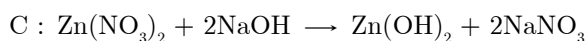
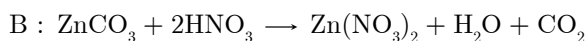
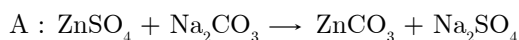
- (i) Treatment of lead carbonate with nitric acid.
- (ii) $\text{PbCO}_3 + 2\text{HNO}_3 \rightarrow \text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$
- (iii) This will lead to the deposition of lead sulphate on the surface of lead carbonate which stops further reaction of sulphuric acid on it.

277. Give the equations for the following conversions A to E.



Ans :

SQP 2010



278. Give suitable chemical terms for the following :

- (i) A salt formed by incomplete neutralisation of an acid by a base.
- (ii) A definite number of water molecules bound to some salts.

- (iii) The process in which a substance absorbs moisture from the atmospheric air to become moist, and ultimately dissolves in the absorbed water.

Ans :

COMP 2013

- (i) Acid salt
(ii) Water of crystallisation
(iii) Deliquescent

279. Solution A is a sodium hydroxide solution. Solution B is a weak acid. Solution C is dilute sulphuric acid. Which solution will :

- (i) Liberate sulphur dioxide from sodium sulphite.
(ii) Give a white precipitate with zinc sulphate solution.
(iii) Contain solute molecules and ions?

Ans :

MAIN 2010

- (i) C
(ii) A
(iii) B

280. A metal, whose alloy finds use in the construction of aircraft, in the powdered form was added to sodium hydroxide solution. A colourless gas was evolved and after the reaction was over, the solution was colourless.

- (i) Name the powdered metal added to sodium hydroxide solution.
(ii) Name the gas evolved.
(iii) Name the salt present in colourless solution.

Ans :

MAIN 2010

- (i) Aluminium
(ii) Hydrogen
(iii) Sodium meta aluminate, (NaAlO₂)

281. Define basicity of an acid. Give the basicity of :

- (i) nitric acid
(ii) acetic acid
(iii) phosphoric acid.

Ans :

SQP 2012

Basicity of an acid is defined as the number of hydronium ions produced by the ionisation of one molecule of the acid in an aqueous solution.

- (i) Basicity of nitric acid = 1
(ii) Basicity of acetic acid = 1
(iii) Basicity of phosphoric acid = 3

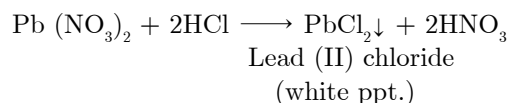
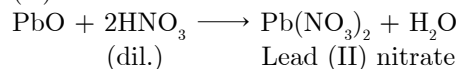
282. (a) Outline the steps necessary to convert insoluble lead (II) oxide into soluble lead (II) chloride.

- (b) If iron reacts with dilute sulphuric acid, what will be the products ?
(c) A solution of iron (III) chloride has a pH less than 7. Is the solution acidic or alkaline ?

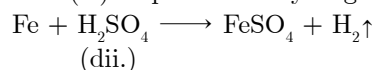
Ans :

COMP 2000

- (a) Lead (II) oxide is dissolved in dilute nitric acid to give soluble lead nitrate. The lead nitrate so obtained is treated with dilute hydrochloric acid to get a precipitate of lead (II) chloride.



- (b) Iron (II) sulphate and hydrogen.



- (c) The solution is acidic because pH < 7.

283. Sulphuric acid can be used to prepare a number of gases in the laboratory. Write balanced equations for reactions in which the following gases are obtained using dilute sulphuric acid as one of the reactants.

- (a) Hydrogen
(b) Carbon dioxide
(c) Sulphur dioxide

Ans :

SQP 2005

- (a) $\text{Zn} + \text{H}_2\text{SO}_4 \text{ (dil.)} \longrightarrow \text{ZnSO}_4 + \text{H}_2\uparrow$
or any other active metal except Na, K, Ca, Sn, Pb.
(b) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \text{ (dil.)} \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2\uparrow$
or any other metallic carbonate or bicarbonate except of calcium and lead.
(c) $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 \text{ (dil.)} \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2\uparrow$
or any other metallic sulphite or bisulphite.

- 284.** (a) A solution has a pH of 7. Explain how you would (i) increase its pH, (ii) decrease its pH
(b) If a solution changes the colour of litmus from red to blue, what can you say about its pH?
(c) What can you say about the pH of a solution that liberates CO₂ from sodium carbonate ?

Ans :

MAIN 2000

- (a) (i) By adding some alkali like NaOH.
(ii) By adding some acid like HCl.
(b) Since the solution changes the colour of litmus

from red to blue, it is alkaline and hence it has $\text{pH} > 7$.

- (c) Since the solution liberates CO_2 from sodium carbonate, it should be acidic and has $\text{pH} < 7$.

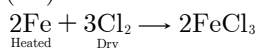
285. (a) Outline the steps required to convert hydrogen chloride to anhydrous iron (III) chloride. Write the equation(s) for the reaction(s) which take place.

- (b) (i) What are the two steps to change lead carbonate to lead chloride?
(ii) Give the name of a soluble salt of lead and write the equation for the action of heat on this salt.

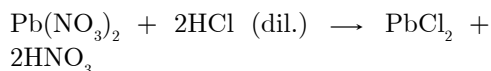
Ans :

SQP 2004

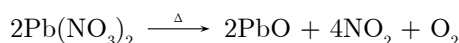
(a) $\text{MnO}_2 + 4\text{HCl (conc.)} \rightarrow \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$
Chlorine is dried by passing through concentrated H_2SO_4 . Then dried chlorine is passed over heated iron to get anhydrous iron (III) chloride.



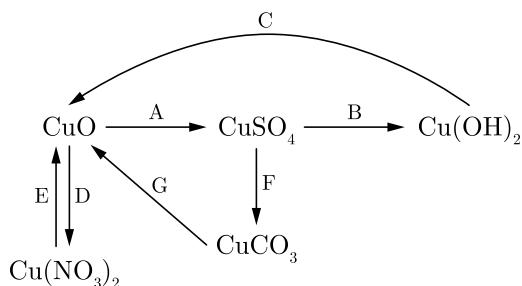
(b) (i) $\text{PbCO}_3 + 2\text{HNO}_3 (\text{dil.}) \rightarrow \text{Pb(NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$



(ii) Lead nitrate

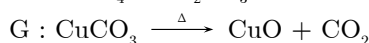
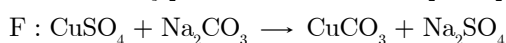
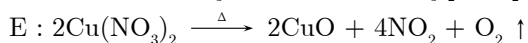
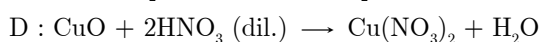
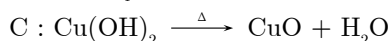
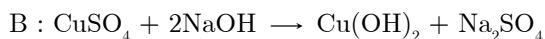


286. How are the following conversions carried out? Give balanced chemical equations only.



Ans :

COMP 2012



287. (a) A solution has a pH of 7. Explain how you would:

- (i) Increase its pH.
(ii) Decrease its pH.

(b) If a solution changes the colour of litmus from red to blue, what can you say about its pH?

(c) What can you say about the pH of a solution that liberates carbon dioxide from sodium carbonate?

Ans :

MAIN 2008

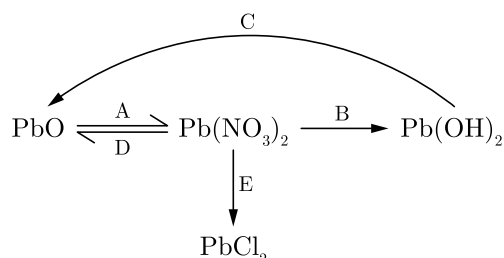
(a) (i) By adding an alkali

(ii) By adding an acid.

(b) More than seven.

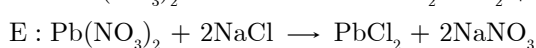
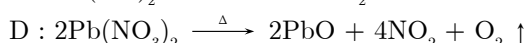
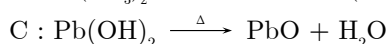
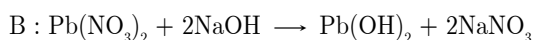
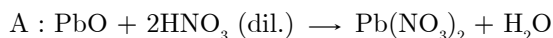
(c) Less than seven.

288. How are the following conversions carried out? Give balanced chemical equations only.

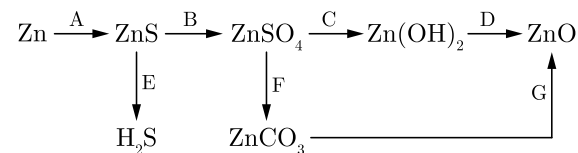


Ans :

SQP 2020

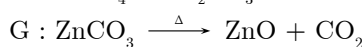
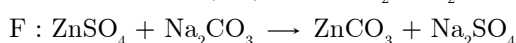
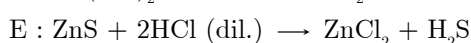
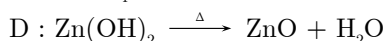
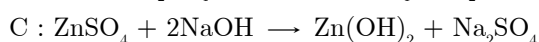
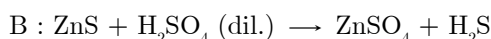
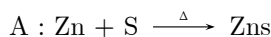


289. How are the following conversions carried out? Give balanced chemical equations only.



Ans :

MAIN 2002



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(i)	(ii)	(iii)	(iv)	(v)	(vi)
A					

A Ammonia B Copper Oxide

C Copper Sulphate D Hydrogen Chloride

E Hydrogen Sulphide F Lead Bromide

- (i) Although this compound is not a metal hydroxide, its solution is alkaline in nature.
(ii) A solution of this compound is used as the electrolyte when copper is purified.
(iii) When this compound is electrolysed in the molten state, lead is obtained at the cathode.
(iv) This compound can be oxidised to chlorine.
(v) This compound smells of rotten eggs.
(vi) This compound can be reduced to copper when heated with coke.

Ans :

SQP 2006

(i)	(ii)	(iii)	(iv)	(v)	(vi)
A	C	F	D	E	B

296. Choose the most appropriate answer from the following list of oxides which fit the description.

Each answer may be used only once:

[SO₂, SiO₂, Al₂O₃, MgO, CO, Na₂O]

- (i) A basic oxide.
(ii) An oxide which dissolves in water forming an acid.
(iii) An amphoteric oxide.
(iv) A covalent oxide of a metalloid.

Ans :

SQP 2015

- (i) Na₂O
(ii) SO₂
(iii) Al₂O₃
(iv) SiO₂

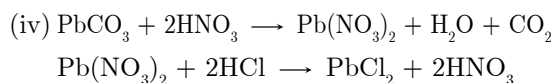
297. Give the equation for the preparation of each of the following salts from the starting material given.

- (i) Copper sulphate from copper(II) oxide.
(ii) Iron(III) chloride from Iron.
(iii) Potassium sulphate from potassium hydroxide solution.
(iv) Lead chloride from lead carbonate (two equations).

Ans :

SQP 2010

- (i) $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$
(ii) $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$
(iii) $2\text{KOH} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$



298. How are the following salts prepared in the laboratory? Give balanced chemical equations only.

- (a) Iron (III) chloride
(b) Magnesium sulphate
(c) Sodium sulphate
(d) Lead chloride
(e) Lead nitrate

Ans :

SQP 2015

- (a) $2\text{Fe} + 3\text{Cl}_2 \xrightarrow[\text{Dry}]{\text{Heated}} 2\text{FeCl}_3$
(b) $\text{Mg} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{MgSO}_4 + \text{H}_2 \uparrow$
(c) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$
 $2\text{NaOH} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
(d) $\text{Pb(NO}_3)_2 + 2\text{HCl} (\text{dil.}) \rightarrow \text{PbCl}_2 \downarrow + 2\text{HNO}_3$
 $\text{Pb(NO}_3)_2 + 2\text{NaCl} \rightarrow \text{PbCl}_2 \downarrow + 2\text{NaNO}_3$
(e) $\text{PbO} + 2\text{HNO}_3 (\text{dil.}) \rightarrow \text{Pb(NO}_3)_2 + \text{H}_2\text{O}$

299. Answer the questions below, relating your answers only to salts in the following list : Sodium chloride, anhydrous Calcium chloride, Copper sulphate water.

- (a) What name is given to the water in the compound, copper sulphate water ?
(b) If copper sulphate water is heated, anhydrous copper sulphate is formed. What is its colour?
(c) By what means other than heating, could you dehydrate copper sulphate water and obtain anhydrous copper sulphate ?
(d) Which one of the salts in the given list is deliquescent ?

Ans :

MAIN 2017

- (a) Water of crystallisation
(b) White
(c) By adding conc. H₂SO₄
(d) Anhydrous calcium chloride

300. Give one example each of the sodium salts as :

- (i) acid salt
(ii) normal salt
(iii) mixed salt
(iv) complex salt

Ans :

COMP 2019

- (i) Sodium bisulphate
(ii) Sodium sulphate
(iii) Sodium potassium sulphate
(iv) Sodium argentocyanide.

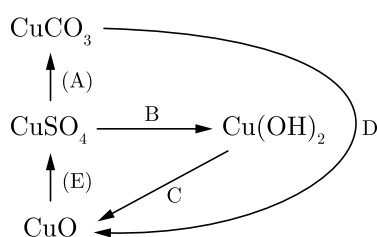
- (a) A salt is a chemical compound which, on dissolving in water, produces positively charged particle other than hydronium ion and negatively charged particle other than hydroxyl ion.
- (b) Insoluble salts are prepared by precipitation.
- (c) Iron (III) chloride or ferric chloride

$$2\text{Fe} + 3\text{Cl}_2 \xrightarrow[\text{Dry}]{\text{Heated}} 2\text{FeCl}_3$$
- (d) By neutralising sodium carbonate or sodium hydroxide with dilute sulphuric acid.

$$\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$$

$$2\text{NaOH} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$$

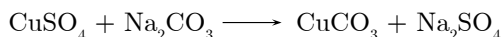
311. How are the following conversions brought about, write briefly in words and give chemical equations involved ?



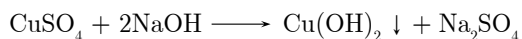
Ans :

MAIN 2018

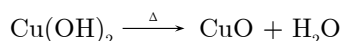
A By adding sodium carbonate solution to copper sulphate solution



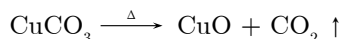
B By adding dil. sodium hydroxide solution to copper sulphate solution



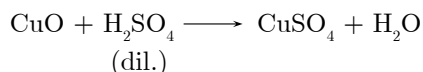
C By heating copper hydroxide strongly



D By heating copper carbonate



E By the action of dilute sulphuric acid with CuO



312. Identify which of the following terms match with the appropriate descriptions (i) to (v).

A : Hydracid

B : Monobasic acid

C : Less volatile acid

D : Weak acid

E : Dibasic acid

F : More volatile acid

(i) An acid having basicity 1 and having only one replaceable hydrogen ion per molecule of the acid.

- (ii) An acid which dissociates to give a low concentration of H^+ ions.
- (iii) An acid containing hydrogen and a non-metallic element other than oxygen.
- (iv) The type of acid which generally displaces another acid when heated with salt.
- (v) The type of acid which reacts with a base to give an acid salt and a normal salt.

Ans :

COMP 2020

(i) - B, (ii) - D, (iii) - A, (iv) - F, (v) - E

313. For each of the salts A, B, C and D suggest a suitable method of preparation which relates to its description given below.

(a) 'A' is a sodium salt.

(b) 'B' is an insoluble salt.

(c) 'C' is a soluble salt of copper.

(d) 'D' is a soluble salt of zinc.

(Do not describe the procedure for the preparation. Refer only to the appropriate method.)

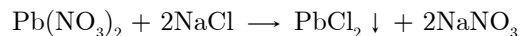
Ans :

SQP 2021

(a) By neutralisation, e.g.



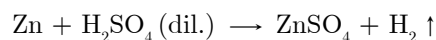
(b) By precipitation, e.g.



(c) By double decomposition, e.g.



(d) Simple displacement, e.g.



314. How can you obtain the following gases by using dilute acid and one other substance?

(a) Hydrogen

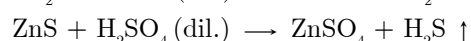
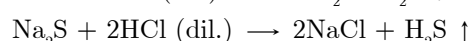
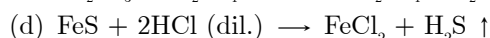
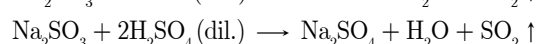
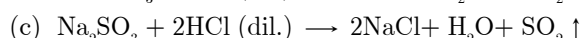
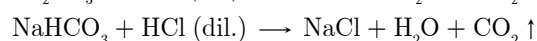
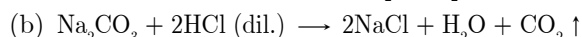
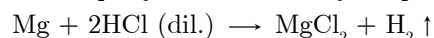
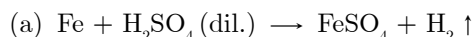
(b) Carbon dioxide

(c) Sulphur dioxide

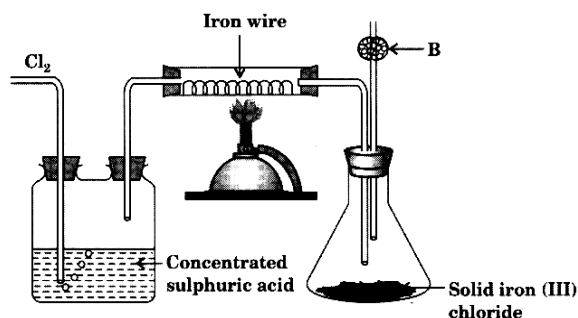
(d) Hydrogen sulphide

Ans :

COMP 2005



306. (a) The diagram given below is to prepare iron(III) chloride in the laboratory :



- What is substance B?
 - What is the purpose of B?
 - Why is iron(III) chloride to be stored in a closed container?
 - Write the equation for the reaction between iron and chlorine.
- (b) Write the equation(s) for the reaction(s) to prepare lead sulphate from lead carbonate.

Ans :

MAIN 2023

- Anhydrous calcium chloride
 - Drying agent
 - As it is highly deliquescent.
 - $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$
- $$\text{PbCO}_3 + 2\text{HNO}_3 (\text{dil.}) \rightarrow \text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$$

$$\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{PbSO}_4 + 2\text{HNO}_3$$

307. From the following formula AgCl , CuCO_3 , $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, KNO_3 , NaCl , NaHSO_4 , $\text{Pb}(\text{NO}_3)_2$, ZnCO_3 , $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$

Choose one in each case having the following descriptions :

- an acid salt
- an insoluble chloride
- changes from blue to white on treating with conc. H_2SO_4
- changes from green to black on heating
- gives nitrogen dioxide on heating.

Ans :

MAIN 2010

- NaHSO_4
- AgCl
- $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- CuCO_3
- $\text{Pb}(\text{NO}_3)_2$

308. Write balanced chemical equation to support each of the statement given below (use only dilute

sulphuric acid).

- Basic oxide + Acid $\rightarrow$ Salt + Water
- Amphoteric oxide + Acid $\rightarrow$ Salt + Water
- Alkali + Acid $\rightarrow$ Salt + Water
- Base + Acid $\rightarrow$ Salt + Water
- Active metal + Acid $\rightarrow$ Salt + Hydrogen
- Metallic carbonate + Acid $\rightarrow$ Salt + Water + Carbon dioxide

Ans :

COMP 2011

- $\text{MgO} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2\text{O}$
- $\text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$
- $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- $\text{Cu}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O}$
- $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
- $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$

309. How are the following salts prepared in the laboratory? Give balanced chemical equations only.

- Lead carbonate
- Lead sulphate
- Copper sulphate
- Magnesium chloride
- Silver chloride

Ans :

SQP 2015

- $$\text{Pb}(\text{NO}_3)_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{PbCO}_3 + 2\text{NaNO}_3$$

$$\text{Pb}(\text{NO}_3)_2 + \text{K}_2\text{CO}_3 \rightarrow \text{PbCO}_3 + 2\text{KNO}_3$$
- $$\text{Pb}(\text{NO}_3)_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{NaNO}_3$$

$$\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow \text{PbSO}_4 + 2\text{HNO}_3$$
- $$\text{CuO} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$$

$$\text{CuCO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{CuSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$$
- $$\text{Mg} + 2\text{HCl} (\text{dil.}) \rightarrow \text{MgCl}_2 + \text{H}_2 \uparrow$$

$$\text{MgO} + 2\text{HCl} (\text{dil.}) \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$$

$$\text{MgCO}_3 + 2\text{HCl} (\text{dil.}) \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$$
- $$\text{AgNO}_3 + \text{HCl} (\text{dil.}) \rightarrow \text{AgCl} + \text{HNO}_3$$

310. Answer the following questions relating to salts and their preparation:

- What is a salt?
- What kind of salt is prepared by precipitation?
- Name a salt prepared by direct combination. Write the equation for the reaction that takes place while preparing the salt you have named.
- What procedure would be used to prepare sodium salt such as sodium sulphate. (Give only the name of the procedure.)

Ans :

COMP 2017

- 301.** (a) The pH value of pure water is 7. Compare the pH values of sulphur dioxide solution and ammonia solution with that of pure water.
 (b) Name:
 (i) Two bases which are not alkalis.
 (ii) A normal salt and acid salt of same acid.
 (iii) A salt insoluble in cold water but soluble in hot water.

Ans :

MAIN 2015

- (a) pH of sulphur dioxide solution is less than seven.
 pH of ammonia solution is more than seven.
 (b) (i) Magnesium hydroxide and copper hydroxide.
 (ii) Sodium sulphate and sodium bisulphate.
 (iii) Lead chloride.
- 302.** Solutions *A*, *B*, *C* and *D* are having pH 1, 5, 8 and 14 respectively. In this context, answer the following questions.
 (i) Choose the solutions which are acidic in nature.
 (ii) Choose the solutions which are basic in nature.
 (iii) Choose the solutions which are highly acidic and highly alkaline.
 (iv) Choose the solutions which contain both ions and molecules.

Ans :

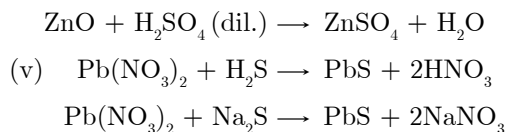
COMP 2017

- (i) *A* and *B*
 (ii) *C* and *D*
 (iii) Highly acidic - *A*
 Highly alkaline - *D*
 (iv) *B* and *C*
- 303.** How are the following salts prepared in the laboratory? Give balanced chemical equations only.
 (i) Iron (II) sulphide
 (ii) Sodium chloride
 (iii) Iron (II) chloride
 (iv) Zinc sulphate
 (v) Lead sulphide

Ans :

MAIN 2019

- (i) $\text{Fe} + \text{S} \xrightarrow{\Delta} \text{FeS}$
 (ii) $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$
 $\text{NaOH} + \text{HCl} (\text{dil.}) \rightarrow \text{NaCl} + \text{H}_2\text{O}$
 (iii) $\text{Fe} + 2\text{HCl} (\text{dil.}) \rightarrow \text{FeCl}_2 + \text{H}_2 \uparrow$
 (iv) $\text{Zn} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{ZnSO}_4 + \text{H}_2 \uparrow$



- 304.** Select from the list given below (*A* to *D*), one substance in each case which matches the description given in parts (i) to (iv).

Note : Each substance is used only once in the answer.

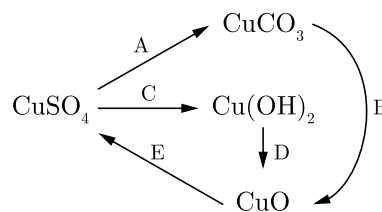
- (A) Iron (III) chloride
 (B) Chromium sulphate
 (C) Lead (II) chloride
 (D) Sodium chloride.
 (i) A compound which is deliquescent.
 (ii) A compound which is insoluble in cold water, but soluble in hot water.
 (iii) A compound whose aqueous solution is neutral in nature.
 (iv) The compound which is responsible for the green colouration when sulphur dioxide is passed through acidified potassium dichromate solution.

Ans :

SQP 2020

- (i) *A*
 (ii) *C*
 (iii) *D*
 (iv) *B*

- 305.** For each of the conversions *A*, *B*, *C*, *D* and *E* in the scheme below, state how the conversions can be carried out.



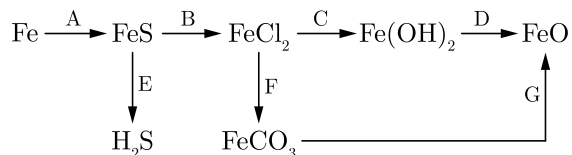
Ans :

COMP 2021

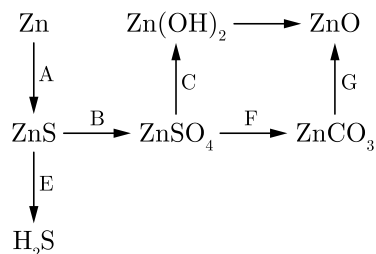
- A. $\text{CuSO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{CuCO}_3 + \text{Na}_2\text{SO}_4$
 B. $\text{CuCO}_3 \xrightarrow{\Delta} \text{CuO} + \text{CO}_2 \uparrow$
 C. $\text{CuSO}_4 + 2\text{NaOH} \rightarrow \text{Cu}(\text{OH})_2 + \text{Na}_2\text{SO}_4$
 D. $\text{Cu}(\text{OH})_2 \xrightarrow{\Delta} \text{CuO} + \text{H}_2\text{O}$
 E. $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$

315. How are the following conversions carried out ?
Give balanced chemical equations only.

(a)

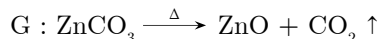
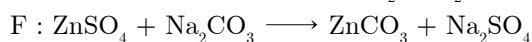
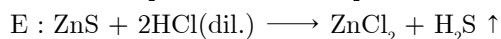
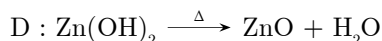
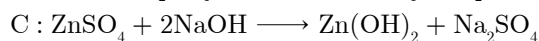
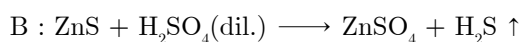
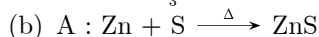
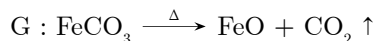
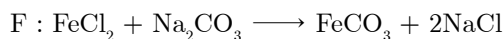
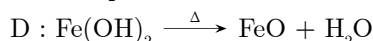
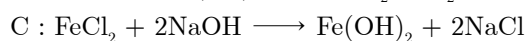
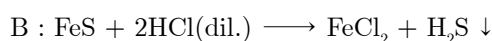
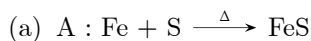


(b)



Ans :

SCP 2010



CASE BASED QUESTION

316. Study the table related to colour change with indicators and answer the questions that follow.

Solutions	Colour change with phenolphthalein indicator	Colour change with methyl orange indicator
<i>P</i>	Pink	Yellow

<i>Q</i>	Colourless	Orange
<i>R</i>	Colourless	Red

- Name the solution which is acidic.
- Arrange the given solutions in increasing order of their pH value.
- What is the name of solution *P* and *Q* ?
- When solution *P* added to the china rose indicator, what is the colour of solution *P* ?

Ans :

- Solution *R* is acidic because it changes to red on adding methyl orange indicator.
- $P < Q < R$
- Solution *P* and *Q* could be NaOH and NaCl.
- Green.

317. When the rain water contains large quantities of acids like nitric acid and sulphuric acid formed by dissolution of oxides of nitrogen and sulphur in water it is called as *P*. *Q* is formed of acidic water received on soil through rain, fog and snow. *R* is formed of wind-blown acidic gases and particles in the atmosphere which fall on ground with rain water.

- Identify the labelled parts as *P*, *Q* and *R* in this passage.
- Among *P*, *Q* and *R*, which part is mainly responsible for half of acidity in atmosphere that comes to earth ?

Ans :

- In the given passage, *P*, *Q* and *R* are acid rain, wet deposition and dry deposition respectively.
- About half of acidity in the atmosphere comes to earth through i.e., dry deposition (*R*).

318. Study the table and answer the following questions.

S. No.	Solution	pH limit
1.	Saliva	6.5-7.5
2.	Lemon juice	2.2-2.4
3.	Tomato juice	4.0-4.4
4.	Coffee	4.5-5.5

- What is the change on litmus paper when drops of tomato juice are dropped on it ?
- What is the nature of saliva given in table ?
- What is the effect of acid over pH paper ?
- What is the effect of base on litmus paper ?

Ans :

- (i) The litmus paper will turn red.
- (ii) Saliva is neither acidic nor basic, it comes under neutral sense.
- (iii) The pH paper is changed from blue to red in colour.
- (iv) Turns red litmus to blue in colour.

319. Acids, bases and salts are three main categories of chemical compounds. These have certain definite properties which distinguish one class from the other.

The acids are sour in taste while bases are bitter in taste. Tasting a substance is not a good way of finding out if it is an acid or a base! Acids and bases can be better distinguished with the help of indicators. Indicators are substances that undergo a change of colour with a change of acidic, neutral or basic medium. Many of these indicators are derived from natural substances such as extracts from flower petals and barrier. Litmus, a purple dye is extracted from the lichen plant. Some indicators are prepared artificially. For example, methyl orange and phenolphthalein. Given below is a table of indicators and their colour change in acidic and basic medium.

Indicator	Colour in Acid	Colour in Alkali
Litmus	Red	Blue
Methyl	Pinkish red	Yellow
Phenolphthalein	Colourless	Pink

- (i) Give two examples each of natural and artificial indicators.
- (ii) An aqueous solution turns red litmus solution blue. Excess addition of which solution would reverse the change-ammonium hydroxide solution or hydrochloric acid?
- (iii) What will be the change in colour when a few drops of phenolphthalein is added to a solution having pH 8.5
- (iv) What is universal indicator?

Ans :

- (i) Natural Indicators : Turmeric and red cabbage, Artificial Indicators : Methyl red and methyl orange
- (ii) Hydrochloric acid because adding excess acid to the base would turn blue litmus solution red.
- (iii) It changes into pink.
- (iv) Universal indicator is a mixture of dyes that

changes colour gradually over a range of pH and is used in testing for acids and alkalis.

320. The pH scale can be used to determine the strength of acid solutions as well as basic solutions by making use of hydrogen ion concentrations in them. Consider two solutions *A* and *B* having pH values 3 and 9.5, respectively.

- (i) Which solution will turn blue litmus red ?
- (ii) Which solution will turn phenolphthalein from colourless to pink ?
- (iii) Water is a neutral substance. What colour will you get when you add a few drops of universal indicator to a test tube containing distilled water?

Ans :

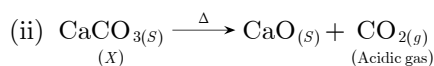
- (i) Solution *A* will turn blue litmus to red as its value of pH is 3.
- (ii) Solution *B* will turn phenolphthalein from colourless to pink as it is basic in nature.
- (iii) It turns the universal indicator solution green as its pH value is 7.

321. A metal carbonate *X* on heating with an acid gives a gas which when passed through a solution *Y* gives the carbonate back. On the other hand, a gas *G* that is obtained at anode during electrolysis of brine is passed on dry *Y*, it gives a compound *Z*, used for disinfecting drinking water.

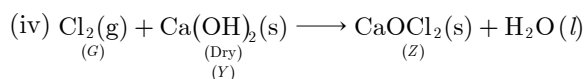
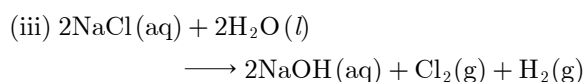
- (i) Identify *X*, *Y*, *G* and *Z*.
- (ii) What is the nature of the gas evolved when *X* is heated ?
- (iii) Write the reaction involved in the formation of *G* ?
- (iv) Write the reaction involved when *G* reacts with *Y*.

Ans :

- (i) *X* is calcium carbonate (CaCO_3).
Y is slaked lime [Ca(OH)_2].
G is chlorine (Cl_2) gas.
Z is bleaching powder (CaOCl_2).



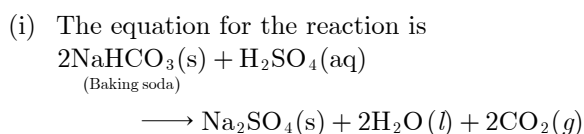
The gas CO_2 is acidic in nature.



322. Baking soda is used in small amounts for making bread and cakes. It helps to make these soft and spongy. An aqueous solution of baking soda turns red litmus blue. It is also used in soda acid fire extinguisher. Use this information to answer the following questions.

- Write the equation for the reaction between baking soda and acid.
- How does it help in extinguishing fire?
- What is the reaction involved when it is heated?
- Is the pH value of baking soda solution lower than or higher than 7?

Ans :



- The CO_2 gas produced by the reaction of baking soda and acid in the soda-acid fire extinguisher, helps in extinguishing fire.
- The reaction involved is



- The pH value of baking soda solution is higher than 7, i.e. it is alkaline.

323. Study these table related to answer the questions that follow :

	Substance	pH	Colour shown by universal indicator
1.	A	6.5	Greenish yellow
2.	B	10.5	Navy blue
3.	C	0	Dard red
4.	D	8.5	Greenish blue
5.	E	4.0	Orange

Answer the questions giving examples in each case.

- Which substance may be used as a preservative?
- Which substance may be used in antacids?
- Which substance may be used in cakes to make them fluffy?
- Which substance is a strong acid?

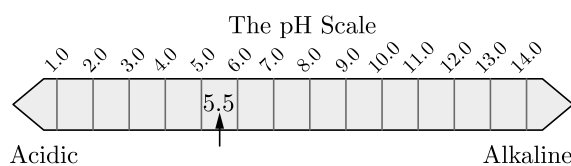
Ans :

- Substance E may be used as a preservative, e.g. vinager.

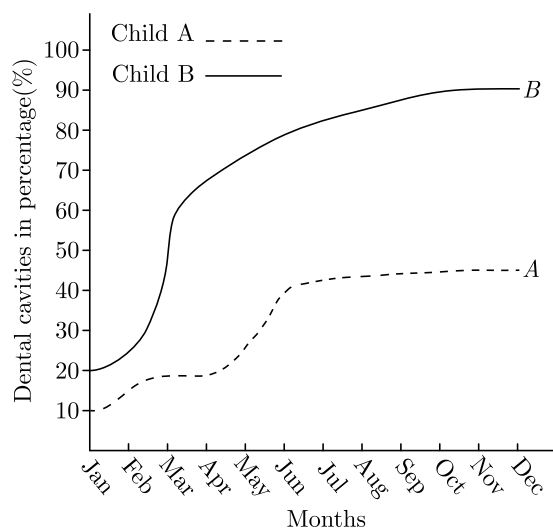
- Substance B may be used in antacids, e.g. milk of magnesia.
- Substance D may be used in cakes to make them fluffy, e.g. baking soda.
- Substance C is a strong acid, e.g. conc.HCl.

324. Children eat a lot of sugary foods such as cakes, pastries, chocolates etc. which can lead to tooth decay. Tooth decay is the gradual destruction of hard outer tissues of the tooth that leads to the formation of cavities or caries in tooth.

Whenever we eat any food, some of the food particles stick in-between our teeth. The bacteria present in our mouth break down the sugar present in the food to form acid. This acid changes the pH of the mouth which may be the main cause of tooth decay.



- What is meant by saying that pH change may be the main cause of tooth decay?
- What is the critical pH at which tooth decay starts?
- The nature of the toothpaste used for cleaning teeth is
- Based on the data shown in the graph below, which of the two children A and B, would have more teeth with cavities and why?



Ans :

- Tooth decay starts when the pH of the mouth falls below 5.5. Acid becomes strong enough

to corrode hard enamel of tooth.

(ii) 5.5

(iii) basic

(iv) Child B

Eating lots of chocolates, chips or candies leads to tooth cavity.

- 325.** (i) Complete the table below about the reactions of some elements with oxygen in the air.

The first line has been completed for you.

Element	Observations during reaction	pH of aqueous solution of oxide	Is the oxide an acid or a base?
calcium	burns with a red glow	13	base
carbon			
magnesium			
sulfur			

- (ii) Describe how the results in the table can be used to decide whether an element is a metal or a non-metal.

Ans :

(i)

Element	Observations during reaction	pH of aqueous solution of oxide	Is the oxide an acid or a base?
calcium	burns with a red glow	13	base
carbon	burns with a red glow	5	acid
magnesium	burns with a white light	9	base
sulfur	burns with purple/blue flame	1	acid

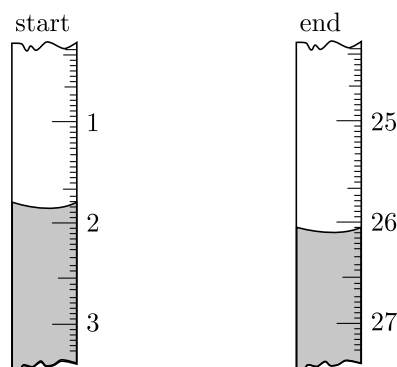
- (ii) Metals produce basic oxides. Non-metals produce acidic oxides

- 326.** A student carried out a titration to find the concentration of some hydrochloric acid. The student measured the volume of hydrochloric acid needed to neutralise 25cm³ of 0.200 mol/dm³ potassium hydroxide solution. The equation for

the reaction is:



The diagrams show the readings on the burette at the start and finish of the titration.



- (i) Use the diagrams to complete the table. Enter the values to the nearest 0.05cm³.

Burette reading at end / cm ³	
Burette reading at start / cm ³	
Volume of acid added / cm ³	

- (ii) Calculate the amount, in moles, of potassium hydroxide solution used.
 (iii) Calculate the concentration, in mol/dm³, of the hydrochloric acid solution.

Ans :

(i)

burette reading at end in cm ³	26
burette reading at start in cm ³	1.75
volume of acid added in cm ³	24.35

- (ii) Moles of potassium hydroxide solution

$$= 0.200 \times \frac{25}{1000} = 0.005$$

- (iii) The concentration(in mol/dm³) of the hydrochloric acid solution

$$= \frac{0.005 \times 1000}{24.35} = 0.205$$

- 327.** A dry pellet of a common base *B* when kept in open absorbs moisture and turns sticky. The compound is also a by-product of chlor-alkali process.

- (i) What is name of *B* ?
 (ii) What type of reaction occurs when *B* is treated with an acid?
 (iii) Write the balanced chemical equation for the reaction of *B* with CO₂.
 (iv) Which gas is evolved when *B* reacts with Zn.

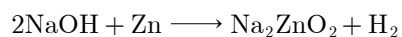
Ans :

- (i) B is sodium hydroxide (NaOH).
(ii) Neutralisation reaction occurs when B is treated with an acid.

- (iii) The chemical reaction is



- (iv) The chemical reaction is



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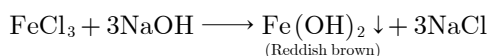
- 38.** When sodium hydroxide is added to a solution of ferric chloride write equation for the reaction taking place.

- Blue colour precipitate of Ferric chloride is formed at the product side.
- Ferric Oxide is formed at the product side.
- Reddish Brown Colour precipitate of ferric hydroxide and NaCl is formed at the product side.
- Light Brown crystals of ferric chloride is formed at the end of product side.

Ans :

SQP 2009

When sodium hydroxide solution is added to ferric chloride, a reddish brown precipitate of ferric hydroxide, insoluble even in the excess of the sodium hydroxide is obtained.



Thus (c) is correct option.

- 39.** Match the columns:

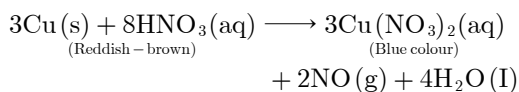
	Column A		Column B
(1)	Copper(II) nitrate	(A)	Green
(2)	Iron(II) sulphate	(B)	White
(3)	Magnesium chloride	(C)	Pink
(4)	Cobalt chloride	(D)	Blue

- (a) 1-D, 2-A, 3-B, 4-C
(b) 1-D, 2-B, 3-A, 4-C
(c) 1-C, 2-B, 3-A, 4-D
(d) 1-D, 2-A, 3-C, 4-B

Ans :

SQP 2015

1. When the copper is first oxidized, the solution is very concentrated and the Cu^{2+} product is initially coordinated to nitrate ions from the nitric acid, giving the solution first a green and then a green-brownish colour. When the solution is diluted with water, Water molecules displace the nitrate ions in the coordinate sites around the copper ions, causing the solution to change to a blue colour.



2. The ferrous sulphate is green in colour. On heating, it changes the colour from green to white.
3. Magnesium chloride is an inorganic salt which is white in colour.

- Cobalt Chloride is blue in colour in its dry form but it turns pink when hydrated.

Thus (a) is correct option.

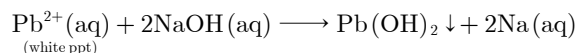
- 40.** Hydroxide of this metal is soluble in NaOH.

- (a) Lead (b) Magnesium
(c) Silver (d) Copper

Ans :

COMP 2017

Lead hydroxide is soluble in NaOH due to the formation of lead hydroxide.



Thus (a) is correct option.

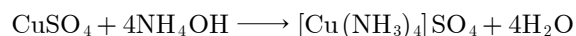
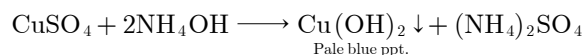
- 41.** Ammonium hydroxide solution is slowly added and then in excess to copper sulphate solution.

- Light brown crystals of copper chloride is formed at the end of product side.
- Reddish brown colour precipitate of copper sulphate and ammonium hydroxide is formed at the product side.
- Copper oxide is formed at the product side.
- Blue colour precipitate of copper hydroxide is formed at the product side.

Ans :

MAIN 2019

Ammonium hydroxide solution, when slowly added to copper sulphate solution, light blue precipitate of copper hydroxide is obtained, which is soluble in excess of ammonium hydroxide to form an intense deep blue solution of tetra amine cupric sulphate.



Tetra amine cupric
sulphate
(Soluble complex)
Deep blue solution

Thus (d) is correct option.

- 42.** The salt whose solution gives a pale green precipitate with NaOH solution and a white ppt. with BaCl_2 soln. is:

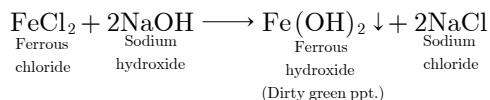
- Iron (III) sulphate
- Iron (II) chloride
- Iron (II) sulphate
- Iron (III) chloride

Ans :

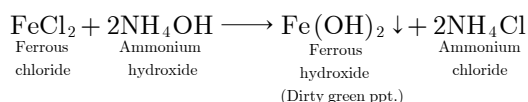
COMP 2010

When ferrous sulphate reacts with NaOH gives Ferrous hydroxide and Barium sulphate at the product side.

dirty green precipitate is formed which turns reddish brown after sometime and is insoluble in excess of sodium hydroxide.

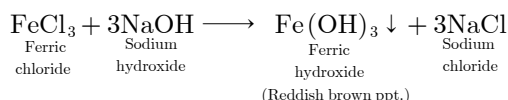


- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of ferrous salt, a dirty green precipitate is formed which turns reddish brown after sometime and is insoluble in excess of ammonium hydroxide.

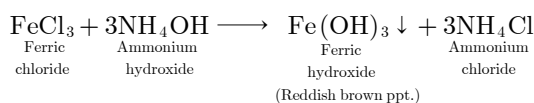


1.6 Reaction of Sodium hydroxide and Ammonium hydroxide with the soluble salt of ferric:

- (1) With NaOH : On adding sodium hydroxide drop by drop to a solution of ferric salt, a reddish brown precipitate is formed which is insoluble in excess of sodium hydroxide.

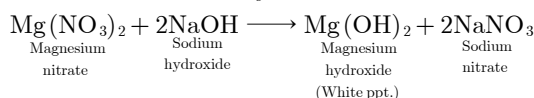


- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of ferric salt, a reddish brown precipitate is formed which is insoluble in excess of ammonium hydroxide.

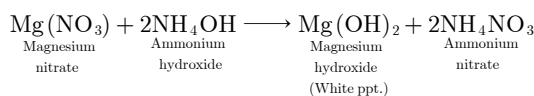


1.7 Reaction of Sodium hydroxide and Ammonium hydroxide with soluble salt of Magnesium:

- (1) With NaOH : On adding sodium hydroxide drop by drop to a solution of magnesium salt, a white precipitate appears which is insoluble in excess of sodium hydroxide.



- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of magnesium salt, a white precipitate appears which is insoluble in excess of ammonium hydroxide.



1.8 Colour of Salt Solutions

The salts on dissolving in water form different coloured salt solutions.

	Name of the salt	Colour of the salt solution
(i)	Ferrous salt	Pale green
(ii)	Ferric salt	Yellow
(iii)	Cupric salt	Blue (except CuCO_3 which is a green coloured insoluble salt)
(iv)	Lead salt	Colourless solution (only two salts of lead are soluble in water: (i) lead nitrate (ii) lead acetate)
(v)	Zinc salt	Colourless solutions
(vi)	Calcium salt	Colourless solutions

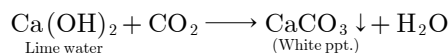
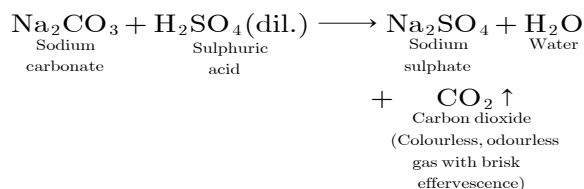
2. ACID RADICALS

The acid radicals are divided in three main categories:

- (i) The acid radicals or anions detected by dilute Sulphuric acid are
- Carbonate - CO_3^{2-}
 - Sulphite - SO_3^{2-}
 - Sulphide - S^{2-}
- (ii) The acid radicals or anions detected by concentrated Sulphuric acid are
- Chloride - Cl^-
 - Nitrate - NO_3^-
- (iii) The acid radical or anion neither detected by dilute Sulphuric acid nor by concentrated Sulphuric acid is Sulphate - SO_4^{2-}

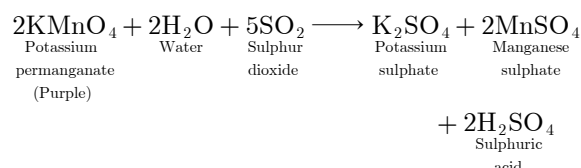
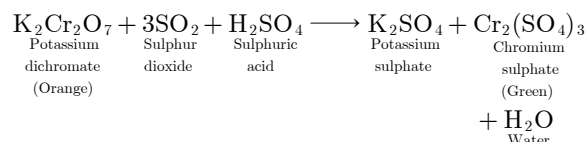
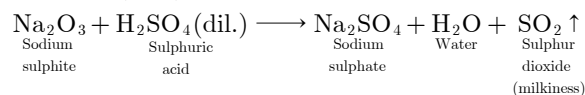
3. DETECTION OF CARBONATE

On adding dilute Sulphuric acid to a metallic Carbonate a colourless and odourless gas evolved with brisk effervescence which turns Lime water milky.

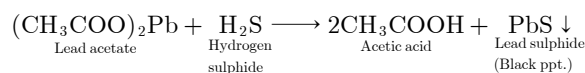
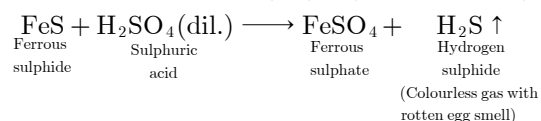


4. DETECTION OF SULPHITE

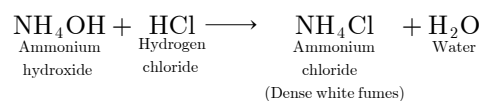
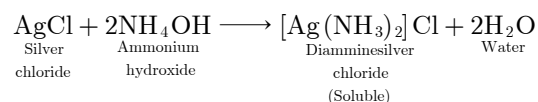
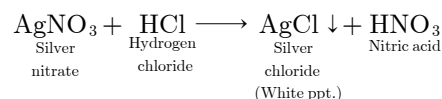
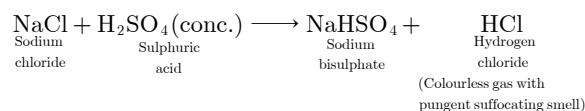
On adding dilute Sulphuric acid to a metallic Sulphite a colourless gas having burning sulphur smell evolves which turns acidified Potassium dichromate solution from orange to green and Potassium permanganate solution from purple to colourless, i.e., it decolourizes.

**5. DETECTION OF SULPHIDE**

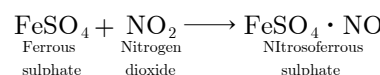
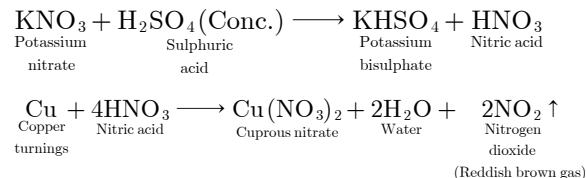
On adding dilute Sulphuric acid to metallic Sulphide a colourless gas having rotten egg smell evolves which turns lead acetate solution black.

**6. DETECTION OF CHLORIDE**

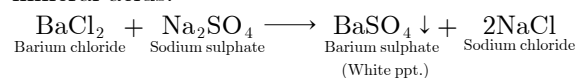
On adding concentrated Sulphuric acid to metallic Chlorides a colourless gas having pungent suffocating smell which fumes in moist air evolves which gives white ppt. with silver nitrate solution which is soluble in excess of Ammonium hydroxide and dense white fumes with Ammonium hydroxide.

**7. DETECTION OF NITRATE**

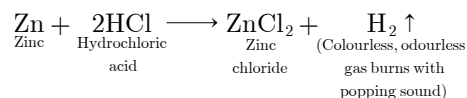
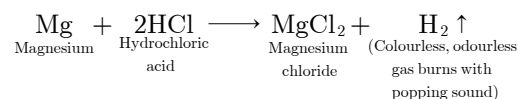
On adding concentrated Sulphuric acid to metallic Nitrate in presence of Copper turnings and heated strongly a reddish brown gas having pungent suffocating smell evolves which turns freshly prepared acidified Ferrous sulphate solution brown black.

**8. DETECTION OF SULPHATE**

To the salt solution of a soluble metallic Sulphate, Barium chloride solution is added, a white precipitate appears which is insoluble in all mineral acids.

**9. DETECTION OF HYDROGEN**

On reaction of active metals with dilute acids a colourless and odourless gas evolves which burns with a popping sound.



The colour, odour of the gases can be summarized as follows:

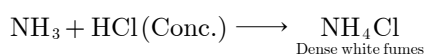
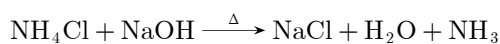
	Name of the gas evolved	Colour of the gas	Odour of the gas
(i)	Carbon dioxide	Colourless	Odourless
(ii)	Sulphur dioxide	Colourless	Burning sulphur smell
(iii)	Hydrogen sulphide	Colourless	Rotten egg smell
(iv)	Hydrogen chloride gas	Colourless gas fumes in moist air	Pungent suffocating smell
(v)	Nitrogen dioxide	Reddish brown	Pungent suffocating

(vi)	Hydrogen	Colourless	Odourless
(vii)	Ammonia	Colourless	Pungent irritating

- Metals like sodium, potassium and calcium are not used for the preparation of hydrogen in laboratory as the reaction is highly vigorous and explosive.
- Amphoteric nature of metals, their oxides and hydroxides

Metals/ Oxides/ Hydroxides	Acidic nature	Alkaline nature
Zn	$\text{Zn} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{ZnSO}_4 + \text{H}_2 \uparrow$ $\text{Zn} + 2\text{HCl} (\text{dil.}) \rightarrow \text{ZnCl}_2 + \text{H}_2 \uparrow$	$\text{Zn} + 2\text{NaOH} (\text{dil.}) \xrightarrow{\Delta} \text{Na}_2\text{ZnO}_2 + \text{H}_2 \uparrow$ $\text{Zn} + 2\text{KOH} (\text{dil.}) \xrightarrow{\Delta} \text{K}_2\text{ZnO}_2 + \text{H}_2 \uparrow$
ZnO	$\text{ZnO} + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$ $\text{ZnO} + 2\text{HCl} (\text{dil.}) \rightarrow \text{ZnCl}_2 + \text{H}_2\text{O}$	$\text{ZnO} + 2\text{NaOH} (\text{dil.}) \xrightarrow{\Delta} \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O} \uparrow$ $\text{ZnO} + 2\text{KOH} (\text{dil.}) \xrightarrow{\Delta} \text{K}_2\text{ZnO}_2 + \text{H}_2\text{O}$
$\text{Zn}(\text{OH})_2$	$\text{Zn}(\text{OH})_2 + \text{H}_2\text{SO}_4 (\text{dil.}) \rightarrow \text{ZnSO}_4 + 2\text{H}_2\text{O}$ $\text{Zn}(\text{OH})_2 + 2\text{HCl} (\text{dil.}) \rightarrow \text{ZnCl}_2 + 2\text{H}_2\text{O}$	$\text{Zn}(\text{OH})_2 + 2\text{NaOH} (\text{dil.}) \xrightarrow{\Delta} \text{Na}_2\text{ZnO}_2 + 2\text{H}_2\text{O} \uparrow$ $\text{Zn}(\text{OH})_2 + 2\text{KOH} (\text{dil.}) \xrightarrow{\Delta} \text{K}_2\text{ZnO}_2 + 2\text{H}_2\text{O} \uparrow$

- Action of sodium hydroxide on Ammonium salts: Ammonium chloride on heating with sodium hydroxide produces colourless gas having pungent irritating odour which gives dense white fumes with concentrated HCl and turns Nessler's reagent brown.



MULTIPLE CHOICE QUESTION

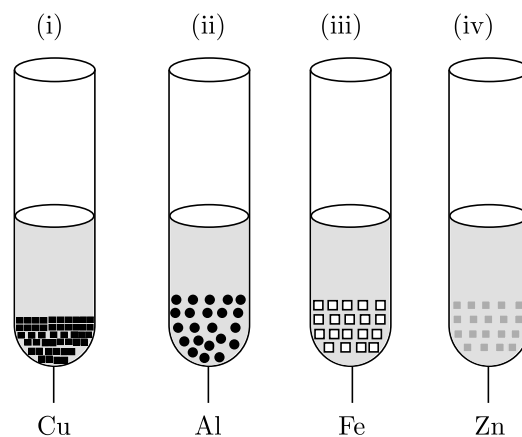
- Aqueous lead (II) nitrate can be distinguished from aqueous zinc nitrate by adding any of the following solution in excess, except:
 - aqueous potassium chloride
 - aqueous sodium sulphate
 - dilute sulphuric acid
 - sodium hydroxide solution

Ans :

SQP 2025

Thus (d) is correct option.

- A student takes Cu, Al, Fe and Zn strips, separately in four test tubes labeled as I, II, III and IV respectively. He adds 10 ml of freshly prepared ferrous sulphate solution to each test tube and observes the colour of the metal residue in each case.



He would observe a black residue in the test tubes:

- (I) and (II)
- (I) and (III)
- (II) and (III)
- (II) and (IV)

Ans :

SQP 2025

In test tubes II and IV. Al and Zn are more reactive than Fe, thus they displace iron (black residue) from ferrous sulphate solution.

Thus (d) is correct option.

- Rotten egg smell is due to the liberation of:

- HCl gas
- H_2S gas
- Cl_2 gas
- SO_2 gas

Ans :

MAIN 2024

The rotten egg smell is due to the liberation of hydrogen sulphide gas (H_2S).

Thus (b) is correct option.

NODIA

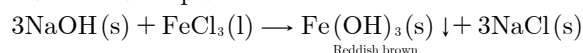
- The colour of the precipitate formed after the addition of a small amount of sodium hydroxide solution to an aqueous solution of ferric chloride is

- gelatinous white
- pale blue
- reddish brown
- dirty green

Ans :

COMP 2021

When NaOH is added to ferric chloride following reaction takes place :



Thus (c) is correct option.

5. Aqueous solution of cupric chloride forms a deep blue solution on addition of
- drop wise sodium hydroxide
 - excess sodium hydroxide
 - drop wise ammonium hydroxide
 - excess ammonium hydroxide

Ans :

MAIN 2021

Thus (d) is correct option.

6. The percentage of hydrogen present in NaOH is (Relative molecular mass of NaOH = 40) (At. wt. of H = 1).
- 2.5
 - 25
 - 0.25
 - 0.025

Ans :

SQP 2021

Molecular mass of NaOH = 40

Atomic weight of H = 1

Percentage of element in a compound

$$= \frac{\text{Total wt. of element in one molecule}}{\text{Gram molecular wt. of compound}} \times 100$$

$$= \frac{1}{40} \times 100 = 2.5$$

Thus (a) is correct option.

7. The salt solution which does not react with ammonium hydroxide is
- lead nitrate
 - zinc nitrate
 - calcium nitrate
 - copper nitrate

Ans :

SQP 2018

Calcium nitrate ($\text{Ca}(\text{NO}_3)_2$) is a salt solution that does not react with ammonium hydroxide (NH_4OH). When ammonium hydroxide is added to calcium nitrate, there is no change to either solution, nor is a precipitate formed.

Thus (c) is correct option.

8. If the empirical mass of the formula PQ_2 is 10 and the relative molecular mass is 30, then the molecular formula will be
- PQ_2
 - P_3Q_2
 - P_6Q_3
 - P_3Q_6

Ans :

COMP 2021

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

$$= \frac{30}{10} = 3$$

Molecular formula = $n \times$ Empirical formula

$$= 3 \times (PQ_2) = P_3Q_6$$

Thus (d) is correct option.

9. The salt solution which does not react with ammonium hydroxide is :
- Calcium Nitrate
 - Zinc Nitrate
 - Lead Nitrate
 - Copper Nitrate

Ans :

MAIN 2018

Calcium nitrate does not react with Ammonium hydroxide. When ammonium hydroxide is added to calcium nitrate, there's no change to either mixture because no reaction occurs. This is because ammonium hydroxide is a weak base and doesn't provide enough OH^- ions to cause precipitation.

Thus (a) is correct option.

10. Hydroxide of this metal is soluble in sodium hydroxide solution.

- Magnesium
- Lead
- Silver
- Copper

Ans :

SQP 2011

Hydroxide of this metal is soluble in sodium hydroxide solution is Lead.

Thus (b) is correct option.

11. If the empirical formula of a compound is CH and its vapour density is 13, then its molecular formula will be (At. wt. C = 12, H = 1)
- CH
 - C_2H_2
 - C_4H_4
 - C_3H_3

Ans :

COMP 2021

$$n = \frac{2 \times \text{Vapour density}}{\text{Empirical formula wt.}}$$

$$= \frac{2 \times 13}{13} = 2$$

Molecular formula = $n \times$ Empirical formula

$$= 2 \times \text{CH} = \text{C}_2\text{H}_2$$

Thus (b) is correct option.

12. Reagent which forms deep blue solution with copper sulphate
- Copper Sulphate (CuSO_4)
 - Ammonium Hydroxide [NH_4OH]
 - Ammonia (NH_3)
 - Calcite (CaCO_3)

Ans :

SQP 2014

Ammonia gas on passing through copper sulphate solution gives deep blue solution.

Thus (b) is correct option.

13. The salt which gives a dirty green precipitate with sodium hydroxide solution is
 (a) iron (III) sulphate
 (b) iron (II) chloride
 (c) iron (II) sulphate
 (d) iron (III) chloride

Ans :

MAIN 2008

Iron [II] sulphate or ferrous sulphate with NaOH to form sodium sulphate along with iron [II] hydroxide. This iron [II] hydroxide precipitates in the form of a green coloured solid.

Thus (c) is correct option.

14. Which one of the following salt solutions on reaction with excess of ammonium hydroxide solution results finally in dissolution of the precipitate first formed ?
 (a) $\text{AlCl}_3(\text{aq})$ (b) $\text{ZnSO}_4(\text{aq})$
 (c) $\text{Fe}(\text{SO}_4)_3(\text{aq})$ (d) $\text{FeSO}_4(\text{aq})$

Ans :

COMP 2015

Zinc Sulphate when reacted with excess of ammonium hydroxide solution, Zinc hydroxide is precipitated at the end of the reaction.

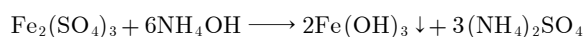
Thus (b) is correct option.

15. Ammonium hydroxide is added to Iron(III) sulphate solution.
 (a) Ferric Oxide is formed at the product side.
 (b) Reddish brown colour precipitate of ferric hydroxide and NaCl is formed at the product side
 (c) Light blue of Ferric chloride is formed at the product side.
 (d) Light Brown crystals of ferric chloride is formed at the end of product side

Ans :

SQP 2011

A reddish brown precipitate of iron (III) hydroxide is formed.



Thus (a) is correct option.

16. If relative molecular mass of butane (C_4H_{10}) is, 58 then its vapour density will be
 (a) 58 (b) 29
 (c) 32 (d) 16

Ans :

COMP 2021

$$\begin{aligned} \text{Vapour density} &= \frac{\text{Relative molecular mass}}{2} \\ &= \frac{58}{2} = 29 \end{aligned}$$

Thus (b) is correct option.

17. A solution of the compound which gives a dirty green precipitate with sodium hydroxide.
 (a) Ferrous sulphate
 (b) Lead carbonate
 (c) Ammonium sulphate
 (d) Chlorine

Ans :

MAIN 2008

Ferrous sulphate when reacts with NaOH, the dirty Screen precipitate ferrous hydroxide and sodium sulphate is formed at the product side.

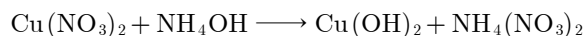
Thus (a) is correct option.

18. Which solution becomes a deep/inky blue colour when excess of ammonium hydroxide is added to it.
 (a) Lead nitrate
 (b) Iron [II] sulphate
 (c) Iron [III] chloride
 (d) Copper nitrate

Ans :

COMP 2010

When copper nitrate reacts with ammonium hydroxide, copper hydroxide and ammonium nitrate is formed at the product side.



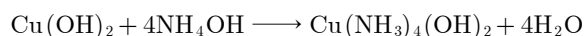
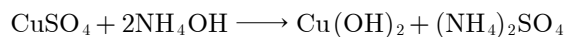
Thus (d) is correct option.

19. The precipitate of which of the following compounds is soluble in excess of ammonia solution ?
 (a) Iron(II) chloride
 (b) Magnesium chloride
 (c) Lead nitrate
 (d) Copper(II) sulphate

Ans :

MAIN 2015

When NH_4OH solution is added drop by drop to copper sulphate solution a pale blue / bluish white precipitate is formed which is soluble in excess of NH_4OH and deep blue / inky blue solution is formed.



Thus (d) is correct option.

20. The oxide and hydroxide of which metal is amphoteric :
 (a) Iron (b) Copper
 (c) Zinc (d) Manganese

Ans :

SQP 2020

CHAPTER 4

ANALYTICAL CHEMISTRY

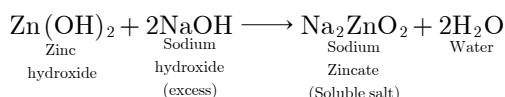
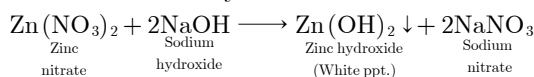
SUMMARY

1. ALKALIS

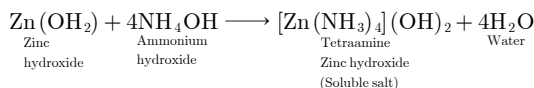
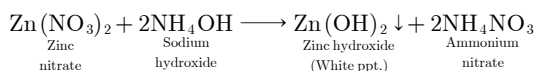
Alkalis, i.e. sodium hydroxide and ammonium hydroxide react with the soluble salts of metal to precipitate different coloured hydroxides.

1.1 Reaction of Sodium hydroxide and Ammonium hydroxide with the soluble salt of zinc:

- (1) With NaOH : On adding Sodium hydroxide drop by drop to a solution of Zinc salt, a white precipitate is formed which is soluble in excess of sodium hydroxide.

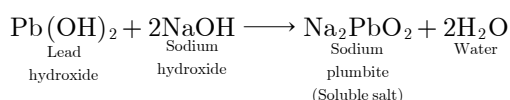
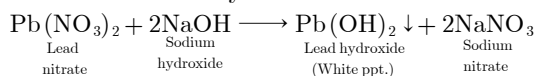


- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of zinc salt, a white precipitate is formed which is soluble in excess of ammonium hydroxide.

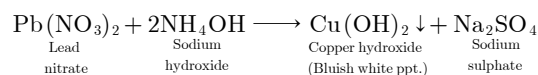


1.2 Reaction of Sodium hydroxide and Ammonium hydroxide with the soluble salt of lead:

- (1) With NaOH: On adding Sodium hydroxide drop by drop to a solution of Lead salt, a white precipitate is formed which is soluble in excess of Sodium hydroxide.



- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of lead salt, a white precipitate is formed which is insoluble in excess of ammonium hydroxide.

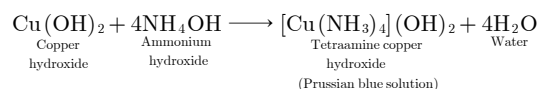
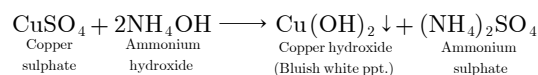


1.3 Reaction of Sodium hydroxide and Ammonium hydroxide with the soluble salt of copper:

- (1) With NaOH: On adding sodium hydroxide drop by drop to a solution of copper salt, a bluish white precipitate is formed which is insoluble in excess of Sodium hydroxide.

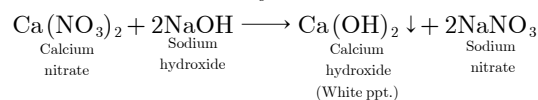


- (2) With NH_4OH : On adding ammonium hydroxide drop by drop to a solution of copper salt, a pale blue or bluish white precipitate is formed which dissolves in excess of ammonium hydroxide to give deep blue or inky blue or prussian blue solution.



1.4 Reaction of Sodium hydroxide and Ammonium hydroxide with the soluble salt of calcium:

- (1) With NaOH: On adding sodium hydroxide drop by drop to a solution of calcium salt, a white precipitate is formed which is insoluble in excess of sodium hydroxide.



- (2) With NH_4OH : No visible reaction.

1.5 Reaction of Sodium hydroxide and Ammonium hydroxide with soluble salt of Ferrous:

- (1) With NaOH: On adding sodium hydroxide drop by drop to a solution of ferrous salt, a

Ans :

SQP 2018

Thus (c) is correct option.

31. A metal M shows different colour in differently combined state as listed in the table below

Metal Compound	Colour
K_2MO_4	Yellow
$K_2M_2O_7$	Orange

Identify the metal

- (a) Cr (b) Mn
(c) Fe (d) Ni

Ans :

MAIN 2019

As, per the colours given in the table, the metal 'M' is Cr.

K_2CrO_4	→	Potassium chromate
$K_2Cr_2O_7$	→	Potassium dichromate

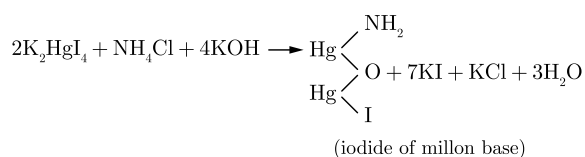
Thus (a) is correct option.

32. A colourless gas having pungent irritating odour gives dense white fumes with conc. HCl and turns Nessler's reagent brown. The colourless gas is
(a) NH_3 (b) H_2
(c) NH_4Cl (d) Cl_2

Ans :

COMP 2012

Nessler's reagent is prepared by combining potassium iodide and mercuric chloride. It is used to test presence of NH_3 or NH_4^+ ions.



Also, NH_3 when react with HCl (conc), it gives white fumes of NH_4Cl .



It has irritating odour also. Hence, the given gas is NH_3 .

Thus (a) is correct option.

33. A chloride which forms a precipitate that is soluble in excess of ammonium hydroxide, is
(a) Copper chloride
(b) Ferrous chloride
(c) Ferric chloride
(d) Calcium chloride

Ans :

SQP 2018

Copper chloride forms a precipitate that is soluble in excess of ammonium hydroxide.

Thus (d) is correct option.

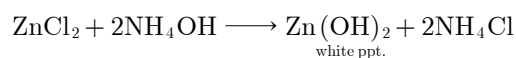
34. Zinc chloride solution reacts with ammonium hydroxide solution to give a coloured precipitate.
(a) blue (b) green
(c) white (d) yellow

Ans :

COMP 2007

The reactions that occur when excess ammonium hydroxide solution is introduced to zinc chloride solution are as follows.

The white gelatinous $Zn(OH)_2$ is generated first, which dissolves in excess NH_4OH to form the following product:



Thus (c) is correct option.

35. The colour of hydrated zinc sulphate is
(a) blue (b) black
(c) white (d) reddish

Ans :

SQP 2005

$ZnSO_4 \cdot 7H_2O$ is a hydrated zinc sulphate which is also known as white vitrol. Due to its water of crystallization, the colour of hydrated zinc sulphate is white.

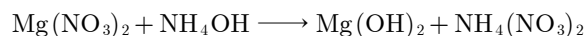
Thus (c) is correct option.

36. Name the reagent from the following which can be used to distinguish zinc nitrate solution from magnesium nitrate.
(a) H_2SO_4 (b) $NaOH(aq)$
(c) $BaCl_2$ (d) $NH_4OH(aq)$

Ans :

MAIN 2002

Ammonium Hydroxide can be used to distinguish zinc nitrate solution from magnesium nitrate by forming magnesium hydroxide and ammonium nitrate at the product side.



Thus (d) is correct option.

37. Soluble complex formed when zinc reacts with sodium hydroxide
(a) Zinc Oxide (ZnO)
(b) Zinc Hydroxide ($Zn[OH]_2$)
(c) No reaction
(d) Sodium Zincate [Na_2ZnO_2]

Ans :

COMP 2004

Thus (d) is correct option.

Zinc oxide and hydroxide can react with both acidic and basic oxides.

Thus (c) is correct option.

- 21.** Amphoteric oxides and hydroxides react with an , to give salt and water only.

- (a) Acid, Alkali (b) Base, Alkali
(c) Acid, Base (d) None of these

Ans :

COMP 2021

Amphoteric oxides and hydroxides reacts with both acid and alkali metals to form salt and water. Thus (a) is correct option.

- 22.** Salts of which elements are generally coloured :

- (a) Inner-transition (b) Normal
(c) Lanthanide's (d) Transition

Ans :

SQP 2023

Transition salts has one or more unpaired electrons which jumps on to the higher energy level when they receive light. Thus, these transitional salts absorb radiations and produces colourful compounds.

Thus (d) is correct option.

- 23.** An example of weak alkali solution is

- (a) Sodium hydroxide
(b) Nitrogen dioxide
(c) Potassium hydroxide
(d) Ammonium hydroxide

Ans :

COMP 2021

Ammonium hydroxide is a weak alkali solution as OH^- ion does not dissociate completely into the water.

Thus (d) is correct option.

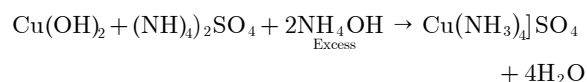
- 24.** A metal hydroxide which is insoluble in caustic but soluble in excess of NH_4OH is

- (a) $\text{Zn}(\text{OH})_2$ (b) $\text{Cu}(\text{OH})_2$
(c) $\text{CO}(\text{OH})_2$ (d) None of these

Ans :

COMP 2005

$\text{Cu}(\text{OH})_2$ is insoluble in excess of NaOH but soluble in excess of ammonium hydroxide and gives deep blue or prussian blue solution. The reaction is as follow



Thus (b) is correct option.

- 25.** Ammonium hydroxide is a weak alkali which dissociates partially to furnish OH^- ions precipitate metal hydroxides.

- (a) Insufficient, Soluble
(b) Insufficient, Insoluble
(c) Sufficient, Insoluble
(d) Sufficient, Soluble

Ans :

SQP 2010

Ammonium hydroxide is a weak alkali which dissociates partially to furnish insufficient OH^- ions which precipitate soluble metal hydroxides.

Thus (a) is correct option.

- 26.** Which of the following hydroxides possesses pale blue colour?

- (a) Lead hydroxide (b) Ferrous hydroxide
(c) Zinc hydroxide (d) Copper hydroxide

Ans :

SQP 2010

Thus (d) is correct option.

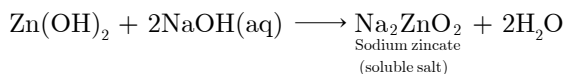
- 27.** Which of the following hydroxide is soluble in excess of NaOH ?

- (a) $\text{Cr}(\text{OH})_3$ (b) $\text{Zn}(\text{OH})_2$
(c) $\text{Ca}(\text{OH})_2$ (d) $\text{Fe}(\text{OH})_3$

Ans :

MAIN 2008

When $\text{Zn}(\text{OH})_2$ is added in excess of NaOH solution, it dissolved in that due to formation of soluble zincate ions.



$\text{Zn}(\text{OH})_2$ is amphoteric, so it reacts as an acid with the base to give a soluble complex.

Thus (b) is correct option.

- 28.** Zinc hydroxide forms gelatinous ppts.

- (a) red soluble (b) yellow insoluble
(c) white soluble (d) white insoluble

Ans :

SQP 2011

Zinc hydroxide forms gelatinous white precipitate soluble in excess of Ammonium hydroxide.

Thus (c) is correct option.

- 29.** is the least soluble of the common alkalies.

- (a) Magnesium Hydroxide
(b) Calcium Hydroxide
(c) Potassium Hydroxide
(d) Lithium Hydroxide

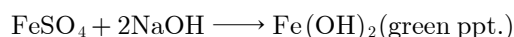
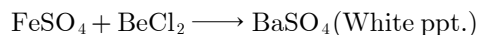
Ans :

COMP 2013

Thus (b) is correct option.

- 30.** Sodium and potassium salts are in colour.

- (a) Red (b) Brown
(c) Colourless (d) Blue



Thus (c) is correct option.

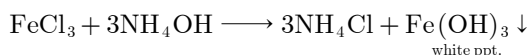
43. Ammonium hydroxide solution is added to Iron (III) chloride solution.

- Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
- Zinc Oxide is formed at the product side.
- Ammonium Chloride and white precipitate of $\text{Fe}(\text{OH})_3$ is formed at the end of product side.
- Light Brown crystals of Copper hydroxide is formed at the end of product side.

Ans :

SQP 2020

A reddish brown ppt. of ferric hydroxide insoluble in excess of NH_4OH is formed.



Thus (c) is correct option.

44. The following table shows the tests a student performed on four different aqueous solutions which are X, Y, Z and W. Based on the observations provided, identify the cation present.

Chemical test	Observation	Conclusion
To solution 'X' ammonium hydroxide is added in minimum quantity first and then in excess.	A dirty white ppt. is formed which dissolves in excess to form a clear solution.	(i)
To solution 'Y' ammonium hydroxide is added in minimum quantity first and then in excess.	A pale blue ppt. is formed which dissolves in excess to form a clear inky blue solution.	(ii)
To solution 'W' a small quantity of sodium hydroxide solution is added and then in excess.	A white ppt. is formed which remain insoluble.	(iii)

Chemical test	Observation	Conclusion
To a salt 'Z' calcium hydroxide solution is added and then heated.	A pungent smelling gas turning moist red litmus paper blue is obtained.	(iv)

- (i) Ca^{2+} , (ii) Cu^{2+} , (iii) Zn^{2+} , (iv) NH_4^+
- (i) Ba^{2+} , (ii) Cu^{2+} , (iii) Ca^{2+} , (iv) NH_4^+
- (i) Zn^{2+} , (ii) Cu^{2+} , (iii) Ca^{2+} , (iv) NH_4^+
- (i) Cu^{2+} , (ii) Zn^{2+} , (iii) Ca^{2+} , (iv) NH_4^+

Ans :

COMP 2005

- $\text{X} - \text{Zn}^{2+}$
- $\text{Y} - \text{Cu}^{2+}$
- $\text{W} - \text{Ca}^{2+}$
- $\text{Z} - \text{NH}_4^+$

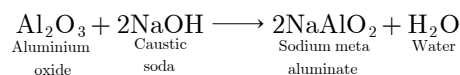
Thus (c) is correct option.

45. Caustic soda solution and aluminium oxide.

- $\text{Al}_2\text{O}_3 + 2\text{NaOH} \longrightarrow 2\text{NaAlO} + \text{H}_2\text{O}$
- $\text{Al}_2\text{O}_3 + 2\text{NaOH} \longrightarrow 2\text{NaAlO}_3 + \text{H}_2\text{O}$
- $\text{Al}_2\text{O}_3 + 2\text{NaOH} \longrightarrow 2\text{NaAlO}_2 + \text{H}_2$
- $\text{Al}_2\text{O}_3 + 2\text{NaOH} \longrightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$

Ans :

SQP 2006



Thus (d) is correct option.

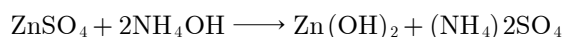
46. Ammonium hydroxide is added to zinc sulphate solution. Write the name and the formula of the final product.

- Light Brown crystals of ammonium chloride is formed at the end of product side.
- Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
- Zinc Oxide is formed at the product side.
- Colourless precipitate of Tetra amine Zinc Sulphate is formed at the product side.

Ans :

MAIN 2010

White ppt. of $\text{Zn}(\text{OH})_2$ formed which redissolves to give a colourless solution of tetra-amine zinc sulphate $[\text{Zn}(\text{NH}_3)_4]\text{SO}_4$



Colourless white, gelatinous ppt. colourless with excess of NH_4OH , ppt. dissolves

Magnesium hydroxide precipitates because it is insoluble in water and excess NaOH.

Thus (a) is correct option.

- 107. Assertion :** Calcium hydroxide is insoluble in excess sodium hydroxide.

Reason : Calcium hydroxide forms a stable complex with sodium ions.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

COMP 2015

Calcium hydroxide does not form a stable complex with sodium ions, hence it remains insoluble.

Thus (c) is correct option.

- 108. Assertion :** Ferrous chloride reacts with ammonium hydroxide to form a dirty green precipitate.

Reason : Ferrous hydroxide is green and turns brown on oxidation.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

SQP 2002

Ferrous hydroxide forms a green precipitate, which turns brown when oxidized to ferric hydroxide.

Thus (a) is correct option.

- 109. Assertion :** Ferric hydroxide precipitates are insoluble in excess sodium hydroxide.

Reason : Ferric hydroxide is not amphoteric.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

MAIN 2020

Ferric hydroxide is not amphoteric, so it does not dissolve in excess sodium hydroxide.

Thus (a) is correct option.

- 110. Assertion :** Magnesium nitrate forms a white precipitate with ammonium hydroxide.

Reason : Magnesium hydroxide is insoluble in ammonium hydroxide.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

COMP 2002

Magnesium hydroxide is insoluble in ammonium hydroxide, resulting in a white precipitate.

Thus (a) is correct option.

- 111. Assertion :** Copper hydroxide forms a blue solution in excess ammonium hydroxide.

Reason : Copper forms a soluble complex with ammonium ions.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

SQP 2010

The deep blue solution is due to the formation of the soluble tetraamminecopper(II) complex.

Thus (a) is correct option.

NODIA

ONE MARK QUESTIONS

DIRECTION : Name of the following :

- 112.** A yellow monoxide that dissolves in hot and concentrated alkali.

Ans :

COMP 2010

Lead monoxide, PbO

- 113.** State your observation in the following case :
When excess sodium hydroxide is added to calcium nitrate solution.

Ans :

MAIN 2000

White precipitates are formed that are sparingly soluble in water.

55. Which white precipitate is soluble in excess NH_4OH

(a) NaCl (b) NaOH
(c) $\text{Mg}(\text{OH})_2$ (d) AgCl

Ans :

MAIN 2019

The white precipitate of silver chloride is soluble. Thus (d) is correct option.

56. The gas evolved on reaction of Aluminium with boiling concentrated caustic alkali.

(a) Carbon monoxide gas
(b) Nitrogen gas
(c) Carbon dioxide gas
(d) Hydrogen gas

Ans :

COMP 2010

Metal aluminate is formed and hydrogen gas is liberated. For example, on reaction with sodium hydroxide, sodium aluminate is formed.



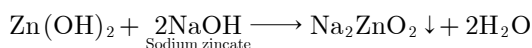
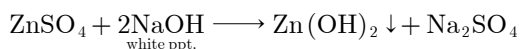
Thus (d) is correct option.

57. Sodium hydroxide solution is slowly added and then in excess to zinc sulphate solution.

(a) Sodium Sulphate and water is formed at the product side.
(b) Sodium Hydroxide and water is formed at the product side.
(c) Sodium Zincate and hydrogen gas is released at the product side.
(d) Sodium Zincate and water is formed at the product side.

Ans :

SQP 2008



Thus (d) is correct option.

58. Sodium hydroxide solution is added to the solutions containing the ions mentioned in list X. Y gives the details of the precipitate. Match the ions with their coloured precipitates.

	List X		List Y
(1)	Pb^{2+}	(A)	Reddish brown
(2)	Zn^{2+}	(B)	White insoluble in excess
(3)	Cu^{2+}	(C)	Dirty green
(4)	Fe^{2+}	(D)	White soluble in excess
(5)	Fe^{3+}	(E)	White soluble in excess
(6)	Ca^{2+}	(F)	Blue

(a) 1-D, 2-B, 3-A, 4-D, 5-F, 6-E
(b) 1-D, 2-E, 3-C, 4-A, 5-F, 6-B
(c) 1-D, 2-E, 3-B, 4-A, 5-F, 6-C
(d) 1-E, 2-C, 3-D, 4-A, 5-F, 6-B

Ans :

COMP 2010

	List X		List Y
(1)	Pb^{2+}	(E)	White soluble in excess
(2)	Zn^{2+}	(C)	Dirty green
(3)	Cu^{2+}	(D)	White soluble in excess
(4)	Fe^{2+}	(A)	Reddish brown
(5)	Fe^{3+}	(F)	Blue
(6)	Ca^{2+}	(B)	White insoluble in excess

Thus (d) is correct option.

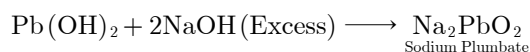
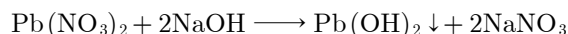
59. To a solution of lead nitrate small amount of sodium hydroxide is added and then excess of sodium hydroxide is added.

(a) Lead iodide is formed at the end of the product side.
(b) Sodium Hydroxide and Oxygen gas is released at the product side.
(c) A yellow coloured precipitate of lead hydroxide is formed.
(d) Sodium Plumbate is formed at the product side.

Ans :

MAIN 2015

A curdy white precipitate of lead hydroxide is formed which dissolves in excess NaOH giving a colourless solution.



Thus (d) is correct option.

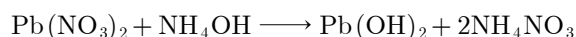
60. Which solution gives a white precipitate with excess ammonium hydroxide solution.

(a) Lead nitrate
(b) Iron [II] sulphate
(c) Iron [III] chloride
(d) Copper nitrate

Ans :

COMP 2017

Lead nitrate gives white precipitate of lead hydroxide when reacted with NH_4OH .



Thus (a) is correct option.

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Thus (c) is correct option.

76. Dilute sulphuric acid will produce a white precipitate when added to a solution of
 (a) Copper nitrate (b) Zinc nitrate
 (c) Sodium nitrate (d) Lead nitrate

Ans :

SQP 2000

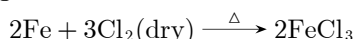
Thus (d) is correct option.

77. Anhydrous iron(III) chloride is prepared by :
 (a) Neutralization
 (b) Simple displacement
 (c) Decomposition
 (d) Direct combination

Ans :

MAIN 2005

Anhydrous iron (III) chloride is prepared by direct combination. Iron metal is heated with dry chlorine gas.



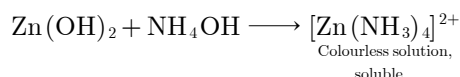
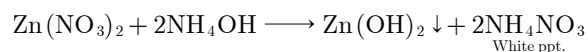
Thus (c) is correct option.

78. Ammonium hydroxide solution is added to zinc nitrate solution in minimum quantities and then in excess.
 (a) Reddish Brown- Colour precipitate of Zinc hydroxide and NaCl is formed at the product side.
 (b) Colour less and soluble $[\text{Zn}(\text{NH}_3)_4]^{2+}$ is formed at the product side.
 (c) Zinc Oxide is formed at the product side.
 (d) Light Brown crystals of Copper hydroxide is formed at the end of product side

Ans :

COMP 2010

Initially a white ppt. is formed which disappears (dissolves) in excess of ammonium hydroxide.



Thus (b) is correct option.

79. Match the columns:

	Column A		Column B
(1)	$\text{Pb}(\text{NO}_3)_2$ from PbO	(A)	Simple
(2)	MgCl_2 from Mg	(B)	Displacement
(3)	FeCl_3 from Fe	(C)	Titration
(4)	NaNO_3 from NaOH	(D)	Neutralization

(a) 1-D, 2-A, 3-B, 4-C

- (b) 1-B, 2-C, 3-D, 4-A
 (c) 1-C, 2-B, 3-A, 4-D
 (d) 1-D, 2-A, 3-C, 4-B

Ans :

SQP 2000

	Column A		Column B
(1)	$\text{Pb}(\text{NO}_3)_2$ from PbO	(D)	Neutralization
(2)	MgCl_2 from Mg	(A)	Simple
(3)	FeCl_3 from Fe	(B)	Displacement
(4)	NaNO_3 from NaOH	(C)	Titration

- When $\text{Pb}(\text{NO}_3)_2$ is heated, the lead monoxide which is yellow in colour is precipitated at the product side.
- The reaction $\text{Mg}(\text{s}) + 2\text{HCl} \longrightarrow \text{MgCl}_2 + \text{H}_2$ represents a displacement reaction. Mg metal displaces hydrogen from HCl. In a displacement reactor; a more reactive element displaces a less reactive element from its salt solution.
- The reaction $2\text{Fe} + 3\text{Cl}_2 \longrightarrow 2\text{FeCl}_3$ is a combination reaction because chlorine is a stronger oxidising agent.
- The reaction represents a neutralisation reaction in which base (NaOH) reacts with an acid (HNO_3) to form salt (NaNO_3) and water (H_2O).



Thus (a) is correct option.

80. and salt dissolve in sodium hydroxide.
 (a) Sodium, Zinc (b) Sodium, Lead
 (c) Lead, Copper (d) Zinc, Lead

Ans :

COMP 2001

Lead and zinc salt dissolves in NaOH to form a clear solution of Na_2ZnO_2 or Na_2PbO_2 .

Thus (d) is correct option.

81. Lead hydroxide is soluble in but insoluble in
 (a) HCl , H_2SO_4 (b) H_2SO_4 , NaOH
 (c) NH_4OH , HCl (d) NaOH, NH_4OH

Ans :

MAIN 2007

Lead hydroxide ($\text{Pb}(\text{OH})_2$) is insoluble in acetone and acetic acid, but soluble in dilute acids and alkalis. In water, it's slightly soluble, with 155 mg/L dissolving at 20°C . It's also slightly soluble in aqueous carbonate solutions.

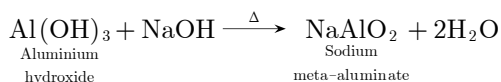
Thus (d) is correct option.

69. Action of sodium hydroxide on freshly precipitated aluminium hydroxide.

- (a) $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAlO}_2 + 2\text{H}_2$
 (b) $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAlO} + 2\text{H}_2\text{O}$
 (c) $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAlO}_2 + 2\text{H}_2\text{O}$
 (d) $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAlO}_2 + 2\text{OH}$

Ans :

SQP 2017



Thus (c) is correct option.

70. Match the columns A with Column B:

	Column A		Column B
(1)	Pb^{2+}	(A)	Reddish brown
(2)	Fe^{2+}	(B)	White insoluble in excess
(3)	Zn^{2+}	(C)	Dirty green
(4)	Fe^{3+}	(D)	White soluble in excess

- (a) 1-C, 2-B, 3-B, 4-D
 (b) 1-D, 2-A, 3-B, 4-C
 (c) 1-B, 2-C, 3-D, 4-A
 (d) 1-D, 2-A, 3-C, 4-B

Ans :

COMP 2018

	Column A		Column B
(1)	Pb^{2+}	(B)	White insoluble in excess
(2)	Fe^{2+}	(C)	Dirty green
(3)	Zn^{2+}	(D)	White soluble in excess
(4)	Fe^{3+}	(A)	Reddish brown

- When Lead nitrate reacts with sodium hydroxide ion, then the colourless lead solution changes to white colour due to the precipitation of lead hydroxide.
- Iron oxide is black in colour but it changes to green colour when hydrated due to the addition of extra water molecules.
- Zinc salts have no unpaired electrons in their valence shells. Thus Zn^{2+} is white in colour.
- Fe^{3+} is brown in colour due to the presence of unpaired electrons in its valence shell.

Thus (c) is correct option.

71. Oxides and hydroxides of certain metals such as,, are amphoteric in nature.

- (a) zinc, sodium, aluminium
 (b) zinc, lead, aluminium
 (c) aluminium, copper, sodium
 (d) zinc, lead, copper

Ans :

MAIN 2000

Amphoteric oxides are metal oxides that react with both acids and bases to create salts and water. Amphoteric oxides or hydroxides are formed by several metals, including zinc, tin, lead, aluminium and beryllium.

Thus (b) is correct option.

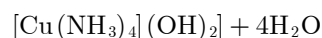
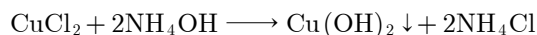
72. A chloride which forms a precipitate that is soluble in excess of ammonium hydroxide is :

- (a) Calcium chloride
 (b) Ferrous chloride
 (c) Copper chloride
 (d) Ferric chloride

Ans :

COMP 2011

Copper chloride forms a precipitate that is soluble in excess of ammonium hydroxide forms Cuprammine hydroxide (water soluble) at the product side.



Thus (c) is correct option.

73. Colour of potassium permanganate is

- (a) Pink (b) Green
 (c) Brown (d) Purple

Ans :

SQP 2015

Thus (d) is correct option.

74. Dirty green precipitates are formed by salts.

- (a) Zinc (b) Copper
 (c) Magnesium (d) Mercury

Ans :

MAIN 2018

Thus (a) is correct option.

75. Which of the following alkali metal hydroxides is the least soluble in water?

- (a) CsOH (b) KOH
 (c) LiOH (d) NaOH

Ans :

COMP 2015

61. Which one of the following salt solutions on reaction with excess sodium hydroxide solution gives a clear solution finally ?

(a) $\text{ZnSO}_4(\text{aq})$ (b) $\text{CuSO}_4(\text{aq})$
 (c) $\text{FeCl}_3(\text{aq})$ (d) $\text{Pb}(\text{NO}_3)_2(\text{aq})$

Ans :

SQP 2019

When lead nitrate solution is reacted with excess sodium hydroxide solution it gives a clear solution by forming lead hydroxide which is colourless in nature.

Thus (d) is correct option.

62. You are provided with two test-tubes, A and B. In A, when NaOH was added white ppt. is formed. B which is yellow in colour, when NaOH was added, a colourless solution is formed. A and B are respectively

(a) FeSO_4 and Al_2O_3
 (b) ZnSO_4 and ZnO
 (c) CuSO_4 and ZnO
 (d) $\text{Ca}(\text{NO}_3)_2$ and $\text{Pb}(\text{NO}_3)_2$

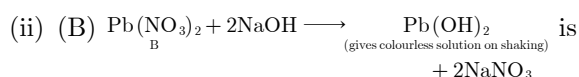
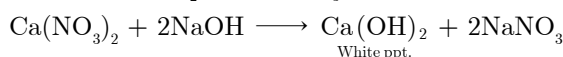
Ans :

COMP 2020

$\text{A} + \text{NaOH} \longrightarrow \text{white ppt.}$

$\text{B} + \text{NaOH} \longrightarrow \text{gives colourless solution}$
Yellow

Thus, (i) (A) is $\text{Ca}(\text{NO}_3)_2$, because it gives white ppt. of $\text{Ca}(\text{OH})_2$ and NaNO_3 .



Thus (d) is correct option.

63. A yellow monoxide that dissolves in hot and concentrated alkali.

(a) ZnO (b) CuO
 (c) AgO (d) PbO

Ans :

MAIN 2021

Lead (II) oxide, also known as PbO , is a yellow monoxide that dissolves in hot and concentrated caustic alkali. When heated, PbO appears orange, but it's buff-yellow when cool.

Thus (d) is correct option.

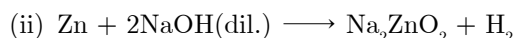
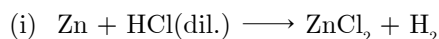
64. Zn metal shows amphoteric behaviour. It can be shown by

(a) its reaction with dil. NaOH only.
 (b) its reaction with both dil. HCl and dil. NaOH.
 (c) its reaction with dil. HCl only.
 (d) it does not react with either dil. HCl or dil. NaOH.

Ans :

SQP 2000

Zinc (Zn) shows amphoteric behaviour with dil., HCl and dil. NaOH, as it reacts with both as follows.



Thus (b) is correct option.

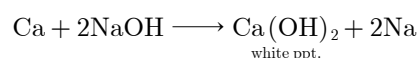
65. Calcium salts with sodium hydroxide give precipitates.

(a) white (b) blue
 (c) pink (d) green

Ans :

SQP 2005

Calcium when reacts with sodium hydroxide, it gives calcium hydroxide as white precipitate and sodium metal.



Thus (a) is correct option.

66. The valency of copper in copper sulphate is

(a) one (b) three
 (c) four (d) two

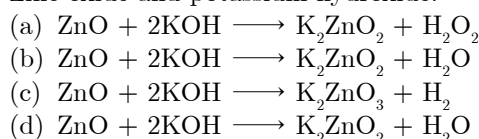
Ans :

MAIN 2010

Since the valency of the sulphate ion has been given as 2. Hence, the copper ion has positive charge. Therefore, valency of copper is 2.

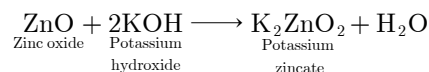
Thus (d) is correct option.

67. Zinc oxide and potassium hydroxide.



Ans :

COMP 2015



Thus (b) is correct option.

68. react with metal cations to produce coloured insoluble hydroxides.

(a) Alkalies
 (b) Halogens
 (c) Alkaline Metals
 (d) Transition Metals

Ans :

MAIN 2017

Hydroxides react with metal cations to produce colored insoluble hydroxides in a process called the sodium hydroxide test:

Thus (a) is correct option.

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92. Which one of the following salt solution on reaction with excess of ammonium hydroxide gives a deep blue solution ?

(a) FeCl_3 (aq) (b) $\text{Al}_2(\text{SO}_4)_3$ (aq)
(c) CuSO_4 (aq) (d) ZnSO_4 (aq).

Ans :

SQP 2010

Copper sulphate (CuSO_4) salt solution on reacting with Ammonium hydroxide solution gives a deep blue solution.

Thus (c) is correct option.

93. The hydroxide which is soluble in excess of NaOH is :

(a) $\text{Al}(\text{OH})_3$ (b) $\text{Fe}(\text{OH})_2$
(c) $\text{Fe}(\text{OH})_3$ (d) $\text{Zn}(\text{OH})_2$

Ans :

MAIN 2015

Zinc Hydroxide is soluble in excess of NaOH due to the formation of soluble sodium tetrahydroxozincate (II).

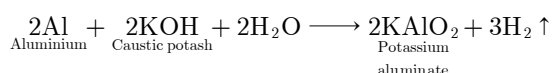
Thus (d) is correct option.

94. Aluminium and caustic potash solution.

(a) $2\text{Al} + 2\text{KOH} + 2\text{H}_2\text{O} \longrightarrow 2\text{KAlO}_2 + 3\text{H}_2$
(b) $2\text{Al} + 2\text{KOH} + 2\text{H}_2\text{O} \longrightarrow 2\text{KAl} + 3\text{H}_2\text{O}$
(c) $2\text{Al} + 2\text{KOH} + 2\text{H}_2\text{O} \longrightarrow \text{KAlO}_2 + 3\text{H}_2$
(d) $2\text{Al} + 2\text{KOH} + 2\text{H}_2\text{O} \longrightarrow 2\text{KAlO} + 3\text{H}_2$

Ans :

COMP 2019



Thus (b) is correct option.

95. The metal oxide which can react with acid as well as alkali is

(a) silver oxide (b) copper (II) oxide
(c) calcium oxide (d) aluminium oxide

Ans :

SQP 2020

Aluminium oxide is a metal oxide that can react with both acids and alkalis, also known as bases. Metal oxides that react with both acids and bases are called amphoteric oxides.

Thus (d) is correct option.

96. A substance which reacts with another substance

(a) Product (b) Catalyst
(c) Reagent (d) Inhibitor

Ans :

MAIN 2009

The substance (or substances) initially involved in a chemical reaction are called reactants or

reagents.

Thus (c) is correct option.

97. A metal which is amphoteric in nature.

(a) Manganese (b) Copper
(c) Zinc (d) Sodium

Ans :

SQP 2000

Some Metal oxides such as Aluminium oxide, Zinc oxide, etc. are both acidic as well as basic in nature. Such metal oxides react with both acids as well as the base to produce salt and water. These oxides are known as amphoteric oxides.

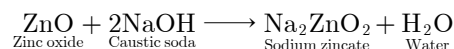
Thus (c) is correct option.

98. Caustic soda solution and zinc oxide.

(a) $\text{ZnO} + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO} + \text{H}_2\text{O}$
(b) $\text{ZnO} + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O}$
(c) $\text{ZnO} + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O}_2$
(d) $\text{ZnO} + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2$

Ans :

COMP 2001



Thus (b) is correct option.

99. Potassium permanganate is in colour.

(a) Green (b) Brown
(c) Pink (d) Purple

Ans :

MAIN 2008

Potassium permanganate is a chemical compound with the formula KMnO_4 . In an aqueous solution, it appears as a deep violet or purple color. It is often used as a disinfectant and in water treatment processes.

Thus (d) is correct option.

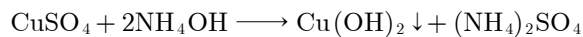
100. Ammonium hydroxide solution is added to Copper(II) nitrate solution in small quantities and then in excess.

(a) Zinc Oxide is formed at the product side.
(b) Reddish Brown Colour precipitate of Zinc hydroxide and NaCl is formed at the product side
(c) Tetra-amine Copper Sulphate is formed at the product side.
(d) Light Brown crystals of Copper hydroxide is formed at the end of product side.

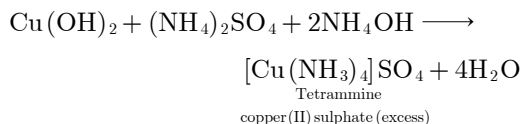
Ans :

COMP 2018

Initially a light blue ppt. is formed which on addition of excess of ammonium hydroxide dissolves and a deep inky blue solution is formed.



Blue with Pale blue ppt. Colourless in solution
excess of NH_4OH , ppt. dissolves



Thus (c) is correct option.

101. Dirty green precipitates are formed by

- (a) Ferric Chloride
- (b) Magnesium Sulphate
- (c) Ammonium Sulphate
- (d) Ferrous Sulphate

Ans :

SQP 2010

A dirty green precipitate can form when ferrous sulfate FeSO_4 is added to sodium hydroxide NaOH . Thus (d) is correct option.

ASSERTION AND REASON

102. Assertion : Zinc hydroxide dissolves in excess sodium hydroxide to form sodium zincate.

Reason : Zinc hydroxide is amphoteric in nature.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

SQP 2005

Zinc hydroxide, being amphoteric, reacts with excess sodium hydroxide to form sodium zincate, demonstrating its ability to act as both an acid and a base.

Thus (a) is correct option.

103. Assertion : Lead hydroxide is insoluble in excess ammonium hydroxide.

Reason : Lead hydroxide forms a stable complex with ammonium ions.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

MAIN 2010

Lead hydroxide is insoluble in excess ammonium hydroxide, indicating no complex formation with ammonium ions.

Thus (c) is correct option.

104. Assertion : A dirty green precipitate forms when ferrous salts react with sodium hydroxide.

Reason : Ferrous hydroxide is green in color and oxidizes to brown ferric hydroxide

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

COMP 2018

Ferrous hydroxide forms a dirty green precipitate, which turns brown upon oxidation to ferric hydroxide.

Thus (a) is correct option.

105. Assertion : Ammonium hydroxide forms a deep blue solution with copper salts.

Reason : Tetraamminecopper(II) complex forms in excess ammonium hydroxide

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

SQP 2007

The deep blue solution is due to the formation of the tetraamminecopper(II) complex.

Thus (a) is correct option.

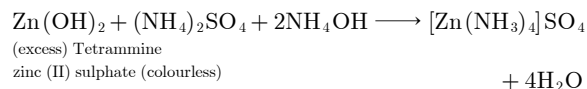
106. Assertion : Magnesium hydroxide precipitates with sodium hydroxide.

Reason : Magnesium hydroxide is insoluble in water and excess sodium hydroxide.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true, but Reason is false.
- (d) Assertion is false, but Reason is true.

Ans :

MAIN 2012



Thus (d) is correct option.

47. An amphoteric hydroxide having gelatinous white ppt.
- Sodium hydroxide
 - Zinc hydroxide
 - Copper (II) hydroxide
 - None of these

Ans :

COMP 2013

Some amphoteric hydroxides can form a gelatinous white precipitate, including aluminum hydroxide and zinc hydro.

Thus (b) is correct option.

48. Which of the following analysis deals with the identification of unknown substance?
- Quantitative analysis
 - Qualitative analysis
 - Both (a) and (b)
 - None of the above

Ans :

SQP 2017

Qualitative analysis is the branch of chemistry that identifies unknown substances in a sample through chemical tests and physical and chemical properties.

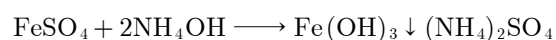
Thus (b) is correct option.

49. Ammonium hydroxide solution is added to Iron(II) sulphate solution.
- Blue colour precipitate of Ferric hydroxide is formed at the product side.
 - Light Brown crystals of ferric chloride is formed at the end of product side.
 - Ferric Oxide is formed at the product side.
 - Green precipitate of ferric hydroxide and ammonium sulphate is formed at the product side.

Ans :

COMP 2019

A dirty green ppt. of ferrous hydroxide Fe(OH)_2 , insoluble in excess of NH_4OH , is formed



Thus (d) is correct option.

50. Hydroxide of this metal is soluble in sodium hydroxide solution :
- Magnesium
 - Silver
 - Lead
 - Copper

Ans :

SQP 2020

The dioxide of lead forms when lead is heated in the presence of air. It is amphoteric which means that it dissolves in both acidic and basic solutions. Hence, lead can be soluble in excess of sodium hydroxide solution.

Thus (c) is correct option.

51. Sodium zincate and water is obtained on reaction of with concentrated caustic soda.
- Lead
 - Zinc
 - Sodium
 - Zinc hydroxide

Ans :

MAIN 2023

Zinc reacts with hot and conc. sodium hydroxide or caustic soda to produce sodium zincate with the liberation of hydrogen gas



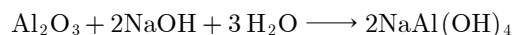
Thus (b) is correct option.

52. The substance/s which react/s with hot conc. NaOH soln. and undergoes a neutralization reaction
- Al
 - Al_2O_3
 - Al(OH)_3
 - None of these

Ans :

COMP 2000

Aluminium oxide Al_2O_3 displays acidic properties and thus undergoes neutralisation reaction with hot conc. NaOH as:



Thus (b) is correct option.

53. The process of formation of a solid substance by mixing the solutions of substances.
- Precipitation
 - Condensation
 - Sublimation
 - Distillation

Ans :

COMP 2014

Precipitation is the process of formation of an insoluble solid when solutions are mixed. The solid thus formed is called precipitate.

Thus (a) is correct option.

54. Salts of normal elements [1(IA) to 17(VIIA)] are generally
- blue
 - green
 - white
 - colourless

Ans :

SQP 2018

Salts of normal elements [1 (IA) to 17 (VIIA)] are generally colourless in nature due to the presence of paired electrons in their valence shell.

Thus (d) is correct option.

114. A white insoluble oxide that dissolves when fused with caustic soda or caustic potash.

Ans : MAIN 2008

Aluminium oxide, Al_2O_3

115. A hydroxide which is soluble in excess of ammonium hydroxide.

Ans : SQP 2013

Zinc hydroxide, $\text{Zn}(\text{OH})_2$

116. What do you observe when excess of ammonia is passed through an aqueous solution of lead nitrate ?

Ans : COMP 2006

White precipitate appears which are insoluble in excess of ammonia.

117. Name a gas which turns acidified potassium dichromate clear green.

Ans : SQP 2012

Sulphur dioxide.

118. What do you observe when sodium hydroxide solution is added to zinc sulphate solution in excess ?

Ans : COMP 2003

A white ppt. is produced which dissolves in an excess of sodium hydroxide.

119. Copy and complete the following table which refers to the action of heat on some carbonates.

Carbonate	Colour of residue on cooling
Zinc carbonate	
Lead carbonate	
Copper carbonate	

Ans : MAIN 2010

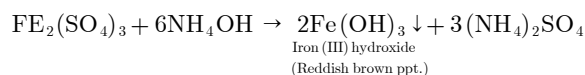
Carbonate	Colour of residue on cooling
Zinc carbonate	White
Lead carbonate	Yellow
Copper carbonate	Black

120. State what do you observe when ammonium hydroxide is added to iron (III) sulphate solution.

Ans : COMP 2011

A reddish brown precipitate of iron (III) hydroxide

is produced.



121. Name a chloride of metal which is soluble in excess of ammonium hydroxide. What is the product formed ?

Ans : SQP 2017

Zinc chloride, ZnCl_2 .

The final product formed is tetraamine zinc (II) chloride which is soluble and colourless.

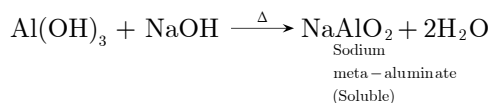
122. What do you see when sodium hydroxide solution is added to zinc sulphate till it is in excess.

Ans : COMP 2019

On adding sodium hydroxide solution to zinc sulphate solution, a white precipitate is formed which is soluble in excess of sodium hydroxide.

123. What is the reaction of freshly precipitated aluminium hydroxide with caustic soda solution? Give equation.

Ans : MAIN 2023



124. Give two examples of amphoteric hydroxides.

Ans : SQP 2021

- (i) Aluminium hydroxide, $\text{Al}(\text{OH})_3$
(ii) Zinc hydroxide, $\text{Zn}(\text{OH})_2$.

125. Name the reagent used to distinguish zinc nitrate solution from magnesium nitrate solution.

Ans : COMP 2022

Ammonium hydroxide/Sodium hydroxide.

126. Choose from the following list of substances, as to what matches the description given below :
(Acetylene gas, aqua fortis, coke, brass, barium chloride, bronze, platinum).

An aqueous salt solution used for testing sulphate radical.

Ans : MAIN 2021

Barium chloride.

DIRECTION : Fill in the blanks.

127. (AgCl/PbCl₂), a white precipitate is soluble in excess NH_4OH .

161. Identify only the anion present in the following compound:

- The compound on heating produces a colourless gas which turns lime water milky and has no effect on acidified potassium dichromate solution.
- The solution of the compound which on treating with concentrated sulphuric acid and freshly prepared ferrous sulphate solution produces a brown ring.

Ans :

MAIN 2024

- Anion is Carbonate. When metal carbonates are heated, a colourless and an odourless gas is evolved. This gas is carbon dioxide (CO_2). When CO_2 is passed through lime water, it turns lime water milky. Also, this gas doesn't show any effect when passed through the solution of acidified potassium dichromate.
- A brown-coloured ring is generally formed at the junction of the test tube containing the mixture of ferrous sulphate and sulphuric acid. This ring indicates the presence of nitrates ion In the given solution.

162. Rita was given an unknown salt for identification. She prepared a solution of the salt and divided it into two parts.

- To the first part of the salt solution, she added a few drops of ammonium hydroxide and obtained a reddish-brown precipitate.
- To the second part of the salt solution, she added a few drops of silver nitrate solution and obtained a white precipitate.

Name:

- the cation present and
- the anion present in the salt given for identification.

Ans :

MAIN 2024

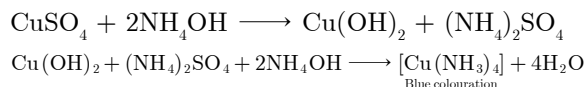
- Ferric chloride (FeCl_3) reacts with ammonium hydroxide to give a reddish brown precipitate. The cation part is (Fe^{3+}).
- Ferric chloride (FeCl_3) reacts with a silver chloride precipitate, a white precipitate of silver chloride is formed. The anion part is Chloride ions (Cl^-).

163. State one relevant observation for the following reaction :

Addition of excess ammonium hydroxide into copper sulphate solution.

Ans :

COMP 2020



When excess ammonium hydroxide is added to copper sulphate solution, pale blue precipitates appear which dissolve in excess of ammonium hydroxide forming blue colouration.

164. Distinguish between the following pairs of compounds using a reagent as a chemical test:

- Calcium nitrate and Zinc nitrate solution.
- Ammonium sulphate crystals and Sodium sulphate crystals.

Ans :

SQP 2020

(i)

Calcium nitrate	Zinc nitrate
When sodium hydroxide is added, white precipitates of calcium hydroxide are formed. $\text{Ca}(\text{NO}_3)_2 + 2\text{NaOH} \rightarrow \text{Ca}(\text{OH})_2 + 2\text{NaNO}_3$ white ppt	When sodium hydroxide is added, gelatinous white ppt. of zinc hydroxide are formed. These precipitates dissolve in excess of sodium hydroxide to form sodium zincate. $\text{Zn}(\text{NO}_3)_2 + 2\text{NaOH} \rightarrow \text{Zn}(\text{OH})_2 + 2\text{NaNO}_3$ $\text{Zn}(\text{OH})_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O}$

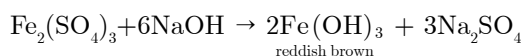
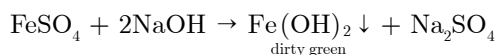
(ii)

Ammonium sulphate crystals	Sodium sulphate crystals
Add sodium hydroxide to ammonium sulphate crystals and heat. $(\text{NH}_4)_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} + 2\text{NH}_3 \downarrow$	Add sodium hydroxide to sodium sulphate crystals and heat. $\text{Na}_2\text{SO}_4 + \text{NaOH} \rightarrow \text{No reaction is observed.}$

165. Distinguish between the following pair of compounds using the reagent given in the bracket. Ferrous sulphate solution and ferric sulphate solution. (using sodium hydroxide solution)

Ans :

COMP 2019



dilute hydrochloric acid or dilute nitric acid.

Ans : SQP 2020
 SO_4^{-2}

DIRECTION : Write balanced chemical equations for the following:

146. Sodium hydroxide is added to copper sulphate solution.

Ans : MAIN 2008
 $\text{CuSO}_4 + 2\text{NaOH} \longrightarrow \text{Cu}(\text{OH})_2\downarrow + \text{Na}_2\text{SO}_4$

147. Ammonium hydroxide is added to iron(III) chloride solution.

Ans : SQP 2002
 $3\text{NH}_4\text{OH} + \text{FeCl}_3 \longrightarrow \text{Fe}(\text{OH})_3\downarrow + 3\text{NH}_4\text{Cl}$

148. Sodium hydroxide is added to iron(II) chloride solution.

Ans : COMP 2018
 $2\text{NaOH} + \text{FeCl}_2 \longrightarrow \text{Fe}(\text{OH})_2\downarrow + 2\text{NaCl}$

149. Sodium hydroxide is added to calcium nitrate.

Ans : MAIN 2005
 $\text{Ca}(\text{NO}_3)_2 + 2\text{NaOH} \longrightarrow \text{Ca}(\text{OH})_2\downarrow + 2\text{NaNO}_3$

150. Sodium hydroxide solution is added to zinc sulphate first a little then in excess.

Ans : SQP 2019
 $\text{ZnSO}_4 + 2\text{NaOH} \longrightarrow \text{Zn}(\text{OH})_2 + \text{Na}_2\text{SO}_4$
 $\text{Zn}(\text{OH})_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + 2\text{H}_2\text{O}$

151. Reaction of lead nitrate solution with ammonium hydroxide.

Ans : SQP 2020
 $\text{Pb}(\text{NO}_3)_2 + 2\text{NH}_4\text{OH} \longrightarrow \text{Pb}(\text{OH})_2 + 2\text{NH}_4\text{NO}_3$

152. Zinc is warmed with NaOH (Caustic soda) solution.

Ans : COMP 2000
 $\text{Zn} + 2\text{NaOH} \xrightarrow{\text{Warm}} \text{Na}_2\text{ZnO}_2 + \text{H}_2$

153. Copper sulphate solution is added to sodium hydroxide solution.

Ans : SQP 2005
 $\text{CuSO}_4 + 2\text{NaOH} \longrightarrow \text{Cu}(\text{OH})_2 + \text{Na}_2\text{SO}_4$

154. Aluminium,

Ans : COMP 2000
 $2\text{Al} + 2\text{NaOH} + 2\text{H}_2\text{O} \xrightarrow{\text{Warm}} 2\text{NaAlO}_2 + 3\text{H}_2$

155. Ammonium hydroxide is added to ferrous sulphate solution.

Ans : MAIN 2019
 $\text{FeSO}_4 + 2\text{NH}_4\text{OH} \longrightarrow (\text{NH}_4)_2\text{SO}_4 + \text{Fe}(\text{OH})_2\downarrow$

156. Reaction of sodium hydroxide solution with iron (III) chloride solution.

Ans : SQP 2018
 $\text{FeCl}_3 + 3\text{NaOH} \longrightarrow \text{Fe}(\text{OH})_3 + 3\text{NaCl}$

157. Reaction of zinc with potassium hydroxide solution.

Ans : SQP 2018
 $\text{Zn} + 2\text{KOH} \longrightarrow \text{K}_2\text{ZnO}_2 + \text{H}_2\text{O}$

158. Sulphur is heated with concentrated sulphuric acid.

Ans : COMP 2010
 $\text{S} + 2\text{H}_2\text{SO}_4 \rightarrow 3\text{SO}_2 + 2\text{H}_2\text{O}$

159. Ammonium chloride is heated with sodium hydroxide.

Ans : COMP 2010
 $\text{NH}_4\text{Cl} + \text{NaOH} \rightarrow \text{NaCl} + \text{NH}_3 + \text{H}_2\text{O}$

TWO MARKS QUESTIONS

160. Pratik heated 11.2 grams of element 'M' (atomic weight 56) with 4.8 grams of element 'N' (atomic weight 16) to form a compound. Find the empirical formula of the compound obtained by Pratik.

Ans : SQP 2025

$$M = \frac{11.2}{56} = 0.2$$

$$N = \frac{4.8}{16} = 0.3$$

or

$$M:N = 2 : 3$$

Empirical formula is M_2N_3

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- (d) During the electrolysis of copper sulphate solution, if is used as electrode, the colour of the electrolyte does not fade. [copper/platinum]
- (e) The process of heating the concentrated ore in a limited supply or absence of air is [roasting/calcination]

Ans :

MAIN 2024

- (a) FeCl_3
 (b) Al_2O_3
 (c) Copper nitrate
 (d) Copper
 (e) Calcination

193. Write the colours of the following salts :

- (a) Ferrous salts
 (b) Cuprous salts
 (c) Cupric salts
 (d) Calcium salts
 (e) Aluminium salts

Ans :

COMP 2020

- (a) Light green
 (b) Blue
 (c) Blue
 (d) White
 (e) Colourless

194. Sodium hydroxide solution is added to the solutions containing the ions mentioned in list X. List Y gives the details of the precipitate. Match the ions with their coloured precipitates.

	List X		List Y
(i)	Pb^{+2}	(A)	Reddish brown
(ii)	Fe^{+2}	(B)	White insoluble in excess
(iii)	Zn^{+2}	(C)	Dirty green
(iv)	Fe^{3+}	(D)	White soluble in excess
(v)	Cu^{+2}	(E)	White soluble in excess
(vi)	Ca^{+2}	(F)	Blue

Ans :

COMP 2011

- (i) D or E
 (ii) C
 (iii) D or E
 (iv) A
 (v) F
 (vi) B

195. What are the colour of the precipitates when ammonium hydroxide is added to the following solutions?

- (a) Iron(II) chloride
 (b) Iron(III) chloride
 (c) Lead nitrate
 (d) Zinc nitrate
 (e) Copper nitrate

Ans :

SQP 2023

- (a) Dirty green precipitate which changes to reddish brown.
 (b) Reddish brown precipitate.
 (c) White precipitate.
 (d) White precipitate.
 (e) Bluish white precipitate.

196. What do you observe when caustic soda solution is added to the following solutions: first a little and then in excess.

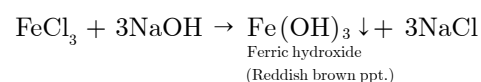
- (i) FeCl_3
 (ii) $\text{Al}_2(\text{SO}_4)_3$
 (iii) ZnSO_4
 (iv) $\text{Pb}(\text{NO}_3)_2$
 (v) CuSO_4

Also give balanced chemical equations.

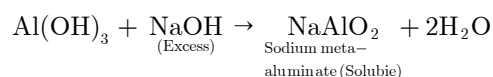
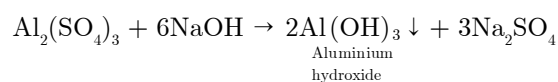
Ans :

SQP 2005

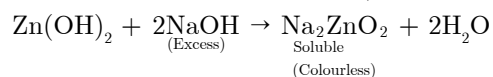
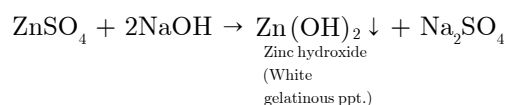
- (i) FeCl_3 : A reddish brown ppt. of ferric hydroxide is obtained which is insoluble in excess of caustic soda solution.



- (ii) $\text{Al}_2(\text{SO}_4)_3$: A gelatinous white ppt. of aluminium hydroxide is obtained which is soluble in excess of caustic soda solution.



- (iii) ZnSO_4 : A gelatinous white ppt. of zinc hydroxide is obtained which is soluble in excess of caustic soda solution.



- (iv) $\text{Pb}(\text{NO}_3)_2$: A white ppt. of lead (II) hydroxide is obtained which is soluble in excess of caustic soda solution.

166. State two relevant observations for each of the following:

- Ammonium hydroxide solution is added to copper (II) nitrate solution in small quantities and then in excess.
- Ammonium hydroxide solution is added to zinc nitrate solution in minimum quantities and then in excess.

Ans : SQP 2013

- Pale blue ppt appears which dissolves in excess of NH_4OH to give deep blue solution.
- White ppt appears which is soluble in excess of NH_4OH .

167. State one observation for each of the following:

- Excess ammonium hydroxide solution is added to lead nitrate solution.
- Sodium hydroxide solution is added to ferric chloride solution at first a little and then in excess.

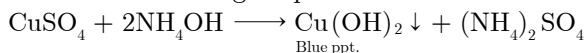
Ans : SQP 2012

- A white ppt. of $\text{Pb}(\text{OH})_2$ is formed which is insoluble in excess of NH_4OH .
- A reddish brown ppt. of $[\text{Fe}(\text{OH})_3]$ is formed which is insoluble in excess of NaOH .

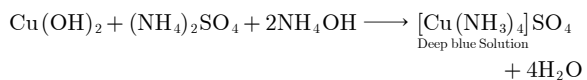
168. What would you observe in the following case ?
Ammonium hydroxide is first added in a small quantity and then in excess to a solution of copper sulphate.

Ans : MAIN 2011

On adding ammonium hydroxide in small amount, blue precipitates will appear. On adding ammonium hydroxide in excess, blue precipitates will dissolve forming deep blue solution.

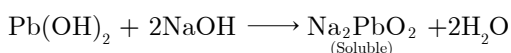
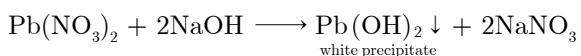


In excess



169. State one relevant observation for the following :
Lead nitrate solution is treated with sodium hydroxide solution drop wise till it is in excess.

Ans : COMP 2018



When drop by drop of sodium hydroxide is added, chalky white precipitates appear. These

precipitates dissolve in excess of sodium hydroxide forming sodium plumbite.

170. How would you distinguish between Zn^{2+} and Pb^{2+} using ammonium hydroxide solution ?

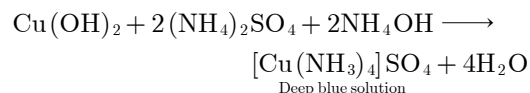
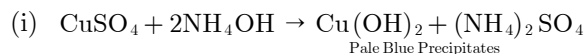
Ans : SQP 2003

Zn^{2+} ions give white precipitate of $\text{Zn}(\text{OH})_2$ with ammonium hydroxide which dissolves in an excess of ammonium hydroxide solution forming a complete tetra-amine zinc (II) ion, $[\text{Zn}(\text{NH}_3)_4]^{2+}$. Pb^{2+} ions form chalky white precipitate with ammonium hydroxide solution which does not dissolve in an excess of ammonium hydroxide solution.

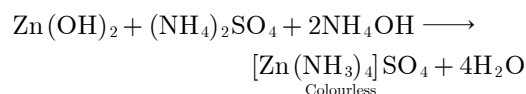
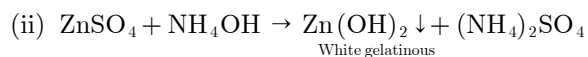
171. State your observations when ammonium hydroxide solution is added drop by drop and then in excess to each of the following solutions :

- copper sulphate solution
- zinc sulphate solution

Ans : COMP 2016



Pale blue precipitates are formed and then these precipitates dissolve in excess of ammonium hydroxide to form deep blue solution.



When ammonium hydroxide is added drop by drop white gelatinous precipitate of zinc hydroxide is formed and on adding excess of ammonium hydroxide colourless solution is formed.

172. State your observations when ammonium hydroxide solution is added drop by drop and then in excess to each of the following solutions:

- Copper sulphate solution
- Zinc sulphate solution.

Ans : MAIN 2010

(i) Pale blue precipitate appears which dissolves in excess of NH_4OH to form a deep blue solution.

(ii) White precipitate appears which dissolves in excess of NH_4OH .

Ans :

SQP 2016

AgCl (because of formation of diammine silver chloride)

- 128.** An alkali which completely dissociates into ions is (ammonium hydroxide, calcium hydroxide, lithium hydroxide).

Ans :

MAIN 2020

Ammonium hydroxide

- 129.** A gas which gives dense white fumes with ammonium hydroxide.

Ans :

COMP 2000

Hydrogen chloride

- 130.** A gas which turns freshly prepared acidified ferrous sulphate solution brown black.

Ans :

MAIN 2008

Nitrogen dioxide

- 131.** A gas which turns lead acetate solution black.

Ans :

SQP 2010

Hydrogen sulphide

- 132.** A gas which decolourises potassium permanganate solution.

Ans :

COMP 2015

Sulphur dioxide

- 133.** A gas which burns with a popping sound.

Ans :

MAIN 2017

Hydrogen

- 134.** A colourless and odourless gas which turns lime water milky.

Ans :

SQP 2019

Carbon dioxide

- 135.** A colourless gas having burning sulphur smell which turns lime water milky

Ans :

COMP 2020

Sulphur dioxide

- 136.** A reddish brown coloured gas having pungent suffocating smell.

Ans :

SQP 2019

Nitrogen dioxide

- 137.** A colourless gas having rotten egg smell.

Ans :

MAIN 2011

Hydrogen sulphide

- 138.** A colourless gas which fumes in moist air.

Ans :

COMP 2017

Hydrogen chloride

DIRECTION : Identify the cations in each of the following case :

- 139.** NaOH solution when added to the Solution (A) gives a reddish brown precipitate.

Ans :

COMP 2019

Ferric

- 140.** NH_4OH Solution when added to the Solution (B) gives white ppt. which does not dissolve in excess.

Ans :

MAIN 2012

Lead

- 141.** NaOH Solution when added to Solution (C) gives white ppt. which is insoluble in excess.

Ans :

SQP 2016

Calcium

- 142.** Compound X on heating with copper turnings and concentrated sulphuric acid liberates a reddish brown gas.

Ans :

SQP 2017

NO_3^{-1}

- 143.** When a solution of compound Y is treated with silver nitrate solution, a white precipitate is obtained which is soluble in excess of ammonium hydroxide solution.

Ans :

MAIN 2020

Cl^{-1}

- 144.** Compound Z on reacting with dilute sulphuric acid liberates a gas which turns lime water milky, but the gas has no effect on acidified potassium dichromate solution.

Ans :

COMP 2010

CO_3^{-2}

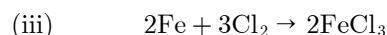
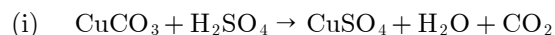
- 145.** Compound L on reacting with barium chloride solution gives a white precipitate insoluble in

the list given, write balanced chemical equation for the preparation of the salts mentioned below:

- (i) copper sulphate
- (ii) sodium zincate
- (iii) ferric chloride

Ans :

SQP 2025



180. Give one test each to distinguish between the following pairs of chemicals :

- (i) Zinc nitrate solution and calcium nitrate solution.
- (ii) Sodium nitrate solution and sodium chloride solution.
- (iii) Iron (III) chloride solution and copper chloride solution.

Ans :

MAIN 2003

Distinction between :

- (i) Zinc nitrate solution and calcium nitrate solution.

Add sodium hydroxide solution to each. In case of zinc nitrate solution, white precipitate first formed dissolves in excess of sodium hydroxide solution but in case of calcium nitrate, white precipitate formed does not dissolve in an excess of sodium hydroxide solution.

- (ii) Sodium nitrate solution and sodium chloride solution.

Add silver nitrate solution to each. Sodium nitrate does not give any precipitate but sodium chloride gives white precipitates.

- (iii) Iron (III) chloride solution and copper chloride solution.

Add ammonium hydroxide solution to each. In case of iron (III) chloride, a reddish brown precipitate is produced which is insoluble in excess of ammonium hydroxide solution. In case of copper chloride, a pale blue precipitate is obtained.

181. Write the observations and balanced equations for the following reactions :

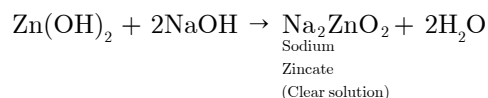
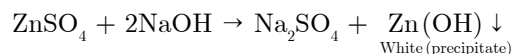
- (i) Sodium hydroxide is added drop-wise till in excess to a solution of zinc sulphate.
- (ii) Ammonium hydroxide is added first in a small quantity and then in excess to a solution of copper sulphate.
- (iii) Excess of ammonium hydroxide is added to a substance obtained by adding hydrochloric

acid in silver nitrate solution.

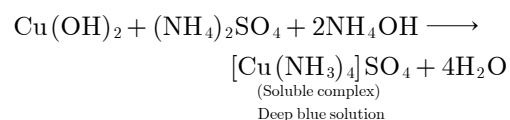
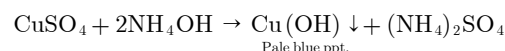
Ans :

COMP 2003

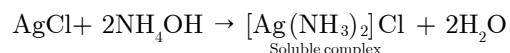
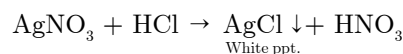
- (i) A white precipitate is formed which dissolves in excess of sodium hydroxide solution.



- (ii) Pale blue ppt. is formed which dissolves in an excess of ammonium hydroxide solution to form deep blue solution.



- (iii) White ppt. is formed by adding hydrochloric acid to silver nitrate solution which dissolves in an excess of ammonium hydroxide.



182. State two relevant observations for each of the following :

- (i) Ammonium hydroxide solution is added to copper (II) nitrate solution in small quantities and then in excess.
- (ii) Ammonium hydroxide solution is added to zinc nitrate solution in minimum quantities and then in excess.

Ans :

SQP 2013

- (i) (1) When NH_4OH is added in small quantity, pale blue ppt. of Cu(OH)_2 are formed.
- (2) When NH_4OH is added in excess, the ppt. dissolve to form a complex to give an inky blue solution.
- (ii) (1) When NH_4OH is added in small quantity, gelatinous white ppt. of Zn(OH)_2 are formed.
- (2) When NH_4OH is added in excess, the ppt. dissolve to form a complex, to give clear solution.

183. Give a chemical test to distinguish between the following pairs of chemicals:

- (i) Lead nitrate solution and Zinc nitrate solution.
- (ii) Sodium chloride solution and Sodium nitrate solution.

173. State one observation for each of the following:

- Excess ammonium hydroxide solution is added to lead nitrate solution.
- Sodium hydroxide solution is added to ferric chloride solution at first a little and then in excess.

Ans :

COMP 2012

- White precipitate appears which remains insoluble in excess of ammonium hydroxide.
- Reddish brown precipitate appears which is insoluble in excess of sodium hydroxide solution.

174. Distinguish between the following pairs of compounds using the test given within brackets:

- Iron(II) sulphate and iron(III) sulphate (using ammonium hydroxide)
- A lead salt and a zinc salt (using excess ammonium hydroxide)

Ans :

SQP 2014

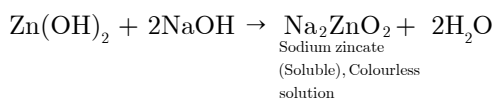
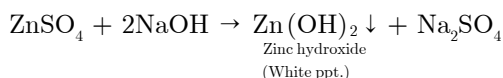
- Iron(II) sulphate (FeSO_4): Dirty green ppt which changes to reddish brown after sometime and the ppt remains insoluble in excess of NH_4OH .
Iron(III) sulphate: Reddish brown ppt appears which is insoluble in excess of NH_4OH .
- Lead salt: White ppt is formed which is insoluble in excess of NH_4OH .
Zinc salt: White ppt is formed which is soluble in excess of NH_4OH .

175. What do you observe when sodium hydroxide solution is added to zinc sulphate solution in excess ?

Ans :

SQP 2015

A white ppt. is produced which dissolves in an excess of sodium hydroxide.



176. Give a chemical test to distinguish between the following pair of compounds : Calcium nitrate solution and zinc nitrate solution.

Ans :

COMP 2013

Add NH_4OH to both the salt solutions.

$\text{Ca(NO}_3)_2$ - White ppts. of Ca(OH)_2 are seen.

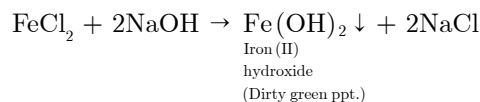
$\text{Zn(NO}_3)_2$ - Gelatinous white ppts. of Zn(OH)_2 are seen which dissolves in excess of NH_4OH .

177. How does sodium hydroxide solution act in distinguishing FeCl_2 solution from FeCl_3 solution?

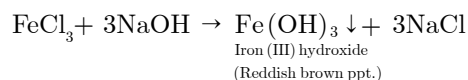
Ans :

COMP 2020

Sodium hydroxide solution gives dirty green precipitates with FeCl_2 solution.



Sodium hydroxide solution gives reddish brown ppt. with FeCl_3 solution.



178. Distinguish between the following pairs of compounds using test given within brackets :

- Iron (II) sulphate and iron (III) sulphate (using ammonium hydroxide)
- A lead salt and a zinc salt (using excess ammonium hydroxide)

Ans :

SQP 2014

(i)	Iron (II) sulphate	Iron (III) sulphate
	$\text{FeSO}_4 + 2\text{NH}_4\text{OH} \rightarrow \text{Fe(OH)}_2 \downarrow + (\text{NH}_4)_2\text{SO}_4$ Dirty green ppts. of Fe(OH)_2 are formed.	$\text{Fe}_2(\text{SO}_4)_3 + 3\text{NH}_4\text{OH} \rightarrow \text{Fe(OH)}_3 \downarrow + 3\text{NH}_4\text{Cl}$ Reddish brown ppts. of Fe(OH)_3 are formed.
(ii)	A lead salt	A zinc salt
	$\text{Pb(NO}_3)_2 + 2\text{NH}_4\text{OH} \rightarrow \text{Pb(OH)}_2 \downarrow + 2\text{NH}_4\text{NO}_3$ It is insoluble in excess and forms chalky white precipitates.	$\text{ZnSO}_4 + 2\text{NH}_4\text{OH} \rightarrow \text{Zn(OH)}_2 \downarrow + (\text{NH}_4)_2\text{SO}_4$ $\text{Zn(OH)}_2 + (\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{NOH} \rightarrow [\text{Zn(NH}_3)_4]\text{SO}_4 + 4\text{H}_2\text{O}$ It is soluble in excess and forms gelatinous white precipitates.

THREE MARKS QUESTIONS

179. You are provided with the list of chemicals mentioned below in the box:

Sodium hydroxide solution, copper carbonate, zinc, hydrochloric acid, copper, dilute sulphuric acid, chlorine, iron Using suitable chemicals from

solution 'E'. In this context answer the following questions.

- Identify A, B, C, D and E.
- Is 'A' soluble in water?
- Write all equations involved in the above reactions.

Ans :

COMP 2007

- A — Copper carbonate
B — Copper sulphate
C — Ammonium hydroxide
D — Copper hydroxide
E — Tetraamine copper hydroxide
- 'A' is insoluble in water.
- $$\underset{\text{A}}{\text{CuCO}_3} + \text{H}_2\text{SO}_4 \longrightarrow \underset{\text{B}}{\text{CuSO}_4} + \text{H}_2\text{O} + \text{CO}_2$$

$$\text{CuSO}_4 + 2\underset{\text{C}}{\text{NH}_4\text{OH}} \longrightarrow \underset{\text{D}}{\text{Cu}(\text{OH})_2} + (\text{NH}_4)_2\text{SO}_4$$

$$\underset{\text{E}}{\text{Cu}(\text{OH})_2} + 4\text{NH}_4\text{OH} \longrightarrow [\text{Cu}(\text{NH}_3)_4](\text{OH})_2 + 4\text{H}_2\text{O}$$

188. A metal, whose alloy finds used in the construction of aircrafts, in the powdered form is added to sodium hydroxide solution. A colourless gas was evolved and after reaction was over, the solution was colourless.

- Name the powdered metal added to sodium hydroxide solution.
- Name the gas evolved.
- Name the salt present in the colourless solution.

Ans :

MAIN 2010

- Aluminium
- Hydrogen
- Sodium meta-aluminate.

189. (a) Sodium hydroxide solution is added to solution 'A'. A white precipitate is formed which is insoluble in excess of sodium hydroxide solution. What is the metal ion present in solution 'A'?

(b) When ammonium hydroxide is added to solution 'B', a pale blue precipitate is formed. This pale blue precipitate dissolves in excess of ammonium hydroxide giving an inky blue solution. What is the cation present in solution 'B'? What is the probable colour of solution 'B'?

Ans :

COMP 2018

- Calcium ion or Ca^{2+}
- Copper ion or Cu^{2+}
The colour of solution 'B' is blue.

190. Using sodium hydroxide solution, how would you distinguish between:

- Zinc nitrate solution and calcium nitrate solution.
- Iron(II) chloride and Iron(III) chloride.
- Lead hydroxide and magnesium hydroxide?

Ans :

SQP 2013

- Sodium hydroxide solution, when added to zinc nitrate solution, a white precipitate is formed which is soluble in excess. On adding sodium hydroxide solution to calcium nitrate, a white precipitate is formed which is insoluble in excess.
- Sodium hydroxide solution, when added to iron(II) chloride, dirty green precipitate is formed which changes to reddish brown after sometime. Sodium hydroxide solution, when added to iron(III) chloride, a reddish brown precipitate is formed.
- Sodium hydroxide, when added to lead hydroxide, dissolves it whereas sodium hydroxide when added to magnesium hydroxide, there is no visible reaction, i.e. magnesium hydroxide remains insoluble.

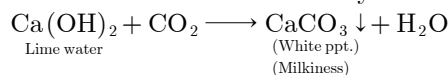
191. Compound 'A' on reaction with dilute hydrochloric acid produces a colourless, odourless gas 'B' with brisk effervescence.

- Identify gas 'B'.
- Identify anion in compound 'A'.
- Give confirmatory test for the gas 'B'.

Ans :

MAIN 2019

- Gas 'B' is carbon dioxide.
- Carbonate; CO_3^{2-} .
- Gas 'B' turns lime water milky.



FOUR MARKS QUESTIONS

192. Complete the following sentence by choosing the correct answer from the brackets:

- The salt that can be prepared by Direct Combination is [FeCl₃/FeCl₂]
- The metallic oxide which can be reduced by using common reducing agents is [Fe₂O₃/Al₂O₃]
- The metal nit rate which on thermal decomposition forms a black residue is [zinc nitrate/copper nitrate]

Ans :

COMP 2018

- (i) Add ammonium hydroxide to the solutions of lead nitrate and zinc nitrate dropwise and then in excess.

Lead Nitrate	Zinc Nitrate
On adding ammonium hydroxide chalky white precipitates of lead hydroxide are formed $\text{Pb}(\text{NO}_3)_2 + 2\text{NH}_4\text{OH} \longrightarrow \text{Pb}(\text{OH})_2 + 2\text{NH}_4\text{NO}_3$	On adding ammonium hydroxide gelatinous white precipitates of zinc hydroxide are formed. $\text{Zn}(\text{NO}_3)_2 + 2\text{NH}_4\text{OH} \longrightarrow \text{Zn}(\text{OH})_2 + 2\text{NH}_4\text{NO}_3$
On adding excess of ammonium hydroxide, the precipitates do not dissolve.	On adding excess of ammonium hydroxide, the precipitates dissolve forming a soluble complex.

- (ii) Add silver nitrate solution to both sodium chloride and sodium nitrate solution and observe.

Sodium Chloride	Sodium Nitrate
Add silver nitrate solution to sodium chloride. $\text{NaCl} + \text{AgNO}_3 \longrightarrow \text{AgCl}\downarrow + \text{NaNO}_3$ You will observe curdy white precipitates of silver chloride.	Add silver nitrate solution to sodium nitrate. No reaction will take place. $\text{NaNO}_3 + \text{AgNO}_3 \longrightarrow \text{No reaction}$

- 184.** Three test tubes contain calcium nitrate solution, zinc nitrate solution and lead nitrate solution respectively. Each solution is divided into two portions (a) and (b). Describe the effect of:

- (a) Adding sodium hydroxide to each portion in turn till it is in excess.
 (b) Adding ammonium hydroxide to each portion in turn till it is in excess.

Ans :

MAIN 2014

- (a) Sodium hydroxide

Salt solution	In small amount	In excess
Calcium nitrate	White precipitate	Insoluble
Zinc nitrate	White precipitate	Soluble
Lead nitrate	White precipitate	Soluble

- (b) Ammonium hydroxide

Salt solution	In small amount	In excess
Calcium nitrate	No visible reaction	No change
Zinc nitrate	White precipitate	Soluble
Lead nitrate	White precipitate	Insoluble

- 185.** How does ammonium hydroxide help in distinguishing between

- (a) Iron(II) chloride and iron(III) chloride,
 (b) Zinc nitrate and lead nitrate,
 (c) Lead hydroxide and zinc hydroxide?

Ans :

COMP 2017

- (a) Iron(II) chloride, on reaction with ammonium hydroxide, form a dirty green precipitate which changes to reddish brown. Ammonium hydroxide, when reacts with iron(III) chloride, forms a reddish brown precipitate.
 (b) Zinc nitrate solution, on reaction with ammonium hydroxide, produces a white precipitate which is soluble in excess.
 Lead nitrate solution, on reaction with ammonium hydroxide, produces a white precipitate which is insoluble in excess.
 (c) Lead hydroxide remains insoluble in ammonium hydroxide, whereas zinc hydroxide dissolves in ammonium hydroxide.

- 186.** You are given the three white powders, calcium carbonate, lead carbonate and zinc carbonate. Describe the tests you would carry out in solution to identify the metal in each of the above compounds. Indicate clearly how you would prepare the solutions for the tests.

Ans :

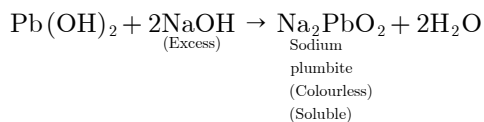
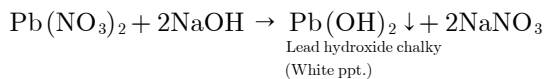
SQP 2016

Calcium carbonate dissolves in dilute nitric acid. To the clear solution, when ammonium hydroxide is added, there is no visible reaction.

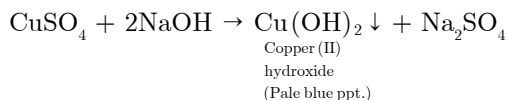
Lead carbonate dissolves in dilute nitric acid. To the clear solution, when ammonium hydroxide is added a white precipitate is formed which is insoluble in excess.

Zinc carbonate dissolves in dilute nitric acid. To the clear solution, when ammonium hydroxide is added, a white precipitate is formed which is soluble in excess.

- 187.** Green coloured amorphous salt 'A' on reaction with dilute sulphuric acid produces a blue coloured solution 'B'. The blue coloured solution on treatment with alkali 'C' produces pale blue precipitate 'D' and on adding excess of 'C', the precipitate 'D' dissolves to give a deep blue



- (v) CuSO_4 : A pale blue ppt. of copper (II) hydroxide is obtained which is insoluble in excess of caustic soda solution.



197. Sodium hydroxide solution is added first in small quantity, then in excess to the aqueous salt solutions of copper (II) sulphate, zinc nitrate, lead nitrate, calcium chloride and iron (III) sulphate. Copy the following table and write the colour of the precipitate in (i) to (v) and the nature of the precipitate (soluble or insoluble) in (vi) to (x)

Aqueous salt solution	Colour of precipitate when NaOH is added in a small quantity	Nature of precipitate (soluble or insoluble) when NaOH is added in excess
Copper (II) sulphate	(i)	(vi)
Zinc nitrate	(ii)	(vii)
Lead nitrate	(iii)	(viii)
Calcium chloride	(iv)	(ix)
Iron (III) sulphate	(v)	(x)

Ans :

COMP 2004

Aqueous salt solution	Colour of precipitate when NaOH is added in a small quantity	Nature of precipitate (soluble or insoluble) when NaOH is added in excess
Copper (II) sulphate	(i) Pale blue	(vi) Insoluble
Zinc nitrate	(ii) White	(vii) Soluble
Lead nitrate	(iii) Curdy white	(viii) Soluble

Calcium chloride	(iv) White	(ix) Insoluble
Iron (III) sulphate	(v) Reddish brown	(x) Insoluble

198. The following table shows the tests a student performed on four different aqueous solutions which are X, Y, Z and W. Based on the observations provided, identify the cation present:

Chemical test	Observation	Conclusion
To solution X, ammonium hydroxide is added in minimum quantity first and then in excess.	A dirty white precipitate is formed which dissolves in excess to form a clear solution.	(i)
To solution Y, ammonium hydroxide is added in minimum quantity first and then in excess.	A pale blue precipitate is formed which dissolves in excess to form a clear inky blue solution.	(ii)
To solution W, a small quantity of sodium hydroxide solution is added and then in excess.	A white precipitate is formed which remains insoluble.	(iii)
To a salt Z, calcium hydroxide solution is added and then heated.	A pungent smelling gas turning moist red litmus paper blue is obtained.	(iv)

Ans :

MAIN 2015

- (i) Zinc
(ii) Copper
(iii) Magnesium
(iv) Ammonia

199. The following table shows the tests of student performed on four aqueous solutions A, B, C and D. Write down in your answer scripts the

- (iv) The insolubility of calcium hydroxide in excess NaOH suggests that hydroxides of alkaline earth metals like calcium are only sparingly soluble, even in strongly basic conditions.

211. Ferric chloride reacts with NaOH to produce a reddish-brown precipitate that remains insoluble in excess NaOH. When NH_4OH is added to the ferric chloride solution, the same reddish-brown precipitate forms, also remaining insoluble in excess NH_4OH . The solution was initially yellow.

- What is the reddish-brown precipitate formed when NaOH is added to ferric chloride and why doesn't it dissolve in excess NaOH?
- Describe the reaction that occurs when NH_4OH is added to ferric chloride, including why the precipitate does not dissolve in excess NH_4OH .
- Given the yellow color of the initial ferric chloride solution, what does this suggest about the visual properties of ferric ions in solution?
- What does the insolubility of ferric hydroxide in both NaOH and NH_4OH suggest about the chemistry of iron(III) hydroxides?

Ans :

- The precipitate is ferric hydroxide ($\text{Fe}(\text{OH})_3$), which remains insoluble in excess NaOH due to its low solubility and inability to form a soluble complex.
- Ferric hydroxide ($\text{Fe}(\text{OH})_3$) forms as a reddish-brown precipitate, which remains insoluble in excess NH_4OH because ferric ions do not form a stable soluble complex with ammonia.
- The yellow color indicates that ferric ions (Fe^{3+}) impart a distinct color to the solution, typical of iron(III) salts in aqueous solutions.
- The insolubility in both reagents suggests that iron(III) hydroxides are highly stable and do not easily form soluble complexes with common bases.

212. A student adds NaOH to a magnesium nitrate solution, resulting in a white precipitate that remains insoluble in excess NaOH. The student then adds NH_4OH to a separate portion of the magnesium nitrate solution and the same white precipitate forms, remaining insoluble in excess NH_4OH .

- What is the white precipitate formed when NaOH is added to magnesium nitrate and why doesn't it dissolve in excess NaOH?
- What happens when NH_4OH is added

to magnesium nitrate and why does the precipitate remain insoluble in excess NH_4OH ?

- Given that the magnesium nitrate solution is colorless, what does this indicate about the behavior of magnesium ions in solution?
- What does the behavior of magnesium hydroxide in both NaOH and NH_4OH suggest about its solubility characteristics?

Ans :

- The white precipitate is magnesium hydroxide ($\text{Mg}(\text{OH})_2$), which remains insoluble in excess NaOH due to its low solubility in water.
- Magnesium hydroxide ($\text{Mg}(\text{OH})_2$) forms again as a white precipitate, which does not dissolve in excess NH_4OH because magnesium does not form a soluble complex with ammonia.
- The colorless solution indicates that magnesium ions (Mg^{2+}) do not impart any color to the solution, typical of magnesium salts in water.
- The consistent insolubility in both reagents suggests that magnesium hydroxide is a poorly soluble compound in basic conditions, regardless of the specific base used.

213. In an experiment, ferrous chloride is treated with NaOH, producing a dirty green precipitate that gradually turns reddish-brown as it oxidizes. NH_4OH is added to a separate portion of ferrous chloride solution, yielding a similar dirty green precipitate that also turns reddish-brown over time. The initial solution was pale green.

- What is the dirty green precipitate formed when NaOH is added to ferrous chloride and why does it turn reddish-brown over time?
- What reaction occurs when NH_4OH is added to ferrous chloride and why does the precipitate undergo a color change?
- Given that the ferrous chloride solution is pale green, what does this suggest about the visual properties of ferrous ions in solution?
- What does the oxidation of ferrous hydroxide to ferric hydroxide suggest about the stability of iron(II) compounds in aqueous environments?

Ans :

- The dirty green precipitate is ferrous hydroxide ($\text{Fe}(\text{OH})_2$), which oxidizes to ferric hydroxide ($\text{Fe}(\text{OH})_3$), turning reddish-brown.
- Ferrous hydroxide ($\text{Fe}(\text{OH})_2$) forms as a dirty green precipitate, which oxidizes to reddish-brown ferric hydroxide ($\text{Fe}(\text{OH})_3$) over time.

- Which two solutions will give a white precipitate when treated with dilute hydrochloric acid followed by Barium chloride solution ?
- Which two solutions will give a white precipitate when treated with dilute nitric acid followed by silver nitrate solution ?
- Which solution will give a white precipitate when either of dilute hydrochloric acid or dilute sulphuric acid is added to it ?
- Which solution becomes deep blue in colour when excess of ammonium hydroxide is added to it ?
- Which solution gives a white precipitate with an excess of ammonium hydroxide solution ?

Ans :

SQP 2005

- B and E
- C and F
- D
- A
- D and E

203. The following table shows the tests a student performed on four different aqueous solutions which are X, Y, Z and W. Based on the observations provided, identify the cation present.

Chemical test	Observation	Conclusion
To solution X, ammonium hydroxide is added in minimum quantity first and then in excess.	A dirty white precipitate is formed which dissolves in excess to form a clear solution.	(i)
To solution Y, ammonium hydroxide is added in minimum quantity first and then in excess.	A pale blue precipitate is formed which dissolves in excess to form a clear inky blue solution.	(ii)
To solution W, a small quantity of sodium hydroxide solution is added and then in excess.	A white precipitate is formed which remains insoluble.	(iii)

To a salt Z, calcium hydroxide solution is added and then heated.	A pungent smelling gas turning moist red litmus paper blue is obtained.	(iv)
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Ans :

COMP 2016

- Zn^{2+}
- Cu^{2+}
- Ca^{2+}
- NH_4^+

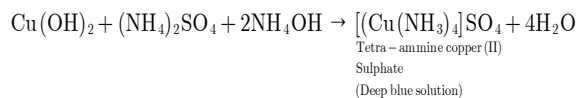
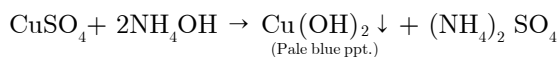
204. What happens when ammonia solution is added

- dropwise and
- in excess to the following solutions :
 - CuSO_4
 - ZnSO_4
 - $\text{Al}_2(\text{SO}_4)_3$
 - FeCl_3
- Also write the balanced equations.

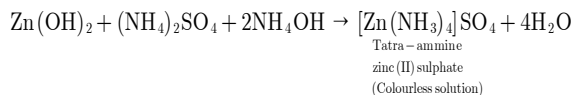
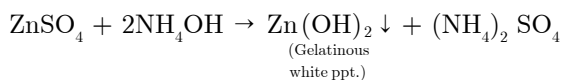
Ans :

MAIN 2010

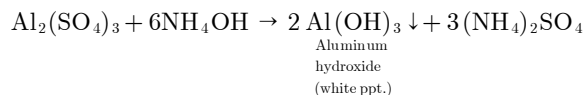
- CuSO_4 : A pale blue ppt. of copper (II) hydroxide is obtained which dissolves in an excess of NH_4OH solution.



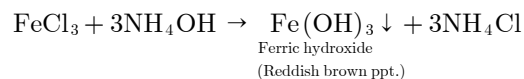
- ZnSO_4 : A gelatinous white ppt. of zinc hydroxide is obtained which is soluble in an excess of ammonium hydroxide solution.



- $\text{Al}_2(\text{SO}_4)_3$: A gelatinous white ppt. of aluminium hydroxide is obtained which is insoluble in an excess of NH_4OH .



- FeCl_3 : A reddish brown ppt. of ferric hydroxide is obtained which is insoluble in an excess of NH_4OH .



- (iii) The colorless solution suggests that barium ions (Ba^{2+}) do not impart any color to the solution, consistent with the behavior of barium salts.
- (iv) The solubility of barium hydroxide indicates that barium salts are generally soluble in water and do not easily precipitate, reflecting the chemistry of barium in aqueous solutions.

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it dissolve in excess NaOH?

- (ii) Describe the reaction that occurs when NH_4OH is added to lead nitrate, including why the precipitate does not dissolve in excess NH_4OH .
- (iii) Given the colorless nature of the lead nitrate solution, what does this suggest about the appearance of lead ions in aqueous solutions?
- (iv) What does the differing solubility of the precipitate in NaOH and NH_4OH indicate about the chemical behavior of lead?

Ans :

- (i) The white precipitate is lead hydroxide ($\text{Pb}(\text{OH})_2$). It dissolves in excess NaOH due to the formation of soluble sodium plumbite.
- (ii) Lead hydroxide ($\text{Pb}(\text{OH})_2$) forms as a white precipitate, which remains insoluble in excess NH_4OH because lead does not form a soluble complex with ammonia.
- (iii) The colorless solution indicates that lead ions (Pb^{2+}) do not impart any color, meaning lead salts typically produce colorless solutions in water.
- (iv) The fact that the precipitate dissolves in NaOH but not in NH_4OH highlights that lead can form soluble complexes with hydroxide ions but not with ammonia, reflecting its limited amphoteric properties.

209. In an experiment, a student adds NaOH to a solution of copper sulfate, resulting in a bluish-white precipitate that does not dissolve in excess NaOH. When NH_4OH is added to the copper sulfate solution, a pale blue precipitate forms, which dissolves in excess NH_4OH to yield a deep blue solution.

- (i) What is the bluish-white precipitate formed when NaOH is added to copper sulfate and why doesn't it dissolve in excess NaOH?
- (ii) Describe the chemical changes that occur when NH_4OH is added to copper sulfate and explain the formation of the deep blue solution.
- (iii) Why does the color of the solution change to deep blue upon the addition of excess NH_4OH and what does this indicate about the interaction between copper and ammonia?
- (iv) Given the initial color of the copper sulfate solution, how does this experiment demonstrate the visual changes associated with complex ion formation?

Ans :

- (i) The precipitate is copper hydroxide ($\text{Cu}(\text{OH})_2$). It does not dissolve in excess NaOH because copper does not form a soluble complex with hydroxide under these conditions.
- (ii) Copper hydroxide ($\text{Cu}(\text{OH})_2$) forms initially as a pale blue precipitate, which dissolves in excess NH_4OH due to the formation of a deep blue tetraamine copper complex.
- (iii) The deep blue color indicates the formation of the tetraamine copper(II) complex, which is highly soluble and stable, showing strong coordination between copper ions and ammonia.
- (iv) The initial blue color of the copper sulfate solution transitions to deep blue with NH_4OH , visually demonstrating how complex ion formation can dramatically alter the appearance of a solution.

210. A solution of calcium nitrate is treated with NaOH, forming a white precipitate that does not dissolve in excess NaOH. NH_4OH is added next, but no visible reaction occurs. The solution remains colorless before and after these reactions.

- (i) What is the white precipitate formed when NaOH is added to calcium nitrate and why doesn't it dissolve in excess NaOH?
- (ii) Why is there no visible reaction when NH_4OH is added to the calcium nitrate solution and what does this indicate about calcium's reactivity?
- (iii) Given that the calcium nitrate solution is colorless, what does this suggest about the properties of calcium ions in aqueous solutions?
- (iv) What does the lack of solubility of calcium hydroxide in excess NaOH suggest about the solubility properties of alkaline earth metal hydroxides?

Ans :

- (i) The white precipitate is calcium hydroxide ($\text{Ca}(\text{OH})_2$). It remains insoluble in excess NaOH because calcium hydroxide has low solubility in water.
- (ii) No reaction occurs with NH_4OH because calcium hydroxide does not react with ammonia to form a soluble complex, indicating limited reactivity with NH_4OH .
- (iii) The colorless nature of the solution suggests that calcium ions (Ca^{2+}) do not contribute color to the solution, consistent with the behavior of calcium salts in water.

205. What do you observe when

- Ammonium hydroxide is added to copper sulphate solution first a little then in excess?
- Sodium hydroxide solution is added to zinc sulphate solution first a little then in excess?
- Calcium nitrate is added to sodium hydroxide solution?
- Sodium hydroxide solution is added to iron(III) chloride solution?
- Ammonium hydroxide solution is added to lead nitrate solution first a little then in excess?

Ans :

COMP 2017

- On adding ammonium hydroxide drop by drop, a bluish white precipitate is formed which dissolves in excess of ammonium hydroxide to give a deep blue or inky blue or prussian blue solution.
- A white precipitate is formed which is soluble in excess.
- A white precipitate is formed which is insoluble in excess.
- A reddish brown precipitate is formed which is insoluble in excess.
- A white precipitate is formed which is insoluble in excess.

206. From the list of the substances given below, choose the substance which fits into the given description:

Ammonium chloride, calcium hydroxide, lime water, ammonia, concentrated hydrochloric acid, zinc carbonate, carbon dioxide, concentrated sulphuric acid, copper carbonate.

- Substance 'A' is formed when water is added to calcium oxide.
- Substance 'A' on reaction with substance 'B' produces alkaline gas 'C'.
- Alkaline gas 'C' on reaction with 'D' produces dense white fumes.
- Substance 'E' on heating alone produces acidic gas 'F' and a yellow residue is left behind.
- When 'F' is passed through 'G', turbidity appears.

Ans :

COMP 2020

- A — Calcium hydroxide
- B — Ammonium chloride, C — Ammonia
- D — Concentrated hydrochloric acid
- E — Zinc carbonate, F — Carbon dioxide
- G — Lime water.

CASE BASED QUESTION

207. A student is working with a solution of zinc nitrate. The student first adds NaOH drop by drop, observing the formation of a white precipitate that eventually dissolves upon adding excess NaOH. Next, NH_4OH is added to the same solution, producing another white precipitate that also dissolves in excess NH_4OH . The zinc nitrate solution remains colorless throughout these reactions.

- What is the identity of the white precipitate formed when NaOH is added to zinc nitrate and why does it dissolve in excess NaOH?
- When NH_4OH is added to zinc nitrate, what chemical reaction occurs and what is the role of excess NH_4OH in this process?
- Given that the solution of zinc nitrate is colorless, how does this inform the behavior of zinc ions in aqueous solutions?
- Why does the white precipitate dissolve in both NaOH and NH_4OH when added in excess and what does this indicate about the chemistry of zinc?

Ans :

- The white precipitate is zinc hydroxide ($\text{Zn}(\text{OH})_2$). It dissolves in excess NaOH to form sodium zincate, a soluble complex.
- Zinc hydroxide ($\text{Zn}(\text{OH})_2$) forms as a white precipitate, which then dissolves in excess NH_4OH due to the formation of a soluble tetraamine zinc complex.
- The colorless solution indicates that zinc ions (Zn^{2+}) do not impart any color to the solution, suggesting that zinc salts generally form colorless solutions in water.
- The dissolution in both reagents indicates that zinc forms soluble complex ions with both hydroxide (forming sodium zincate) and ammonia (forming tetraamine zinc), reflecting its amphoteric nature.

208. A student adds NaOH to a lead nitrate solution, forming a white precipitate that dissolves when excess NaOH is added. When NH_4OH is introduced to the lead nitrate solution, a white precipitate again forms, but this time it does not dissolve in excess NH_4OH . The lead nitrate solution is colorless before and after the reactions.

- What is the white precipitate formed when NaOH is added to lead nitrate and why does

- (iii) The pale green color indicates that ferrous ions (Fe^{2+}) impart a distinct color to the solution, typical of iron(II) salts.
- (iv) The oxidation indicates that iron(II) compounds are prone to oxidation, especially in the presence of oxygen, leading to the formation of more stable iron(III) compounds.

214. A student adds NaOH to a ferric sulfate solution, resulting in the formation of a reddish-brown precipitate that does not dissolve in excess NaOH. The student repeats the experiment with NH_4OH , observing the same reddish-brown precipitate, which also remains insoluble in excess NH_4OH . The initial solution is yellow.

- (i) What is the reddish-brown precipitate formed when NaOH is added to ferric sulfate and why doesn't it dissolve in excess NaOH?
- (ii) What happens when NH_4OH is added to ferric sulfate and why does the precipitate remain insoluble in excess NH_4OH ?
- (iii) Given the yellow color of the ferric sulfate solution, what does this suggest about the appearance of ferric ions in aqueous solutions?
- (iv) What does the insolubility of ferric hydroxide in both NaOH and NH_4OH suggest about the chemical properties of ferric hydroxides?

Ans :

- (i) The precipitate is ferric hydroxide ($\text{Fe}(\text{OH})_3$), which is insoluble in excess NaOH due to its stability and low solubility.
- (ii) Ferric hydroxide ($\text{Fe}(\text{OH})_3$) forms as a reddish-brown precipitate, which remains insoluble in excess NH_4OH because ferric ions do not form a soluble complex with ammonia.
- (iii) The yellow color indicates that ferric ions (Fe^{3+}) impart a distinct color to the solution, characteristic of iron(III) salts in water.
- (iv) The insolubility suggests that ferric hydroxides are highly stable and do not readily form soluble complexes with either base, highlighting their chemical resilience.

215. A student is investigating a solution of ammonium chloride. When the student adds NaOH, a colorless gas with a pungent odor is released, which turns red litmus paper blue. The student then adds NH_4OH to a separate portion of ammonium chloride, but no visible reaction occurs.

- (i) What gas is released when NaOH is added to ammonium chloride and what is its significance?
- (ii) Why does the gas produced in the reaction

turn red litmus paper blue and what does this indicate about the gas's properties?

- (iii) Given that no reaction occurs when NH_4OH is added to ammonium chloride, what does this suggest about the solubility of ammonium salts in water?
- (iv) What does the reaction with NaOH indicate about the behavior of ammonium ions under basic conditions?

Ans :

- (i) The gas is ammonia (NH_3), which is significant because it indicates the presence of ammonium ions (NH_4^+) in the solution.
- (ii) The gas turns red litmus paper blue because ammonia is a basic gas, indicating its alkaline nature.
- (iii) The lack of reaction suggests that ammonium salts, like ammonium chloride, are highly soluble in water and do not precipitate with NH_4OH .
- (iv) The reaction indicates that ammonium ions decompose in the presence of a strong base like NaOH, releasing ammonia gas and forming water and a salt.

216. In an experiment, a student adds NaOH to a barium chloride solution, resulting in no visible reaction. The student then adds NH_4OH to another portion of the barium chloride solution and again, no visible reaction occurs. The solution remains colorless throughout the experiment.

- (i) Why is there no visible reaction when NaOH is added to barium chloride and what does this indicate about barium ions?
- (ii) What does the lack of reaction with NH_4OH suggest about the interaction between barium ions and ammonium hydroxide?
- (iii) Given that the barium chloride solution is colorless, what does this suggest about the visual properties of barium ions in solution?
- (iv) What does the solubility of barium hydroxide in water indicate about the chemical behavior of barium salts in aqueous environments?

Ans :

- (i) No reaction occurs because barium hydroxide ($\text{Ba}(\text{OH})_2$) is highly soluble in water, indicating that barium ions do not form an insoluble precipitate with NaOH.
- (ii) The lack of reaction suggests that barium ions do not form an insoluble complex with ammonium hydroxide, indicating their high solubility in water.

observations (i) to (iv) that were made.

Test	Observation	Conclusions
To solution A, barium chloride solution and dilute hydrochloric acid were added.	(i)	A contains SO_4^{2-} ions.
To solution B, sodium hydroxide solution was added.	(ii)	B contains Fe^{3+} ions.
To solution C, ammonium hydroxide was added slowly till in excess.	(iii)	C contains Cu^{2+} ions.
To solution D, silver nitrate solution and dilute nitric acid were added.	(iv)	D contains Cl^- ions.

Ans :

SQP 2002

- (i) White ppt. insoluble in dilute hydrochloric acid.
- (ii) Reddish brown precipitate.
- (iii) Blue coloured solution is obtained.
- (iv) White precipitate.

200. Sodium hydroxide solution is added to the solutions containing the ions mentioned in list X. List Y gives the details of the precipitate. Match the ions with their coloured precipitates.

	List X		List Y
(i)	Pb^{2+}	A.	Reddish brown
(ii)	Fe^{2+}	B.	White insoluble in excess
(iii)	Zn^{2+}	C.	Dirty green
(iv)	Fe^{3+}	D.	White soluble in excess
(v)	Cu^{2+}	E.	White soluble in excess
(vi)	Ca^{2+}	F.	Blue

Ans :

COMP 2011

- (i) $\text{Pb}^{2+} \rightarrow$ White soluble in excess
- (ii) $\text{Fe}^{2+} \rightarrow$ Dirty green
- (iii) $\text{Zn}^{2+} \rightarrow$ White soluble in excess

- (iv) $\text{Fe}^{3+} \rightarrow$ Reddish brown
- (v) $\text{Cu}^{2+} \rightarrow$ Blue
- (vi) $\text{Ca}^{2+} \rightarrow$ White insoluble in excess.

201. Give one chemical test to distinguish between the following pairs of compounds.

- (i) Zinc sulphate solution and Zinc chloride solution.
- (ii) Iron (II) chloride solution and Iron (III) chloride solution.
- (iii) Calcium nitrate solution and Calcium chloride solution.

Ans :

MAIN 2009

(i)	ZnSO_4 solution	ZnCl_2 solution
	Add BaCl_2 solution to the above solution white precipitates of BaSO_4 are formed. $\text{ZnSO}_4 + \text{BaCl}_2 \rightarrow \text{BaSO}_4 \downarrow + \text{ZnCl}_2$ (White ppt)	Add BaCl_2 solution to the above solution no effect is visualised. $\text{ZnCl}_2 + \text{BaCl}_2 \rightarrow \text{No visual effect}$
(ii)	Iron (II) chloride	Iron (III) chloride
	Add sodium hydroxide to the above solution. Dirty green ppts. are formed. $\text{FeCl}_2 + 2\text{NaOH} \rightarrow 2\text{NaCl} + \text{Fe}(\text{OH})_2 \downarrow$	Add sodium hydroxide to the above solution. Reddish brown ppts. are observed. $\text{FeCl}_3 + 3\text{NaOH} \rightarrow 3\text{NaCl} + \text{Fe}(\text{OH})_3 \downarrow$
(iii)	Calcium nitrate	Calcium chloride
	To this solution add silver nitrate. No reaction takes place. $\text{Ca}(\text{NO}_3)_2 + \text{AgNO}_3 \rightarrow \text{No reaction}$	To this solution add silver nitrate. White precipitates of silver chloride are formed. $\text{CaCl}_2 + 2\text{AgNO}_3 \rightarrow 2\text{AgCl} \downarrow + \text{Ca}(\text{NO}_3)_2$ (curdy white precipitate)

202. The questions (i) to (v) refer to the following salt solutions listed A to F :

- (A) Copper nitrate
- (B) Iron (II) sulphate
- (C) Iron (III) chloride
- (D) Lead nitrate
- (E) Magnesium sulphate
- (F) Zinc chloride

CHAPTER 5

MOLE CONCEPT AND STOICHIOMETRY

SUMMARY

1. GAY LUSSAC'S LAW

Gay Lussac's law states that the pressure exerted by a gas (of given mass and kept at a constant volume) varies directly with the absolute temperature of the gas.

Gay Lussac published the result of his experiment on different gases under the name; "The Law of Combining Volumes of Gases".

Gay Lussac's law is applicable only to gases and not to solids and liquids.

2. ATOMIC WEIGHT

Atomic weight is the number which represents how many times one atom of a substance is heavier than $1/12$ th the mass of an atom of Carbon -12.

3. MOLECULAR WEIGHT

Molecular weight is the number which represents how many times one molecule of a substance is heavier than $1/12$ th the mass of an atom of Carbon -12.

Molecular weight expressed in grams is called gram molecular weight.

4. AVOGADRO'S LAW

According to Avogadro, under the similar conditions of temperature and pressure, equal volumes of all gases contain equal number of molecules.

5. MOLAR VOLUME

The volume occupied by one mole of a gas at S.T.P. (Standard temperature and pressure) is called molar volume. It is equal to 22.4 dm^3 or 22.4 litres.

1. The gram molecular weight of all gases at S.T.P. contains molecules equal to Avogadro's number which is 6.023×10^{23} and it occupies a volume equal to molar volume which is 22.4 dm^3 or 22.4

litres.

2. Number of moles
$$n = \frac{\text{Weight (in grams) of the substance (W)}}{\text{Molecular weight of the substance (M)}}$$
$$n = \frac{W}{M}$$
3. Number of molecules = No. of moles $\times$ Avogadro's number
4. The relationship between mole, gram molecular weight, molar volume and number of molecules can be summarized as follows:

Molecules	Name of the Gas	Mole	Gram Molecular Weight	Number of Molecules	Molar Volume
(1)	O ₂	1 mole	32 g	6.023×10^{23}	22.4 litres
(2)	N ₂	1 mole	28 g	6.023×10^{23}	22.4 litres
(3)	H ₂	1 mole	2 g	6.023×10^{23}	22.4 litres
(4)	CO ₂	1 mole	44 g	6.023×10^{23}	22.4 litres

5. Atomicity is the number of atoms present in one molecule of an element.
6. Metals are mono-atomic, i.e. containing one atom in its molecule.
7. Inert gases are mono-atomic.
8. Gases like Hydrogen (H₂), Oxygen (O₂), Nitrogen (N₂) and chlorine (Cl₂) are diatomic, i.e. containing two atoms in its molecule.
9. The elements containing more than two atoms in its molecule are called as polyatomic.

Example-

Ozone	-	O ₃
Phosphorus	-	P ₄
Sulphur	-	S ₈

10. Vapour density is the ratio between the mass of certain volume of gas or vapour to the mass

of same volume of hydrogen under the similar conditions of temperature and pressure.

Vapour density

$$= \frac{\text{Mass of certain volume of gas or vapour}}{\text{Mass of same volume of Hydrogen}}$$

11. Vapour density is a ratio, so, it has no units.
12. Molecular weight = $2 \times$ Vapour density
13. The percentage composition of a compound is defined as the percentage by weight of each element present in the molecule of a compound.
Percentage composition of a compound

$$= \frac{\text{Weight of an element in a molecule of a compound}}{\text{Gram molecular weight of the compound}} \times 100$$

14. Empirical formula is the formula of a chemical substance which tells the simplest whole number ratio of the atoms of different elements present in its one molecule.
15. Molecular formula is the formula of a chemical substance which represents the actual number of atoms of each element present in its single molecule.
16. In a chemical equation, reactants are written on the left side of the arrow and products are written on the right side of the arrow.

Reactants $\longrightarrow$ Products

17. For the calculation of the numerical based on equation, the equation must be completely balanced.
18. The molecular weights of the products and reactants must be calculated which are required for solving the numerical.
19. Unitary Method is used to find the weight of product or reactant as per the requirement of the problem.
20. In case of gases, the volume required is 22.4 dm^3 for every mole of a gas.
21. Relative Atomic Mass

$$= \frac{\text{Mass of one atom of an element}}{1/2\text{th of mass of an atom of carbon} - 12}$$

22. Relative atomic mass can also be defined with respect to hydrogen. It is the number that represents, how many times one atom of an element is heavier than one atom of hydrogen, whose weight has been taken as unity.

Relative Atomic Mass

$$= \frac{\text{Mass of one atom of an element}}{\text{Mass of one atom of hydrogen (weight taken as unity)}}$$

23. The relative atomic mass of an element expressed in grams is called gram atomic mass or gram atom.

- ## 24. Relative Molecular Mass

$$= \frac{\text{Mass of one molecule of a substance}}{\text{Mass of } 1/12\text{th of an atom of C} - 12}$$

25. Relative molecular mass can also be defined with respect to hydrogen. It is the number that represents how many times one molecule of a substance is heavier than one atom of hydrogen whose weight is taken as unity.
26. The relative molecular mass expressed in grams is called as gram molecular weight or gram molecular mass or gram molecule.

MULTIPLE CHOICE QUESTION

1. Which of the following would weigh the least?
(Atomic masses C = 12, O = 16, Na = 23)
- (a) 2 gram atoms of oxygen
 - (b) one mole of sodium
 - (c) 22.4 litres of carbon dioxide at STP
 - (d) 6.023×10^{22} atoms of carbon

Ans :

SQP 2025

$$\begin{aligned}\text{Number of mole} &= \frac{N}{N_A} \\ &= \frac{6.023 \times 10^{23}}{6.023 \times 10^{23}} \\ &= 1.002 \text{ moles}\end{aligned}$$

Hence, mass of atom = $n \times M_e$

$$= 1.002 \times 12 = 12.02\text{g}$$

Thus (d) is correct option.

2. The ratio between the volumes occupied by 4.4 grams of carbon dioxide and 2 grams of hydrogen gas is:
- (a) 22 : 1 (b) 1 : 2.2
(c) 1 : 10 (d) 10 : 1

Ans :

SQP 2025

Thus (c) is correct option.

3. Which of the following would occupy 22.4 litres at S.T.P.?
- 32 g of oxygen gas
 - 2 moles of hydrogen gas
 - 6.022×10^{23} molecules of ammonia
- (a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

[Atomic weights: O = 16, H = 1, N = 14]

Ans :

MAIN 2024

Since, 1 mole of any gas at STP has volume 22.4 L. So, 32 g of oxygen which is equal to the mass of 1 mole of O_2 gas. Therefore, 32 g of O_2 has volume at STP is 22.4 L.

Since, 6.023×10^{23} molecule of any gas contain 1 mole of gas. Hence, 6.023×10^{23} molecules of ammonia has volume 22.4 L.

Thus (b) is correct option.

4. The ratio between the number of molecules in 2 g of hydrogen and 32 g of oxygen is :

[Given that H = 1, O = 16]

- (a) 1 : 2 (b) 1 : 0.01
(c) 1 : 1 (d) 0.01 : 1

Ans :

COMP 2016

$$\begin{aligned}\text{Mole in 2g of hydrogen} &= \frac{\text{Given mass}}{\text{Molar mass}} \\ &= \frac{2}{2} = 1\text{mol}\end{aligned}$$

$$\text{Mole in 32g of Oxygen} = \frac{32}{16 \times 2} = 1\text{mol}$$

$$\text{Hence the ration} = \frac{1\text{mol}}{1\text{mol}} = 1:1$$

Thus (c) is correct option.

5. The vapour density of carbon dioxide [C = 12, O = 16]

- (a) 32 (b) 16
(c) 44 (d) 22

Ans :

SQP 2012

$$\begin{aligned}\text{Vapour density} &= \frac{12 + (2 \times 16)}{2} \\ &= \frac{44}{2} = 22\end{aligned}$$

Thus (d) is correct option.

6. The gas law which relates the volume of a gas to the number of molecules of the gas is :

- (a) Avogadro's Law (b) Gay Lussac's Law
(c) Boyle's Law (d) Charle's Law

Ans :

MAIN 2008

The gas law which relates the volume of gas to the number of molecules of a gas is Avogadro's Law.

Thus (a) is correct option.

7. The empirical formula for butane is :

- (a) CH_2 (b) C_2H_4
(c) C_4H_8 (d) C_2H_5

Ans :

SQP 2005

Empirical formula of butane is C_2H_5 .

Thus (d) is correct option.

8. Atomic mass of an element expressed in grams is called :

- (a) Gram molecular mass
(b) Net atomic weight
(c) Molecular mass
(d) Gram atomic mass

Ans :

COMP 2004

Mass of an atom expressed in grams is known as gram atomic mass. It is equal to the relative atomic mass or atomic weight in grams.

Thus (d) is correct option.

9. The empirical formula mass for acetylene is :

- (a) 26 g (b) 13 g
(c) 28 g (d) 14 g

Ans :

COMP 2019

Thus (b) is correct option.

The number of atoms present in one molecule of an element is called its :

- (a) Molecular number (b) Atomic number
(c) Atomicity (d) Avogadro's number

Ans :

MAIN 2021

The number of atoms contained in a molecule of an element is called its atomicity.

Thus (c) is correct option.

11. The empirical formula for benzene is :

- (a) CH (b) C_2H_2
(c) C_4H_8 (d) C_6H_6

Ans :

COMP 2023

The empirical formula is the simplest whole-number ratio defining constituent atoms in a species. Thus for benzene, whose molecular formula is C_6H_6 .

Thus (d) is correct option.

12. Twice of vapour density gives us :

- (a) Actual vapour density
(b) Relative vapour density
(c) Molar volume
(d) Molecular mass

Ans :

SQP 2020

Relative molecular mass

$$= 2 \times \text{Vapour density}$$

Thus (d) is correct option.

13. The molecular mass of ammonia gas in grams is :

- (a) 14 g (b) 17 g
(c) 27 g (d) 24 g

- (iii) 11 grams of Carbon dioxide?
 (iv) 3.55 grams of Chlorine?
 (v) 270 grams of Water?

Ans :

COMP 2000

- (i) 10
 (ii) 0.8
 (iii) 0.25
 (iv) 0.05
 (v) 15

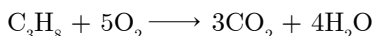
NUMERICAL QUESTION

62. Calculate the volume of oxygen required for the complete combustion of 8.8 g of propane (C_3H_8) [Atomic mass: H = 1, C = 12, O = 16].

Ans :

COMP 2011

We can write the following reaction,



44 g of C_3H_8 requires 5×22.4 dm³ of O_2 .

Hence, 8.8 g of C_3H_8 requires $= \frac{5 \times 22.4}{44} \times 8.8$
 $= 22.4$ dm³

63. Calculate the volume of 320 g of SO_2 at STP (Atomic mass: S = 32, O = 16).

Ans :

SQP 2011

Number of moles of sulphur dioxide

$$= \frac{320}{64} = 5 \text{ moles}$$

$$\text{Volume of } SO_2 = 5 \times 22.4 \text{ dm}^3 \\ = 112.0 \text{ dm}^3$$

64. Calculate the mass of

- (i) 10^{22} atoms of sulphur.
 (ii) 0.1 mole of carbon dioxide.
 [Atomic mass: S = 32, C = 12 and D = 16 and Avogadro's Number = 6×10^{23}]

Ans :

MAIN 2011

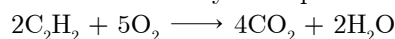
- (i) Mass of 6×10^{23} atoms = 32 g

$$\text{Mass of } 10^{22} \text{ atoms weight} = \frac{32}{6 \times 10^{23}} \times 10^{22} \\ = 0.53 \text{ g}$$

- (ii) Mass of 1 mole of CO_2 = 44 g

$$\text{Mass of 0.1 mole} = 44 \times 0.1 = 4.4 \text{ g}$$

65. (i) Oxygen oxidises ethyne to carbon dioxide and water as shown by the equation:



What volume of ethyne gas at S.T.P. is required to produce 8.4 dm³ of carbon dioxide at S.T.P.? [H = 1, C = 12, O = 16]

- (ii) A compound made up of two elements X and Y has an empirical formula X_2Y . If the atomic weight of X is 10 and that of Y is 5 and the compound has a vapour density 25, find its molecular formula.

Ans :

MAIN 2014

- (i) 4 volume of CO_2 is produced by 2 vol. of C_2H_2 .
 1 vol. of CO_2 will be produced by $\frac{2}{4}$ vol. of C_2H_2 .

Hence, 8.4 dm³ is produced by

$$\frac{2}{4} \times 8.4 = 4.2 \text{ dm}^3$$

- (ii) Empirical Formula Weight (EFW) of X_2Y
 $= 20 + 5 = 25$

$$\text{Mol. Wt} = 2 \times \text{V.D.} = 2 \times 25 = 50$$

$$n = \frac{\text{Mol. Wt}}{\text{EFW}} = \frac{50}{25} = 2$$

$$\text{Hence, Molecular formula} = (X_2Y)_2 = X_4Y_2$$

66. Calculate the percentage of nitrogen and oxygen in ammonium nitrate. [Relative molecular mass of ammonium nitrate is 80, H=1, N=14, O = 16].

Ans :

COMP 2010

$$\text{For } NH_4NO_3 = [14 + (4 \times 1) + 14 + (16 \times 3)] \\ = [14 + 4 + 14 + 48] = 80$$

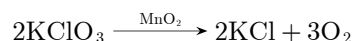
$$\% \text{ of nitrogen} = \frac{28}{80} \times 100 = 35\%$$

$$\% \text{ of oxygen} = \frac{48}{80} \times 100 = 60\%$$

$$\% \text{ of hydrogen} = \frac{4}{80} \times 100 = 5\%$$

35% of nitrogen, 60% of oxygen and 5% of hydrogen.

67. O_2 is evolved by heating $KClO_3$ using MnO_2 as a catalyst



- (i) Calculate the mass of $KClO_3$ required to produce 6.72 litre of O_2 at STP.
 [Atomic masses of K = 39, Cl = 35.5, O = 16].
 (ii) Calculate the number of moles of oxygen present in the above volume and also the number of molecules.
 (iii) Calculate the volume occupied by 0.01 mole of CO_2 at STP.

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Vapour density is indeed a unitless ratio, as explained by the reason.

Thus (a) is correct option.

- 20. Assertion :** Hydrogen gas is monoatomic in nature.

Reason : Hydrogen gas contains two atoms in its molecule, so it is diatomic.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2007

The assertion is false because hydrogen gas (H_2) is diatomic, as correctly explained in the reason. Thus (d) is correct option.

- 21. Assertion :** The molecular formula provides the actual number of atoms of each element in a molecule.

Reason : Empirical formulas represent the simplest whole-number ratio of the atoms in a molecule.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2010

Both the assertion and reason are true statements, but the reason does not directly explain the assertion about the molecular formula. Thus (b) is correct option.

- 22. Assertion :** Vapour density is used to determine molecular weight.

Reason : Molecular weight is twice the vapour density.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2006

Vapour density is indeed used to determine molecular weight and molecular weight is calculated as twice the vapour density, making both the assertion and reason correct and reason is the correct explanation of assertion.

Thus (a) is correct option.

- 23. Assertion :** All inert gases are diatomic.

Reason : Inert gases have complete outer electron shells and exist as monoatomic gases.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2015

The assertion is false because inert gases are monoatomic, which is correctly explained in the reason.

Thus (d) is correct option.

- 24. Assertion :** The atomic weight of an element is expressed in grams and is called gram atomic mass.

Reason : Atomic weight represents how many times one atom of an element is heavier than $1/12$ th the mass of a Carbon-12 atom.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2020

While the atomic weight is indeed based on $1/12$ th the mass of a Carbon-12 atom, it is only called gram atomic mass when expressed in grams.

Thus (c) is correct option.

ONE MARK QUESTIONS

DIRECTION : Fill in the blank from the choices given in brackets :

- 25.** The number of moles in 11 gm of nitrogen gas is _____ (0.39, 0.49, 0.29).
[atomic mass of N = 14]

Ans :

COMP 2020

0.39

- 26.** If two gases under the same conditions have the same number of molecules, then they must have

Ans :

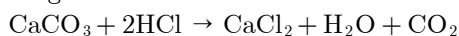
MAIN 2000

same volume.

- (i) 11 g
(ii) 0.4 g

THREE MARKS QUESTIONS

49. Calcium carbonate reacts with dilute hydrochloric acid as given below:



- (a) What is the mass of 5 moles of calcium carbonate? (Retailer molecular mass of calcium carbonate is 100)
(b) How many moles of HCl will react with 5 moles of calcium carbonate?
(c) What is the volume of carbon dioxide liberated at S.T.P. at the same time?

Ans :

MAIN 2024

- (a) Molar mass of $\text{CaCO}_3 = 100 \text{ g/mol}$
Mass of 5 moles of CaCO_3
= Number of moles $\times$ Molar mass
= $5 \text{ mol} \times 100 \frac{\text{g}}{\text{mol}} = 500 \text{ g}$

Therefore, the mass of 5 moles of CaCO_3 is 500 grams.

- (b) According to the balanced equation, 1 mole of calcium carbonate (CaCO_3) reacts with 2 moles of hydrochloric acid (HCl).
Therefore, if you have 5 moles of calcium carbonate, you would need $5 \text{ mol} \times 2 = 10$ moles of hydrochloric acid for a complete reaction.
(c) According to the chemical reaction, 1 mole of calcium carbonate produces 1 mole of carbon dioxide (CO_2). Therefore, 5 moles of calcium carbonate would produce 5 moles of carbon dioxide.

At STP, 1 mole of any gas occupies 22.4 liters.
So, 5 moles of CO_2 occupy

Mass = Number of moles $\times$ Molar volume
at STP

$$\text{Mass} = 5 \text{ mol} \times 22.4 \text{ L} = 112.0 \text{ L}$$

50. What are the informations conveyed by a chemical equation ?

Ans :

SQP 2012

It indicates :

- (i) the names of the reactants and products.
(ii) the relative number of molecules of reactants

and products.

- (iii) the relative number of moles of the reactants and products.
(iv) the relative weights of reactants and products.
(v) the relative volumes of gaseous reactants and products.

51. What are the important applications of Avogadro's law ?

Ans :

COMP 2014

The important applications of Avogadro's law are:

- To determine the atomicity of a gas.
- To determine the molecular formula of a gas.
- To determine the relationship between molecular weight and vapour density of a gas.
- To explain Gay Lussac's law of combining volumes.
- To determine the relationship between gram molecular weight and gram molecular volume of a gas.

52. What is the volume at S.T.P.

- (i) in millilitres of 0.01 mole of Hexane gas [C_6H_{14}] ?
(ii) in litres of 5 moles of Butane gas [C_4H_{10}] ?
(iii) in millilitres of 0.2 mole of Benzene gas [C_6H_6] ?

Ans :

MAIN 2006

- (i) 224 ml
(ii) 112 litres
(iii) 4480 ml

53. What is the number of moles in

- (i) 22.4 litres of Ammonia gas at S.T.P.?
(ii) 44.8 litres of Carbon dioxide at S.T.P.?
(iii) 2.24 litres of Nitrous oxide at S.T.P.?

Ans :

COMP 2010

- (i) 1
(ii) 2
(iii) 0.1

54. What is the volume (in litres) at S.T.P. of

- (i) 16 g of Methane gas?
(ii) 0.14 g of Carbon monoxide gas?
(iii) 1.8 g of Water vapour?

Ans :

SQP 2010

- (i) 22.4 litres
(ii) 0.112 litres
(iii) 2.24 litres

- 39.** How are molecular formula and empirical formula related to each other ?

Ans :

MAIN 2017

Molecular formula of a compound is a simple whole number multiple of its empirical formula. Mathematically,

Molecular formula = $n \times$ Empirical formula
where, n is a simple whole numbers.

or $n = \frac{\text{Molecular formula}}{\text{Empirical formula}}$

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

- 40.** Define empirical formula and molecular formula of a compound.

Ans :

SQP 2020

Empirical formula : It gives us the simplest whole number ratio between the atoms of various elements present in one molecule of a compound.
Molecular formula : It gives us the actual number of atoms of various elements present in one molecule of a compound.

- 41.** Chlorine has atomic weight 35.5. Give reasons.

Ans :

COMP 2021

Chlorine has two isotopes of masses 35 and 37 and are present in the ratio 3 : 1.

Average Atomic weight of chlorine

$$\begin{aligned} &= \frac{(35 \times 3) + (37 \times 1)}{4} \\ &= \frac{105 + 37}{4} = \frac{142}{4} = 35.5 \end{aligned}$$

- 42.** Under the same conditions of temperature and pressure you collect 2 litres of carbon dioxide, 3 litres of chlorine, 5 litres of hydrogen, 4 litres of nitrogen and 1 litre of sulphur dioxide. In which gas sample will there be ?
(a) the greatest number of molecule.
(b) the least number of molecules.

Ans :

MAIN 2021

- (a) 5 litres of hydrogen
(b) 1 litre of sulphur dioxide
(In accordance with the Avogadro's law).

- 43.** How does Avogadro's law explain Gay-Lussac's law of gaseous volumes ?

Ans :

COMP 2000

According to Avogadro's law, equal volumes of all gases under similar conditions of temperature and

pressure contain equal number of molecules.

Since substance react in simple ratio by number of molecules, volumes of the gaseous reactants and products will also bear a simple whole number ratio to one another. This is what Gay Lussac's law states.

- 44.** What is the mass in grams of

- (i) 2.24 millilitres of propane at S.T.P.?
(ii) 448 millilitres of Nitric oxide at S.T.P.?

Ans :

MAIN 2013

- (i) 0.0001 g
(ii) 0.02 g

- 45.** What is the volume (in litres) at S.T.P. occupied by

- (i) 6.023×10^{23} molecules of Sulphur dioxide?
(ii) 12.046×10^{23} molecules of Sulphur trioxide?

Ans :

MAIN 2002

- (i) 22.4 litres
(ii) 44.8 litres

- 46.** What is the mass in grams of 1 mole of

- (i) Hydrogen gas (H_2)
(ii) Ammonia gas (NH_3)

Ans :

COMP 2006

- (i) 2 g
(ii) 17 g

- 47.** Under the same conditions of temperature and pressure, you collect 2 litres of Carbon dioxide, 3 litres of Chlorine, 5 litres of Hydrogen, 4 litres of Nitrogen and 1 litre of Sulphur dioxide. In which gas sample will there be

- (a) the greatest number of molecules?
(b) the least number of molecules?

Justify your answer.

Ans :

COMP 2019

- (a) Hydrogen
(b) Sulphur dioxide

The justification is in accordance to Avogadro's law that under the similar condition of temperature and pressure, equal volumes of all gases contain equal number of molecules. Therefore, the volume of Hydrogen is greater and so, it has greater number of molecules.

- 48.** What is the mass (in grams) of

- (i) 5.6 litres of Propane at S.T.P.?
(ii) 560 ml of Methane at S.T.P.?

Ans :

SQP 2015

remains in the resultant mixture?

- (ii) The mass of 5.6 dm^3 of a certain gas at STP is 12.0 g. Calculate the relative molecular mass of the gas.
- (iii) Find the total percentage of Magnesium in magnesium nitrate crystals, $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. [Mg = 24; N = 14; O = 16 and H = 1]

Ans :

MAIN 2012

- (i) Volume of Ammonia = 44.8 litres
Since, 22.4 L of nitrogen combines with $(3 \times 22.4 = 67.2 \text{ L})$ hydrogen to form 44.8 L of ammonia Hence, Unused nitrogen = $44.8 - 22.4 = 22.4$ litres
- (ii) 5.6 dm^3 of certain gas has mass = 12 g at STP
Hence, 22.4 dm^3 of certain gas has mass = $\frac{22.4 \times 12}{5.6} = 48 \text{ a.m.u.}$
- (iii) % composition = $\frac{24 \times 100}{256} = 9.375\%$

71. Complete the following calculations. Show working for complete credit:

- (i) Calculate the mass of Calcium that will contain the same number of atoms as are present in 3.2 g of Sulphur. [Atomic masses: S = 32, Ca = 40]
- (ii) If 6 litres of hydrogen and 4 litres of chlorine are mixed and exploded and if water is added to the gases formed, find the volume of the residual gas.
- (iii) If the empirical formula of a compound is CH and it has a vapour density of 13, find the molecular formula of the compound.

Ans :

COMP 2015

- (i) Number of moles of sulphur = $\frac{3.2}{32} = 0.1$ mole
0.1 mole of calcium will contain the same number of atoms.
Hence, 0.1 mole of Ca = $0.1 \times 40 = 4 \text{ g}$ of calcium
- (ii) 2 litres
- (iii) $\text{CH} = 12 + 1$
Empirical formula weight (EFW) = 13 g
Mol. Wt = $2 \times \text{V.D.} = 2 \times 13 = 26 \text{ g}$
$$n = \frac{\text{Mol. wt}}{\text{EFW}} = \frac{26}{13}$$

$$n = 2$$

Hence, Molecular formula = (Empirical formula)_n
= $(\text{CH})_2 = \text{C}_2\text{H}_2$

72. (a) A gas cylinder contains 12×10^{24} molecules of oxygen gas. If Avogadro's number is 6×10^{23} ; calculate:
- (i) the mass of oxygen present in the cylinder.
- (ii) the volume of oxygen at S.T.P. present in the cylinder. [O = 16]
- (b) A gaseous hydrocarbon contains 82.76% of carbon. Given that its vapour density is 29, find its molecular formula. [C = 12, H = 1]
- (c) The equation $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$, represents the catalytic oxidation of ammonia. If 100 cm^3 of ammonia is used, calculate the volume of oxygen required to oxidise the ammonia completely.

Ans :

SQP 2016

- (a) (i) 6×10^{23} molecules of O_2 contain 32 g.
 12×10^{24} molecules of O_2 will contain
$$= \frac{32}{6 \times 10^{23}} \times 12 \times 10^{24}$$

$$= 640 \text{ g}$$
- (ii) No. of molecules of O_2
$$= \frac{12 \times 10^{24}}{6 \times 10^{23}} = 20$$

Volume of $\text{O}_2 = 20 \times 22.4 = 448 \text{ L}$

(b)

Elements	Mass %	Atomic Weight	Relative number of atoms	Simple ratio	
C	82.76	12	6.89	1	2
H	17.24	1	17.24	2.5	5

Empirical formula = C_2H_5

$$n = \frac{2 \times \text{Vapour density}}{\text{Empirical formula mass}}$$

$$= \frac{2 \times 29}{24 + 5} = 2$$

Molecular formula = (Empirical formula)_n
= C_4H_{10}

- (c) $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$
4 vol. of NH_3 requires 5 vol. of O_2
Hence, 100 cm^3 of NH_3 requires = $\frac{100 \times 5}{4}$
$$= 125 \text{ cm}^3 \text{ of } \text{O}_2$$

73. (i) State Avogadro's Law.
- (ii) A cylinder contains 68 g of ammonia gas at S.T.P.
- (a) What is the volume occupied by this gas?
- (b) How many moles of ammonia are present

FOUR MARKS QUESTIONS

55. Write the empirical formula of the compounds whose molecular formulae are as follows:

- (i) C_6H_6
- (ii) B_6H_{12}
- (iii) $C_{10}H_{20}Fe_2$
- (iv) N_2O_4
- (v) C_6H_{12}

Ans :

MAIN 2019

- (i) CH
- (ii) BH_2
- (iii) $C_5H_{10}Fe$
- (iv) NO_2
- (v) CH_2

56. (a) A vessel contains N molecules of oxygen at a certain temperature and pressure. How many molecules of sulphur dioxide can the vessel accommodate at the same temperature and pressure ?

- (b) Each of the two flasks contains 2.0 g of gas at the same temperature and pressure. One flask contains oxygen and the other hydrogen.
 - (i) Which sample contains the greater number of molecules ?
 - (ii) If the hydrogen sample contains N molecules, how many molecules are present in oxygen sample ?

Ans :

SQP 2010

- (a) According to Avogadro's law
The number of sulphur dioxide molecules = N
- (b) (i) 2 g of H_2 has greater number of molecules
- (ii) No. of molecules of oxygen

$$= \frac{2}{32} \times N$$

$$= \frac{N}{16}$$

57. Write the empirical formula of the compounds whose molecular formulae are as follows:

- (i) C_4H_{10}
- (ii) B_2H_6
- (iii) C_8H_{18}
- (iv) C_4H_8
- (v) Na_2CO_3

Ans :

SQP 2018

- (i) C_2H_5
- (ii) BH_3
- (iii) C_4H_9
- (iv) CH_2
- (v) Na_2CO_3

58. What is the mass in grams of the compounds in

- (i) 4.2161×10^{23} molecules of Carbonic acid?
- (ii) 6.023×10^{23} molecules of Hydrogen peroxide?
- (iii) 1.2046×10^{21} molecules of Calcium carbonate?
- (iv) 3.0115×10^{23} molecules of Nitrogen dioxide?
- (v) 4.8184×10^{23} molecules of Acetic acid?

Ans :

COMP 2011

- (i) 43.4 g
- (ii) 34 g
- (iii) 0.2 g
- (iv) 23 g
- (v) 48 g

59. What is the number of molecules in

- (i) 10 grams of Calcium carbonate?
- (ii) 3.6 grams of Water?
- (iii) 19.6 grams of Phosphoric acid?
- (iv) 200 grams of Sodium hydroxide?
- (v) 1.5 grams of Ethane gas?

Ans :

SQP 2009

For the convenience in calculation, Avogadro's number may be taken as 6×10^{23} .

- (i) 6×10^{22}
- (ii) 1.2×10^{23}
- (iii) 1.2×10^{23}
- (iv) 3×10^{24}
- (v) 3×10^{22}

60. What is the mass in grams of

- (i) 2 moles of water?
- (ii) 0.25 mole of Calcium carbonate?
- (iii) 0.5 mole of Nitric acid?
- (iv) 3 moles of Sodium hydroxide?
- (v) 10 moles of Glucose?

Ans :

MAIN 2013

- (i) 36 g
- (ii) 25 g
- (iii) 31.5 g
- (iv) 120 g
- (v) 1800 g

61. What is the number of moles in

- (i) 1000 grams of Calcium carbonate?
- (ii) 12.8 grams of Methane?

Ans :

MAIN 2012

The molecular mass of $\text{NH}_3 = 14 + 1 \times 3 = 17 \text{ u}$
Thus (b) is correct option.

14. The molecular mass of benzene is :

- (a) 72 g (b) 28 g
(c) 78 g (d) 68 g

Ans :

COMP 2014

Molecular mass benzene

$$= (\text{Atomic Mass of carbon} \times 6) \\ + (\text{Atomic mass of hydrogen} \times 6) \\ = (12 \times 6) + (1 \times 6) = 78 \text{ g}$$

Thus (c) is correct option.

15. If empirical formula of an organic compound is CH_2O , then its molecular formula can be :

- (a) $\text{C}_6\text{H}_{12}\text{O}_6$ (b) $\text{C}_2\text{H}_4\text{O}$
(c) $\text{C}_3\text{H}_6\text{O}$ (d) $\text{C}_2\text{H}_2\text{O}_2$

Ans :

MAIN 2016

The molecular mass of CH_2O is

$$12 + (2 \times 1) + 16 = 30 \text{ g}$$

The molecular mass of $\text{C}_6\text{H}_{12}\text{O}_6$ is

$$(12 \times 6) + (12 \times 1) + (6 \times 16) = 180 \text{ g}$$

As the molecular mass of $\text{C}_6\text{H}_{12}\text{O}_6$ is the multiple of 30.

Thus (a) is correct option.

ASSERTION AND REASON

16. **Assertion :** The molecular weight of carbon dioxide (CO_2) is 44 g/mol.

Reason : The molecular weight is the number which represents how many times one molecule of a substance is heavier than $1/12$ th the mass of an atom of Carbon-12.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

COMP 2005

The molecular weight of CO_2 is indeed 44 g/mol and molecular weight is defined based on its comparison to $1/12$ th the mass of Carbon-12. Therefore, both the assertion and the reason are

correct, with the reason correctly explaining the assertion.

Thus (a) is correct option.

17. **Assertion :** Avogadro's law states that equal volumes of all gases, under the same conditions of temperature and pressure, contain equal numbers of molecules.

Reason : Avogadro's law applies to solids, liquids and gases.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

SQP 2010

While the assertion is true about Avogadro's law, the reason is false because Avogadro's law only applies to gases, not solids or liquids.

Thus (c) is correct option.

18. **Assertion :** The molar volume of a gas at STP is 22.4 liters.

Reason : Molar volume is the volume occupied by one mole of a gas at standard temperature and pressure.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

MAIN 2002

The assertion correctly states the molar volume at STP and the reason accurately explains the concept of molar volume.

Thus (a) is correct option.

19. **Assertion :** The vapour density of a gas is always a unitless quantity.

Reason : Vapour density is the ratio of the mass of a certain volume of gas to the mass of the same volume of hydrogen under the same conditions of temperature and pressure.

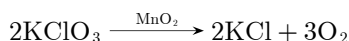
- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

COMP 2018

Ans :

MAIN 2013



- (i) Since, 3×22.4 L of O_2 is produced from 2×122.5 g of KClO_3 .

Hence, 6.72 L O_2 will be produced from

$$= \frac{2 \times 122.5}{3 \times 22.4} \times 6.72$$

$$= 24.5 \text{ g of } \text{KClO}_3$$

- (ii) 3×22.4 L contains 3 moles of oxygen.

Hence, 6.72 L will contain

$$= \frac{3}{3 \times 22.4} \times 6.72$$

$$= 0.3 \text{ moles.}$$

$$\text{No. of molecules} = 0.3 \times 6 \times 10^{23}$$

$$= 18 \times 10^{22} \text{ molecules.}$$

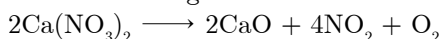
- (iii) Since, 1 mole CO_2 occupies 22.4 L

Hence, 0.01 moles will occupy

$$= 22.4 \times 0.01 \text{ L} = 0.22 \text{ L}$$

68. (i) A gas of mass 32 g has a volume of 20 litres at S.T.P. Calculate the gram molecular weight of the gas.

- (ii) How much calcium oxide is formed when 82 g of calcium nitrate is heated? Also find the volume of nitrogen dioxide evolved:



$$[\text{Ca} = 40, \text{N} = 14, \text{O} = 16]$$

Ans :

SQP 2016

- (i) Since, 20 litres of a gas contains 32 g.

Hence, 22.4 litres will contain

$$= \frac{32}{20} \times 22.4 \text{ g}$$

$$= 35.84 \text{ g}$$

Hence, the molecular weight of the gas is 35.84 g.

- (ii) Molecular weight of $\text{Ca}(\text{NO}_3)_2$

$$= 40 + 2 \times [14 + 3 \times 16]$$

$$= 40 + 2 \times [14 + 48]$$

$$= 40 + 124 = 164 \text{ g}$$

Molecular weight of CaO

$$= 40 + 16 = 56 \text{ g}$$

Since, 164 g of $\text{Ca}(\text{NO}_3)_2$ forms 56 g of CaO .

Hence, 82 g of $\text{Ca}(\text{NO}_3)_2$ will form

$$= \frac{56}{164} \times 82 \text{ g} = 28 \text{ g of } \text{CaO}.$$

Now, 2×164 g of $\text{Ca}(\text{NO}_3)_2$ produces 4×22.4 litres of NO_2

Hence, 82 g of $\text{Ca}(\text{NO}_3)_2$ will produce

$$= \frac{4 \times 22.4}{2 \times 164} \times 82 = 22.4 \text{ litres.}$$

69. 4.5 moles of calcium carbonate are reacted with dilute hydrochloric acid.

- (i) Write the equation for the reaction.

- (ii) What is the mass of 4.5 moles of calcium carbonate? (Relative molecular mass of calcium carbonate is 100).

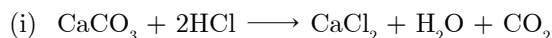
- (iii) What is the volume of carbon dioxide liberated at STP ?

- (iv) What mass of calcium chloride is formed? (Relative molecular mass of calcium chloride is 111).

- (v) How many moles of HCl are used in this reaction?

Ans :

COMP 2010



$$(ii) \quad n = \frac{W}{M}$$

$$W = n \times M$$

$$W = 4.5 \times 100 = 450 \text{ g,}$$

where

n = Number of moles

W = Weight (mass)

M = Molecular weight of CaCO_3 .

- (iii) 1 mole of CaCO_3 liberates 22.4 litres of CO_2

Hence, 4.5 moles of CaCO_3 will liberate $\frac{22.4}{1} \times 4.5 = 100.8$ litres of CO_2

or

100 g of CaCO_3 produces 22.4 litres of CO_2

Hence, 4.5 moles = 450 g of CaCO_3 will produce $\frac{22.4}{100} \times 450 = 100.8$ litres of CO_2

- (iv) 1 mole of CaCO_3 forms 111 g of CaCl_2

4.5 moles of CaCO_3 will form $\frac{111}{1} \times 4.5 = 499.5$ g of CaCl_2

or

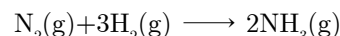
100 g of CaCO_3 produces 111 g of CaCl_2

450 g of CaCO_3 will produce $\frac{111}{100} \times 450 = 499.5$ g of CaCl_2

- (v) 1 mole of CaCO_3 requires 2 moles of HCl

Hence, 4.5 moles of CaCO_3 will require $\frac{2}{1} \times 4.5 = 9$ moles of HCl .

70. (i) 67.2 litres of hydrogen combines with 44.8 litres of nitrogen to form ammonia under specific conditions as:



Calculate the volume of ammonia produced.

What is the other substance, if any, that

DIRECTION : Give one word or phrase for the following :

- 27.** The ratio of the mass of a certain volume of gas to the mass of an equal volume of hydrogen under the same conditions of temperature and pressure.

Ans : COMP 2014

Vapour density

- 28.** The formula that represents the simplest ratio of the various elements present in one molecule of the compound.

Ans : MAIN 2019

Empirical formula

DIRECTION : Answer the following:

- 29.** State Gay-Lussac's law of combining volumes.

Ans : SQP 2011

Whenever gases combine chemically, they do so in volumes which bear a simple whole number ratio to each other as well as to the product, if gaseous, provided the conditions of temperature and pressure remains constant.

- 30.** Define atomicity of a gas.

Ans : SQP 2023

Atomicity of a gas is the number of atoms present in one molecule of a gas.

- 31.** Differentiate between $2H$ and H_2 .

Ans : SQP 2001

$2H$ represents two atoms of hydrogen. H_2 represents one molecule of hydrogen.

- 32.** What is the value of Avogadro's number ?

Ans : COMP 2005

Avogadro's number, $N_A = 6.022 \times 10^{23}$

- 33.** The following question refers to one mole of Chlorine. What is the volume occupied by this gas at S.T.P.?

Ans : SQP 2000

22.4 dm^3 or 22.4 litres

- 34.** Explain why following statement is incorrect:
1 gram of any gas occupies 22.4 litres at S.T.P.

Ans : MAIN 2010

1 mole of a gas at S.T.P. occupies 22.4 litres.

- 35.** Define molar volume of a gas. What is the molar volume of nitrogen at S.T.P. ?

Ans : COMP 2017

Molar volume of a gas is the volume occupied by one mole of a gas at S.T.P. For example, molar volume of nitrogen at S.T.P. is 22.4 litres.

TWO MARKS QUESTIONS

- 36.** Define the following terms:

- (a) Molar volume
(b) Normal salt

Ans : MAIN 2024

- (a) **Molar volume :** Molar volume refers to the volume occupied by one mole of a substance under specific conditions of temperature and pressure.
(b) **Normal salt :** A normal salt is created when a metal or a group of element behaving like a metal completely replaces replaceable hydrogen atom in an acid mole.

- 37.** How will you calculate percentage of an element in a compound ?

Ans : SQP 2023

Percentage of an element in a compound is given as :
Percentage of an element in a compound
$$= \frac{\text{Total weight of the element in the compound}}{\text{Molecular weight of the compound}} \times 100$$

- 38.** State :

- (a) Gay Lussac's law of gaseous volumes
(b) Avogadro's law.

Ans : COMP 2019

- (a) Gay Lussac's law of gaseous volumes : It states that whenever gases react they always do so in volumes which bear a simple whole number ratio to one another and the products, if gaseous all volumes being measured under similar conditions of temperature and pressure.
(b) Avogadro's law : It states that equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules.

in the cylinder?

- (c) How many molecules of ammonia are present in the cylinder? [N = 14, H = 1]

Ans :

MAIN 2014

- (i) According to Avogadro, under the similar conditions of temperature and pressure, equal volumes of all gases contain equal number of molecules.

- (ii) (a) Molecular wt. of Ammonia (NH_3) = 14 + 3 = 17 g

Now, volume of 17 g NH_3 at S.T.P. = 22.4 L

Hence, Volume of 68 g NH_3 at S.T.P.

$$= \frac{22.4}{17} \times 68 = 89.6 \text{ L}$$

- (b) Number of moles (n)

$$= \frac{\text{Weight of the substance (W)}}{\text{Molecular wt. of the substance (M)}}$$

$$= \frac{68}{17} = 4 \text{ moles}$$

- (c) Number of molecules in 1 mole

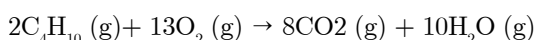
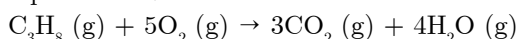
$$= 6.023 \times 10^{23}$$

Hence, Number of molecules in 4 moles

$$= 4 \times 6.023 \times 10^{23}$$

$$= 2.4092 \times 10^{24} \text{ molecules}$$

74. (i) LPG stands for liquefied petroleum gas. Varieties of LPG are marketed including a mixture of propane (60%) and butane (40%). If 10 litre of this mixture is burnt, find the total volume of carbon dioxide gas added to the atmosphere. Combustion reactions can be represented as:



- (ii) Calculate the percentage of nitrogen and oxygen in ammonium nitrate. [Relative molecular mass of ammonium nitrate is 80, H = 1, N = 14, O = 16].

Ans :

SQP 2010

- (i) Quantity of propane = 60% of 10 L

$$= \frac{10 \times 60}{100} = 6 \text{ litres}$$

Quantity of butane = 40% of 10 L

$$= \frac{10 \times 40}{100} = 4 \text{ litres}$$

Now, 1 volume of propane gives 3 volumes of CO_2

6 litres of propane will give $\frac{3}{1} \times 6 = 18$ litres

of CO_2

Also, 2 volumes of butane produces 8 volumes of CO_2

4 litres of butane will produce $\frac{8}{2} \times 4 = 16$ litres of CO_2

Hence, Total volume of CO_2 = 18 + 16 = 34 litres

- (ii) Molecular mass of ammonium nitrate $[\text{NH}_4\text{NO}_3]$ = 14 + 4 + 14 + 48 = 80 g

$$\% \text{ of N} = \frac{28}{80} \times 100 = 35 \%$$

$$\% \text{ of O} = \frac{48}{80} \times 100 = 60 \%$$

75. An organic compound with Vapour density of 94 contains C = 12.67%, H = 2.13% and Br = 85.11%. Find the molecular formula.

Ans :

COMP 2011

Element	%	Atomic mass	Relative number of atoms	Simple ratio
C	12.67	12	1.05	1
H	2.13	1	2.13	2
Br	85.11	80	1.06	1

Empirical formula = CH_2Br

Empirical formula weight = 94

Molecular weight = 2 $\times$ Vapour density

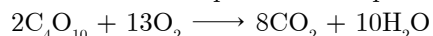
$$= 2 \times 94 = 188.$$

$$\text{Hence, } n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{188}{94} = 2$$

Hence, Molecular formula = $\text{C}_2\text{H}_4\text{Br}_2$

76. Solve the following:

- (i) What volume of oxygen is required to burn completely 90 dm^3 of butane under similar conditions of temperature and pressure?



- (ii) The vapour density of a gas is 8. What would be the volume occupied by 24.0 g of the gas at STP?

- (iii) A vessel contains X number of molecules of hydrogen gas at a certain temperature and pressure. How many molecules of nitrogen gas would be present in the same vessel under the same conditions of temperature and pressure?

Ans :

MAIN 2013

Hence, vols of HCl produced at S.T.P. = 80 mL
(vol. of Cl₂ required = 40 × 2 = 80 mL)

- 100.** Calculate the mass of 2.8 litres of CO₂ at S.T.P.

Ans :

COMP 2011

We know that

1 mole of CO₂ has mass = 44 g

Also, 1 mole of CO₂ has volume at S.T.P.
= 22.4 litres

22.4 L of CO₂ at S.T.P. has mass = 44 g

Hence, 2.8 L of CO₂ at S.T.P. has mass
= $\frac{44}{22.4} \times 2.8 = 5.5$ g

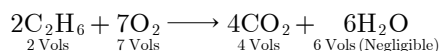
Mass of CO₂ = 5.5 g

- 101.** 2500 cc of oxygen was used with 600 cc of ethane (C₂H₆). Calculate the volume of unused oxygen and volume of carbon dioxide formed, after writing the balanced equation.

Ethane + Oxygen → Carbon dioxide + water

Ans :

MAIN 2013



From the above equation

2 vols of C₂H₆ require 7 vols of O₂

600 cc of C₂H₆ requires O₂ = $\frac{7}{2} \times 600$
= 2100 cc

2 vols of C₂H₆ produce CO₂ = $\frac{4}{2} \times 600$
= 1200 cc

Volume of O left unreacted = 2500 – 2100
= 400 cc

Vol of CO₂ produced = 1200 cc

- 102.** Calculate the percentage of iron in K₃[Fe(CN)₆]

Ans :

SQP 2015

Molecular mass of K₃[Fe(CN)₆]

$$= (3 \times 39) + (56) + (6 \times 12) + (6 \times 14) \\ = 117 + 56 + 72 + 84 = 329$$

Percentage of iron in K₃[Fe(CN)₆]

$$= \frac{56}{329} \times 100 = 17.02$$

- 103.** A compound has the following percentage composition : C = 40%, H = 6.7%, O = 53.3%. The vapour density of the compound is 30. Calculate its molecular formula [C = 12, H = 1, O = 16].

Ans :

MAIN 2017

Element	% age	Atomic mass	% age	Simplest Atomic ratio	Simplest Whole no. ratio
			Atomic mass		
Carbon	40.0	12	$\frac{40}{12}$ = 3.33	$\frac{3.33}{3.33}$ = 1	1
Hydrogen	6.7	1	$\frac{6.7}{1}$ = 6.7	$\frac{6.7}{3.33}$ = 2	2
Oxygen	53.3	16	$\frac{53.3}{16}$ = 3.33	$\frac{3.33}{3.33}$ = 1	1

Empirical formula = C₁H₂O₁ = CH₂O

Empirical formula mass

$$= 12 + 2 \times 1 + 16$$

$$= 12 + 2 + 16 = 30$$

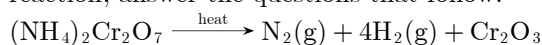
$$\text{V.D.} = 30$$

Molecular mass = 2 × 30 = 60

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

$$= 2 \times \text{C}_1\text{H}_2\text{O}_1 = \text{C}_2\text{H}_4\text{O}_2$$

- 104.** Consider the following reaction and based on the reaction, answer the questions that follow:



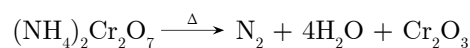
Calculate:

- the quantity in moles of (NH₄)₂Cr₂O₇ if 63 g of (NH₄)₂Cr₂O₇ is heated.
- the quantity in moles of nitrogen formed.
- the volume in litres or dm³ of N₂ evolved at S.T.P.
- the mass in grams of Cr₂O₃ formed at the same time.

[Atomic masses: H = 1, Cr = 52, N = 14]

Ans :

COMP 2019



- (i) Number of moles = $\frac{\text{Given mass}}{\text{Molecular mass}}$
= $\frac{63}{252} = 0.25$ moles

(ii) 0.25 moles

(iii) 252 g (NH₄)₂Cr₂O₇ produces 22.4 L of N₂

Hence, 63 g (NH₄)₂Cr₂O₇ will produce

$$\frac{22.4}{252} \times 63 = 5.6 \text{ L of N}_2$$

(iv) Since, 252 g (NH₄)₂Cr₂O₇ produces 152 g Cr₂O₃

Hence, 63 g (NH₄)₂Cr₂O₇ will produce

Molecular formula of fluoride of Phosphorus = PF_5 .

80. (i) Calculate the percentage of phosphorus in the fertilizer super-phosphate $\text{Ca}(\text{H}_2\text{PO}_4)_2$.
 (ii) A metal M forms a volatile chloride containing 65.5% chlorine. If the density of the chloride relative to hydrogen is 162.5, find the molecular formula of the chloride [$M = 56$].

Ans :

SQP 2001

- (i) Molecular mass of $\text{Ca}(\text{H}_2\text{PO}_4)_2$
 $= 40 + 4 \times 1 + 2 \times 31 + 8 \times 16$
 $= 40 + 4 + 62 + 128 = 234$
 234 g of $\text{Ca}(\text{H}_2\text{PO}_4)_2$ contains P = 62 g
 $\% \text{ age of P in } \text{Ca}(\text{H}_2\text{PO}_4)_2 = \frac{62}{234} \times 100$
 $= 26.5\%$

- (ii) Step 1. To calculate the empirical formula of the compound.

Element	% age	Atomic mass	% age Atomic mass	Simplest Atomic ratio	Simplest Whole no. ratio
M	34.5	56	$\frac{34.5}{56}$ $= 0.61$	$\frac{0.61}{0.61}$ $= 1$	1
Cl	65.5	35.5	$\frac{65.5}{35.5}$ $= 1.84$	$\frac{1.84}{0.61}$ $= 3$	3

Empirical formula = M_1Cl_3

Step 2. To calculate molecular formula of the compound.

$$\begin{aligned}\text{Empirical formula mass} &= 56 + 3 \times 35.5 \\ &= 56 + 106.5 = 162.5\end{aligned}$$

$$\text{Vapour density} = 162.5$$

$$\text{Molecular mass} = 2 \times \text{Vapour density}$$

$$= 2 \times 162.5 = 325$$

$$\begin{aligned}n &= \frac{\text{Molecular mass}}{\text{Empirical formula mass}} \\ &= \frac{325}{162.5} = 2\end{aligned}$$

$$\text{Molecular formula} = n \times \text{Empirical formula}$$

$$= 2 \times \text{M}_1\text{Cl}_3 = \text{M}_2\text{Cl}_6$$

81. (i) Calculate the percentage of platinum in ammonium chloroplatinate $(\text{NH}_4)_2[\text{PtCl}_6]$.
 (ii) The percentage composition of sodium phosphate as determined by analysis is 42.1% sodium, 18.9% phosphorus and 39% oxygen.

Find the empirical formula of the compound.

Ans :

MAIN 2002

- (i) Molecular mass of ammonium chloroplatinate, $(\text{NH}_4)_2\text{PtCl}_6$
 $= 2(14 + 4) + 195 + 6 \times 35.5$
 $= 36 + 195 + 213 = 444$
 Percentage of Pt in ammonium chloroplatinate
 $= \frac{195}{444} \times 100 = 43.92$

- (ii) In sodium phosphate

$$\% \text{ age of Na} = 42.1$$

$$\% \text{ age of P} = 18.9$$

$$\begin{aligned}\% \text{ age of O} &= 100 - (42.1 + 18.9) \\ &= 100 - 61 = 39\end{aligned}$$

To calculate the empirical formula :

Element	% age	At. mass	% age Atomic Mass	Simplest Atomic ratio	Simplest Whole no. ratio
Sodium (Na)	42.1	23	$\frac{42.1}{23}$ $= 1.83$	$\frac{1.83}{0.61}$ $= 3$	3
Phosphorus (P)	18.9	31	$\frac{18.9}{31}$ $= 0.61$	$\frac{0.61}{0.61}$ $= 1$	1
Oxygen (O)	39	16	$\frac{39}{16}$ $= 2.43$	$\frac{2.43}{0.61}$ $= 4$	4

$$\text{Empirical formula} = \text{Na}_3\text{P}_1\text{O}_4 \text{ or } \text{Na}_3\text{PO}_4$$

82. Determine the empirical formula of the compound whose composition by mass is : 42% nitrogen, 48% oxygen and 9% hydrogen.
 $[\text{H} = 1, \text{N} = 14, \text{O} = 16]$

Ans :

COMP 2000

To calculate the empirical formula of the compound.

Element	% age	Atomic mass	% age Atomic mass	Simplest Atomic ratio	Simplest Whole no. ratio
Nitrogen	42	14	$\frac{42}{14} = 3$	$\frac{3}{3} = 1$	1
Oxygen	48	16	$\frac{48}{16} = 3$	$\frac{3}{3} = 1$	1
Hydrogen	9	1	$\frac{9}{1} = 9$	$\frac{9}{3} = 3$	3

$$\text{Empirical formula} = \text{N}_1\text{O}_1\text{H}_3 \text{ or } \text{NOH}_3$$

$$\text{Empirical formula} = \text{CH}_2\text{O}$$

$$\begin{aligned}\text{Empirical formula weight} &= 12 + 2 + 16 \\ &= 30\end{aligned}$$

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula} \\ &= \text{C}_6\text{H}_{12}\text{O}_6.\end{aligned}$$

(iii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
C	26.67	12	2.22	1
H	2.22	1	2.22	1
O	71.11	16	4.44	2

$$\text{Empirical formula} = \text{CHO}_2$$

$$\begin{aligned}\text{Empirical formula weight} &= 12 + 1 + 32 = 45 \\ n &= \frac{\text{Molecular weight}}{\text{Empirical formula weight}} \\ &= \frac{90}{45} = 2\end{aligned}$$

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula} \\ &= \text{C}_2\text{H}_2\text{O}_4\end{aligned}$$

(iv)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
H	2.47	1	2.47	2
P	38.25	31	1.23	1
O	59.28	16	3.70	3

$$\text{Empirical formula} = \text{H}_2\text{PO}_3$$

$$\begin{aligned}\text{Empirical formula weight} &= 2 + 31 + 48 = 81 \\ n &= \frac{\text{Molecular weight}}{\text{Empirical formula weight}} \\ &= \frac{161.94}{81} \\ &= 1.99 \cong 2\end{aligned}$$

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula} \\ &= \text{H}_4\text{P}_2\text{O}_6.\end{aligned}$$

(v)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
Cu	84.11	64	1.3	1
C	15.89	12	1.3	1

$$\text{Empirical formula} = \text{CuC}.$$

$$\text{Empirical formula weight} = 64 + 12 = 76$$

$$\begin{aligned}n &= \frac{\text{Molecular weight}}{\text{Empirical formula weight}} \\ &= \frac{151}{76} = 1.98 \cong 2\end{aligned}$$

Hence, Molecular formula

$$\begin{aligned}&= n \times \text{Empirical formula} \\ &= \text{Cu}_2\text{C}_2\end{aligned}$$

- 109.** The compound A has the following percentage composition by mass : carbon 26.7%, oxygen 71.1%, hydrogen 2.2%. Determine the empirical formula of A. (Work to one decimal place) (H = 1; C = 12; O = 16). If the relative molecular mass of A is 90, what is the molecular formula of A ?

Ans :

SQP 2020

To calculate the empirical formula of the compound.

Element	% age	Atomic mass	% age	Simplest Atomic ratio	Simplest Whole no. ratio
			Atomic mass		
Carbon	26.7	12	$\frac{26.7}{12}$ = 2.2	$\frac{2.2}{2.2}$ = 1	1
Oxygen	71.1	16	$\frac{71.1}{16}$ = 4.4	$\frac{4.4}{2.2}$ = 2	2
Hydrogen	2.2	1	$\frac{2.2}{1}$ = 2.2	$\frac{2.2}{2.2}$ = 1	1

$$\text{Empirical formula of the compound} = \text{C}_1\text{O}_2\text{H}_1$$

To calculate molecular formula of the compound.

$$\begin{aligned}\text{Empirical formula mass} &= 12 + 2 \times 16 + 1 \times 1 \\ &= 12 + 32 + 1 = 45\end{aligned}$$

$$\text{Molecular mass} = 90$$

$$\begin{aligned}n &= \frac{\text{Molecular mass}}{\text{Empirical formula mass}} \\ &= \frac{90}{45} = 2\end{aligned}$$

$$\begin{aligned}\text{Molecular formula} &= n \times \text{Empirical formula} \\ &= 2 \times \text{C}_1\text{O}_2\text{H}_1 = \text{C}_2\text{O}_4\text{H}_2 \\ &= \text{H}_2\text{C}_2\text{O}_4\end{aligned}$$

- 110.** Calculate the percentage of Sodium [Na] in $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ [H = 1, B = 11, O = 16, N = 23]

Ans :

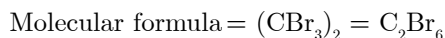
MAIN 2012

$$\text{Molecular mass of } \text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$$

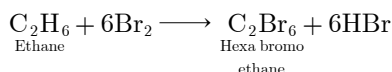
$$n = \frac{\text{Molecular Formula Mass}}{\text{Empirical Formula Mass}}$$

$$= \frac{504}{252}$$

$$n = 2$$



(iii) Substitution Reaction



86. (a) The percentage composition of a gas is : Nitrogen 82.35%, Hydrogen 17.64%
Find the empirical formula of the gas. [N = 14, H = 1]
- (b) (i) If 150 cc of gas A contains X molecules, how many molecules of gas B will be present in 75 cc of B ?
The gases A and B all under the same conditions of temperature and pressure.
- (ii) Name the law on which the above problem is based.

Ans :

COMP 2018

(a)

Symbol	Percentage	Atomic wt.	Relative Ratio	Simplest Ratio
Nitrogen	82.35%	14	$\frac{82.35}{14}$ $= 5.88$	$\frac{5.88}{5.88} = 1$
Hydrogen	17.64%	1	$\frac{17.64}{1}$ $= 17.64$	$\frac{17.64}{5.88} = 3$
Empirical Formula = $\text{N}_1\text{H}_3 = \text{NH}_3$				

- (b) (i) 150 cc of gas A contain X molecules 150cc of gas B will also contain X molecules
75 cc of gas B will contain $\frac{X}{2}$ molecules under the same conditions of temperature and pressure.
- (ii) Avogadro's law
87. (i) Determine the empirical formula of a compound containing 47.9% potassium, 5.5% beryllium and 46.6% fluorine by mass.
(Atomic weight of Be = 9; F = 19; K = 39)
Work to one decimal place.
- (ii) Given that the relative molecular mass of copper oxide is 80, what volume of ammonia (measured at S.T.P.) is required to completely reduce 120 g of copper oxide ?
The equation for the reaction is :
 $3\text{CuO} + 2\text{NH}_3 \longrightarrow 3\text{Cu} + 3\text{H}_2\text{O} + \text{N}_2$
(Volume occupied by 1 mole of gas at S.T.P.

is 22.4 litres).

Ans :

SQP 2006

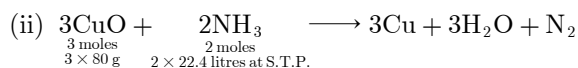
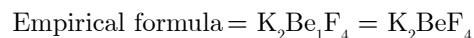
$$\text{K} = 47.9\%$$

$$\text{Be} = 5.5\%$$

$$\text{F} = 46.6\%$$

Atomic weights of Be = 9, F = 19, K = 39

Element	% age	Atomic mass	% age	Simplest Atomic ratio	Simplest Whole no. ratio
			Atomic Mass		
K	47.9	39	$\frac{47.9}{39}$ $= 1.22$	$\frac{1.22}{0.61}$ $= 2$	2
Be	5.5	9	$\frac{5.5}{9}$ $= 0.61$	$\frac{0.61}{0.61}$ $= 1$	1
F	46.6	19	$\frac{46.6}{19}$ $= 2.45$	$\frac{2.45}{0.61}$ $= 4$	4

240 g of CuO requires NH_3 for reduction

$$= 2 \times 22.4 \text{ litres at S.T.P.}$$

120 g of CuO requires NH_3 for reduction

$$= \frac{2 \times 22.4}{240} \times 120$$

$$= 22.4 \text{ L}$$

Volume of NH_3 required at S.T.P. = 22.4 L

88. Calculate the percentage of :

- (i) Fluorine
(ii) Sodium and
(iii) Aluminium
in sodium aluminium fluoride [Na_3AlF_6], to the nearest whole number.
[Atomic Mass : Na = 23, Al = 27, F = 19]

Ans :

MAIN 2020



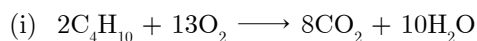
$$3(23) + 1(27) + 6(19) = 210$$

$$(i) \% \text{ of Fluorine} = \frac{114}{210} \times 100 = 54.28\%$$

$$(ii) \text{ Sodium} = \frac{69}{210} \times 100 = 32.85\%$$

$$(iii) \text{ Aluminium} = \frac{27}{210} \times 100 = 12.85\%$$

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2 Volumes of butane requires 13 volumes of oxygen.

Hence, 90 dm³ of butane requires

$$\frac{13}{2} \times 90 = 585 \text{ dm}^3 \text{ of oxygen}$$

(ii) V.D. = 8,

$$\text{R.M.M} = 2 \times \text{V.D.} = 16$$

16 g contains 22.4 L

Hence, 24 g will contain

$$\frac{22.4}{16} \times 24 = 33.6 \text{ L}$$

(iii) X molecules

7. (i) State the volume occupied by 40 gm of methane at STP, if its vapour density (V.D.) is 8.

(ii) Calculate the number of moles present in 160 gm of NaOH.

[Atomic Mass : Na = 23, H = 1, O = 16]

Ans :

COMP 2020

(i) Vapour density of Methane = 8

$$\text{Molecular Mass} = 2 \times \text{V.D.}$$

$$= 2 \times 8 = 16 \text{ gm}$$

16 gm of methane occupies of 22.4l at S.T.P.

1 gm of methane occupies a volume of $\frac{22.4}{16}$

40 gm of methane occupies a volume of

$$\frac{22.4}{16} \times 40 = 56 \text{ gm}$$

(ii) Molecular mass of NaOH = 23 + 1 + 16 = 40
40 gm of NaOH equal to 1 mole

$$1 \text{ gm of NaOH equal to } \frac{1}{40}$$

$$160 \text{ gm of NaOH equals to } \frac{1}{40} \times 160 = 4 \text{ moles}$$

78. (i) A compound has the following percentage composition by mass:

Carbon 14.4%, hydrogen 1.2% and chlorine 84.5%. Determine the empirical formula of this compound. Work correct to 1 decimal place. (H = 1; C = 12; Cl = 35.5)

(ii) The relative molecular mass of this compound is 168, so what is its molecular formula?

(iii) By what type of reaction could this compound be obtained from ethyne?

Ans :

SQP 2009

(i)

Element	% of composition	Atomic mass	Relative number of moles	Simple ratio of moles
C	14.4%	12	$14.4 \div 12 = 1.2$	$1.2 \div 1.2 = 1$
H	1.2%	1	$1.2 \div 1 = 1.2$	$1.2 \div 1.2 = 1$
Cl	84.5%	35.5	$84.5 \div 35.5 = 2.4$	$2.4 \div 1.2 = 2$

Empirical formula of compound = CHCl_2

(ii) Empirical mass of compound

$$= 12 + 1 + 71 = 84$$

Relative molecular mass of compound = 168

$n \times \text{Empirical mass} = \text{Relative molecular mass}$

$$n \times 84 = 168$$

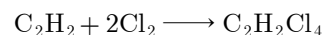
$$n = 168 \div 84 = 2$$

Molecular formula of compound

$$= n \times \text{Empirical formula}$$

$$= 2 \times \text{CHCl}_2 = \text{C}_2\text{H}_2\text{Cl}_4$$

(iii) The compound $\text{C}_2\text{H}_2\text{Cl}_4$ can be obtained from ethyne by addition reaction.



79. 112 cc of a gaseous fluoride of phosphorus has a mass of 0.63 g. Calculate the relative molecular mass of the fluoride. If the molecule of the fluoride contains only one atom of phosphorus, then determine the formula of the phosphorus fluoride. [F = 19; P = 31]

Ans :

MAIN 2000

112 cc of gas at S.T.P. has mass = 0.63 g

22400 cc of gas at S.T.P has mass

$$= \frac{0.63}{112} \times 22400 = 126 \text{ g}$$

Molecular mass of gas = 126

Since the gas i.e. fluoride of phosphorus contains one atom of P,

Its formula can be PF_n

$$\text{Molecular mass of } \text{PF}_n = 31 + n(19)$$

$$= 31 + 19n$$

$$31 + 19n = 126$$

$$19n = 126 - 31$$

$$19n = 95$$

$$n = 5$$

According to the equation

(4 + 5 = 9) vols of reactants produce NO = 4 vols.
27 litres of reactants will produce NO

$$= \frac{4}{9} \times 27 = 12 \text{ L}$$

Vols of NO produced = 12 L

95. A hydrocarbon contains 10.5 g of carbon per gram of hydrogen. Calculate the empirical formula.

Ans :

COMP 2012

In the hydrocarbon,

1 g of hydrogen combines with 10.5 g carbon.
percentage age of H in the hydrocarbon

$$= \frac{1}{10.5 + 1} \times 100$$

$$= \frac{100}{11.5} = \frac{1000}{115} = \frac{200}{23} = 8.696$$

percentage age of C = 100 - 8.696 = 91.304

Element	% age	At. Mass	% age Atomic Mass	Simplest Atomic ratio	Simplest Whole no. ratio
C	91.304	12	$\frac{91.304}{12}$ = 7.609	$\frac{7.609}{7.609}$ = 1	5
H	8.696	1	$\frac{8.696}{1}$ = 8.696	$\frac{8.696}{7.609}$ = 1.142	7

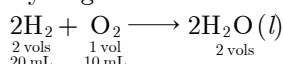
Empirical formula of the hydrocarbon = C₅H₇

96. 20 mL each of oxygen and hydrogen and 10 mL of carbon monoxide are exploded in an enclosure. What will be the volume and composition of the mixture of the gases when they are cooled to room temperature ?

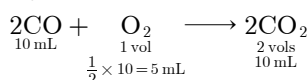
Ans :

SQP 2017

(a) Hydrogen



(b) Carbon monoxide



Total vol. of O₂ used = 10 + 5 = 15 mL

Vol. of O₂ left unreacted = 20 - 15 = 5 mL

Vols of CO₂ produced = 10 mL

Vols of H₂O = Negligible

97. What percentage of water is found Na₂S·9H₂O ?

Ans :

MAIN 2013

Molecular weight of Na₂S·9H₂O

$$= 46 + 32 + 9 \times 18$$

$$= 78 + 162 = 240$$

Percentage of water is Na₂S · 9H₂O

$$= \frac{162}{240} \times 100 = 67.5$$

98. A hydrocarbon contains 17.2% H. If the vapour density is 29, calculate its molecular formula.

Ans :

COMP 2020

(i) To calculate empirical formula of the compound.

Element	% age	Atomic mass	% age Atomic mass	Simplest Atomic ratio	Simplest Whole no. ratio
Carbon	82.8	12	$\frac{82.8}{12}$ = 6.9	$\frac{6.9}{6.9}$ = 1	2
Hydrogen	17.2	1	$\frac{17.2}{1}$ = 17.2	$\frac{17.2}{6.9}$ = 2.5	5

Empirical formula = C₂H₅

(ii) To calculate molecular formula

Empirical formula mass

$$2 \times 12 + 5 \times 1 = 29$$

Vapour density = 29

Molecular mass = 2 × Vapour density

$$= 2 \times 29 = 58$$

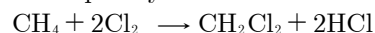
$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

$$= \frac{58}{29} = 2$$

Molecular formula = n × Empirical formula

$$= 2 \times \text{C}_2\text{H}_5 = \text{C}_4\text{H}_{10}$$

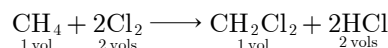
99. Calculate the volume of HCl gas formed and chlorine gas required when 40 mL of methane reacts completely with chlorine at S.T.P.



Ans :

MAIN 2021

The given equation is



According to the above equation

1 vol of CH₄ produces HCl = 2 vol (at S.T.P.)

40 vols of CH₄ produces HCl at S.T.P.

$$= 2 \times 40 = 80 \text{ mL}$$

- 83.** Find the empirical formula and the molecular formula of an organic compound from the data given below :

C = 75.92%, H = 6.32% and N = 17.76%

The vapour density of the compound is 39.5.

$$[C = 12, H = 1, N = 14]$$

Ans :

MAIN 2019

Symbol	Percentage	At. Weight	Relative ratio	Simplest ratio
C	75.92%	12	$\frac{75.92}{12}$ = 6.32	$\frac{6.32}{1.26}$ = 5
H	6.32%	1	$\frac{6.32}{1}$ = 6.32	$\frac{6.32}{1.26}$ = 5
N	17.76%	14	$\frac{17.76}{14}$ = 1.26	$\frac{1.26}{1.26}$ = 1

Empirical Formula = C_5H_5N

Vapour density = 39.5

Molecular Mass = $2 \times \text{V.D.} = 2 \times 39.5 = 79$

Empirical formula Mass

$$= 12 \times 5 + 5 \times 1 + 1 \times 14$$

$$= 60 + 5 + 14 = 79$$

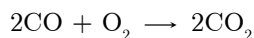
$$n = \frac{\text{Molecular formula mass}}{\text{Empirical formula mass}}$$

$$= \frac{79}{79} = 1$$

Thus, both Empirical formula and Molecular formula are C_5H_5N .

- 84.** Calculate :

- (i) The amount of each reactant required to produce 750 mL of carbon dioxide, when two volumes of carbon monoxide combine with one volume of oxygen to produce two volumes of carbon dioxide.



- (ii) The volume occupied by 80 g of carbon dioxide at STP.

- (iii) Calculate the number of molecules in 4.4 gm of CO_2 .

[Atomic mass of C = 12, O = 16]

Ans :

SQP 2020



- (a) 2 vol. of CO_2 is formed from 2 vol. of CO.

1 vol. of CO_2 is formed from $\frac{2}{2} = 1$ vol. of CO.

750 mL of CO_2 is formed from 750 mL of CO.

- (b) 2 vol. of CO_2 is formed from 1 vol. of O_2 .

1 vol. of CO_2 is formed from $\frac{1}{2}$ vol. of O_2 .

750 mL of CO_2 is formed from $\frac{1}{2} \times 750$ mL of $O_2 = 375$ mL of O_2

- (ii) CO_2

Molecular Mass = $[12 + 16 \times 2] = 44$ g

44 g of CO_2 occupies 22.4 l,

1 g of CO_2 occupies $\frac{22.4}{44}$

80 g of CO_2 occupies $\frac{22.4}{44} \times 80 = \frac{448}{11} = 40.7$ litres

- (iii) 44 g of CO_2 contain 6.022×10^{23} molecules

1 g of CO_2 contain $\frac{6.022 \times 10^{23}}{44}$ molecules

4.4 g of CO_2 contain $\frac{6.022 \times 10^{23}}{44} \times 4.4$ g

$= 6.022 \times 10^{22}$ molecules

- 85.** A compound X consists of 4.8% carbon and 95.2% bromine by mass.

- (i) Determine the empirical formula of this compound working correct to one decimal place (C = 12; Br = 80).

- (ii) If the vapour density of the compound is 252, what is the molecular formula of the compound ?

- (iii) Name the type of chemical reaction by which X can be prepared from ethane.

Ans :

COMP 2007

- (i)

Element	% age	At. Mass	Relative no. of atoms	Simplest ratio	Simplest Whole no. ratio
C	4.8	12	$\frac{4.8}{12}$	0.4	$\frac{0.4}{0.4} = 1$
Br	95.2	80	$\frac{95.2}{80}$	1.2	$\frac{1.2}{0.4} = 3$

Empirical formula = CBr_3

- (ii) V.D. = 252

Molecular Mass = $2 \times \text{V.D.} = 2 \times 252 = 504$

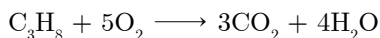
Empirical Formula Mass

$$= C + 3 \times Br = 12 + 3 \times 80$$

$$= 252$$

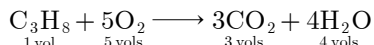
$$\frac{152}{252} \times 63 = 38 \text{ g Cr}_2\text{O}_3$$

- 105.** What volume of propane is burnt for every 500 cc of O_2 used in the reactions under the same conditions ?



Ans :

SQP 2000



According to the above equation

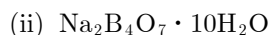
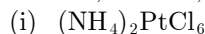
5 vols of O_2 is used for the combustion of 1 vol of C_3H_8

500 cm^3 of O_2 is used for the combustion of C_3H_8

$$= \frac{1}{5} \times 500 = 100 \text{ cm}^3$$

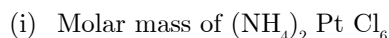
Vol of propane burnt = 100 cm^3

- 106.** Calculate the percentage of underlined elements in the following compounds. (H = 1, C = 12, N = 14, O = 16, B = 11, Na = 23, Pt = 195)



Ans :

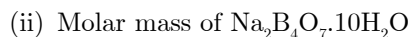
MAIN 2010



$$= (14 + 4) \times 2 + 195 + 6 \times 35.5$$

$$= 36 + 195 + 213 = 444$$

$$\% \text{ of Pt} = \frac{195}{444} \times 100 = 43.9\%$$



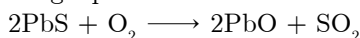
$$= 2 \times 23 + 4 \times 11 + 7 \times 16 + 10 \times 18$$

$$= 46 + 44 + 112 + 180$$

$$= 382 \text{ g}$$

$$\% \text{ of B} = \frac{44}{382} \times 100 = 11.5\%$$

- 107.** Galena, when roasted, reacts according to the following equation:



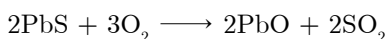
Calculate:

- (a) the weight of PbO formed when 478 g of PbS is roasted .
 (b) the weight of PbS required to produce 5.6 litres of SO_2 at S.T.P.
 (c) the number of moles of Oxygen required at the same time.

$$[\text{Pb} = 207, \text{O} = 16, \text{S} = 32]$$

Ans :

SQP 2017



- (a) Molecular weight of PbS = 207 + 32 = 239 g
 Molecular weight of PbO = 207 + 16 = 223 g
 Now, $2 \times 239 \text{ g}$ of PbS forms $2 \times 223 \text{ g}$ of PbO

Hence, 478 g of PbS will form $\frac{2 \times 223}{2 \times 239} = 446 \text{ g}$ of PbO

- (b) $2 \times 22.4 \text{ dm}^3$ of SO_2 is produced by $2 \times 239 \text{ g}$ of PbS

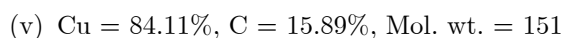
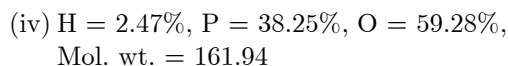
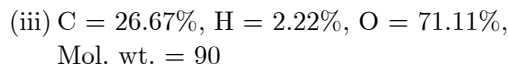
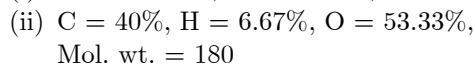
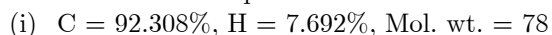
5.6 dm^3 of SO_2 is produced by

$$= \frac{2 \times 239}{2 \times 22.4} \times 5.6 = 59.75 \text{ g}$$

- (c) $2 \times 239 \text{ g}$ of PbS requires 3 moles of O_2

478 g of PbS requires $\frac{3}{2 \times 239} \times 478 = 3$ moles

- 108.** The percentage composition by weight and the molecular weight of some compounds is given below. Find their empirical and molecular formula.



Ans :

COMP 2019

(i)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
C	92.308	12	7.692	1
H	7.692	1	7.692	1

Empirical formula = CH

Empirical formula weight = 12 + 1 = 13

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{78}{13} = 6$$

Molecular formula = $n \times$ Empirical formula

Molecular formula = C_6H_6 .

(ii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
C	40	12	3.33	1
H	6.67	1	6.67	2
O	53.33	16	3.33	1

89. A compound made-up of two elements X and Y has an empirical formula X_2Y . If the atomic weight of X is 10 and that of Y is 5 and the compound has a vapour density 25, find its molecular formula.

Ans :

MAIN 2014

Empirical formula = X_2Y Atomic weight of $X = 10$ Atomic weight of $Y = 5$

V.D. of compound = 25

Molecular mass = $2 \times \text{V.D.} = 2 \times 25 = 50$ Empirical mass = $2 \times 10 + 5$ $= 20 + 5 = 25$

$$n = \frac{\text{Molecular mass}}{\text{Empirical mass}}$$

$$= \frac{50}{25} = 2$$

Molecular formula = $(\text{E.F.})_2$ $= (X_2Y)_2$ $= X_4Y_2$

90. (a) Calculate the empirical formula of the compound having 37.6 % Sodium, 23.1% Silicon and 39.3% Oxygen. (Answer correct to two decimal places)
($O = 16$, $Na = 23$, $Si = 28$)
- (b) The empirical formula of a compound is C_2H_5 . It has a vapour density of 29. Determine the relative molecular mass of the compound and hence its molecular formula.

Ans :

COMP 2017

(a)

Elements	%	Atomic mass	Relative number of atoms	Simplest ratio
Sodium	37.6	23	$\frac{37.6}{23} = 1.6$	$\frac{1.6}{0.8} = 2$
Silicon	23.1	28	$\frac{23.1}{28} = 0.8$	$\frac{0.8}{0.8} = 1$
Oxygen	39.3	16	$\frac{39.3}{16} = 2.4$	$\frac{2.4}{0.8} = 3$

Empirical formula = Na_2SiO_3

- (b) Molecular weight = $2 \times \text{Vapour density (V.D.)}$

$$= 2 \times 29 = 58$$

weight of $C_2H_5 = 24 + 5 = 29$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{58}{29} = 2$$

Thus, molecular formula = $(C_2H_5)_2 = C_4H_{10}$

91. A compound of X and Y has the empirical formula XY_2 . Its vapour density is equal to its empirical formula weight. Determine its molecular formula.

Ans :

SQP 2019

E.F. = XY_2

E.F.W. = V.D.

M.W. = $2 \times \text{V.D.}$ M.W. = $2 \times [\text{E.F.W.}]$ So, molecular formula = $(XY_2)_2 = X_2Y_4$

92. Find the percentage of oxygen in acetic acid.

Ans :

MAIN 2020

Acetic acid is CH_3COOH .

Molecular weight. of acetic acid

$$= 12 + 3 + 12 + 32 + 1 = 60$$

Oxygen present in 60 g of it = 32

$$\begin{aligned} \% \text{ age of oxygen} &= \frac{32}{60} \times 100 = \frac{160}{3} \\ &= 53.33\% \end{aligned}$$

93. Calculate the percentage of water of crystallisation in hydrated copper sulphate $[CuSO_4 \cdot 5H_2O]$.

Ans :

COMP 2023

Molecular mass of $CuSO_4 \cdot 5H_2O$

$$= 63.5 + 32 + (4 \times 16) + 5(2 \times 1) + (16)$$

$$= 63.5 + 32 + 64 + 90 = 249.5 \text{ amu}$$

Percentage of water of crystallisation

$$= \frac{90}{249.5} \times 100 = 36.07\%$$

94. Ammonia may be oxidized to nitrogen monoxide in the presence of a catalyst according to the following equation :

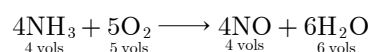


If 27 litres of reactants are consumed, what volume of nitrogen monoxide is produced at the same temperature and pressure ?

Ans :

SQP 2021

The given equation is



$$\begin{aligned}
 &= 2 \times 23 + 4 \times 11 + 7 \times 16 + 10(2 + 16) \\
 &= 46 + 44 + 112 + 180 = 382 \\
 \text{\% age of Na in Na}_2\text{B}_4\text{O}_7 \cdot 10 \text{ H}_2\text{O} \\
 &= \frac{46}{382} \times 100 \\
 &= \frac{23 \times 100}{191} \\
 &= \frac{2300}{191} = 12.04\%
 \end{aligned}$$

111. An acid of Phosphorus has the following percentage composition:
2.47% of Hydrogen, 38.27% of Phosphorus, 59.26% of Oxygen.

Find the empirical formula of this acid and its molecular formula. Given that its relative molecular mass is 162.

Ans :

COMP 2014

Elements	%	Atomic mass	Relative number of atoms	Simplest ratio
Hydrogen	2.47	1	$\frac{2.47}{1} = 2.47$	$\frac{2.47}{1.2} = 2$
Phosphorus	38.27	31	$\frac{38.27}{31} = 1.2$	$\frac{1.2}{1.2} = 1$
Oxygen	59.26	16	$\frac{59.26}{16} = 3.7$	$\frac{3.7}{1.2} = 3$

Empirical formula = H_2PO_3

Molecular weight = 162

Empirical formula weight of H_2PO_3

$$= 2 + 31 + 48 = 81$$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}}$$

The molecular formula = $(\text{H}_2\text{PO}_3)_2 = \text{H}_4\text{P}_2\text{O}_6$

112. How many molecules are present in (the numerical value of Avogadro's number can be used as 6×10^{23})
- 2.2 grams of Carbon dioxide?
 - 16 grams of Sulphur dioxide?
 - 2 grams of Oxygen?
 - 58.5 g of Sodium chloride?
- [C = 12, O = 16, Na = 23, S = 32, Cl = 35.5]

Ans :

SQP 2016

- (a) 44 g of CO_2 contains 6×10^{23} molecules at S.T.P.

$$\begin{aligned}
 2.2 \text{ g of CO}_2 &= \frac{6 \times 10^{23}}{44} \times 2.2 \\
 &= 3 \times 10^{22} \text{ molecules}
 \end{aligned}$$

- (b) 64 g of SO_2 contains 6×10^{23} molecules at S.T.P.

$$\begin{aligned}
 16 \text{ g of SO}_2 &= \frac{6 \times 10^{23}}{64} \times 16 \\
 &= 1.5 \times 10^{23} \text{ molecules}
 \end{aligned}$$

- (c) 32 g of O_2 contains 6×10^{23} molecules at S.T.P.

$$\begin{aligned}
 2 \text{ g of O}_2 &= \frac{6 \times 10^{23}}{32} \times 2 \\
 &= 3.75 \times 10^{22} \text{ molecules}
 \end{aligned}$$

- (d) 58.5 g of NaCl contains 6×10^{23} molecules at S.T.P.

113. Calculate the empirical formula of the compound having following percentage composition:

N = 21.21%, H = 6.06%,

S = 24.24%, O = 48.48%

(H = 1, N = 14, S = 32, O = 16)

Ans :

MAIN 2018

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
Nitrogen	21.21	14	$\frac{21.21}{14} = 1.50$	$\frac{1.5}{0.75} = 2$
Hydrogen	6.06	1	$\frac{6.06}{1} = 6.00$	$\frac{6.0}{0.75} = 8$
Sulphur	24.24	32	$\frac{24.24}{32} = 0.75$	$\frac{0.75}{0.75} = 1$
Oxygen	48.48	16	$\frac{48.48}{16} = 3.00$	$\frac{3.0}{0.75} = 1$

Empirical formula = $\text{N}_2\text{H}_8\text{S}_1\text{O}_4 = (\text{NH}_4)_2\text{SO}_4$

114. The percentage composition by weight and the molecular weight of some compounds is given below. Find their empirical and molecular formula.

- K = 24.68%, Mn = 34.81%, O = 40.51%,
Mol.wt. = 158
- Ca = 34.48%, Si = 24.14%, O = 41.38%,
Mol.wt. = 116
- H = 5.88%, O = 94.12%, Mol.wt. = 34
- P = 49.18%, O = 50.82%, Mol.wt. = 125.94
- B = 86.64%, H = 13.36%, Mol.wt. = 112.29

Ans :

COMP 2020

- (i)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
K	24.68	39	0.63	1

Mn	34.81	55	0.63	1
O	40.51	16	2.53	4

Empirical formula = KMnO_4

Empirical formula weight = $39 + 55 + 64 = 158$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{158}{158} = 1$$

Molecular formula = $n \times$ Empirical formula
= KMnO_4

(ii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
Ca	34.48	40	0.862	1
Si	24.14	28	0.862	1
O	41.38	16	2.58	3

Empirical formula = CaSiO_3

Empirical formula weight = $40 + 28 + 48 = 116$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{116}{116} = 1$$

Molecular formula = $n \times$ Empirical formula
= CaSiO_3 .

(iii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
H	5.88	1	5.88	1
O	94.12	16	5.88	1

Empirical formula = HO

Empirical formula weight = $1 + 16 = 17$

Molecular formula = $n \times$ Empirical formula
= H_2O_2 .

(iv)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
P	49.18	31	1.58	1
O	50.82	16	3.17	2

Empirical formula = PO_2

Empirical formula weight = $31 + 32 = 63$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{125.94}{63} = 1.99 \approx 2$$

Molecular formula = $n \times$ Empirical formula
= P_2O_4

(v)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
B	86.64	11	7.87	3
H	13.36	1	13.36	5

Empirical formula = B_3H_5

Empirical formula weight = $33 + 5 = 38$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{112.29}{38} = 2.9 \approx 3$$

Molecular formula = $n \times$ Empirical formula
= B_9H_{15}

115. Calculate the percentage composition by weight of the following compounds :

- Water (H_2O)
- Ammonia (NH_3)
- Methane (CH_4)
- Hydrochloric acid (HCl)
- Ethane (C_2H_6)

Ans :

MAIN 2007

(i) Water: Chemical formula = H_2O

Relative molar mass = $2 + 16 = 18$ a.m.u.

$$\% \text{ of Hydrogen} = \frac{2}{18} \times 100 = 11.11 \%$$

$$\% \text{ of Oxygen} = \frac{16}{18} \times 100 = 88.89\%$$

(ii) Ammonia: Chemical formula = NH_3

Relative molar mass = $14 + 3 = 17$ a.m.u.

$$\% \text{ of Nitrogen} = \frac{14}{17} \times 100 = 82.35\%$$

$$\% \text{ of Hydrogen} = \frac{3}{17} \times 100 = 17.64\%$$

(iii) Methane: Chemical formula = CH_4

Relative molar mass = $12 + 4 = 16$ a.m.u.

$$\% \text{ of Carbon} = \frac{12}{16} \times 100 = 75\%$$

$$\% \text{ of Hydrogen} = \frac{4}{16} \times 100 = 25\%$$

(iv) Hydrochloric acid: Chemical formula = HCl

$$\text{Relative molar mass} = 1 + 35.5 = 36.5 \text{ a.m.u.}$$

$$\% \text{ of Hydrogen} = \frac{1}{36.5} \times 100 = 2.73\%$$

$$\% \text{ of Chlorine} = \frac{35.5}{36.5} \times 100 = 97.26\%$$

(v) Ethane: Chemical formula = C₂H₆

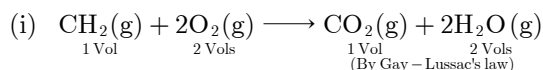
$$\text{Relative molar mass} = 24 + 6 = 30 \text{ a.m.u.}$$

$$\% \text{ of Carbon} = \frac{24}{30} \times 100 = 80\%$$

$$\% \text{ of Hydrogen} = \frac{6}{30} \times 100 = 20\%$$

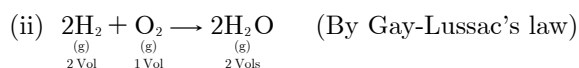
- 116.** Calculate the volume of oxygen required to burn completely a mixture of 22.4 dm³ of CH₄ and 11.2 dm³ of H₂. [all volumes being measured at S.T.P.]

Ans : COMP 2009



$$1 \text{ dm}^3 \text{ of CH}_4 \text{ requires O}_2 = 2 \text{ dm}^3$$

$$22.4 \text{ dm}^3 \text{ of CH}_4 \text{ requires O}_2 = 2 \times 22.4 = 44.8 \text{ dm}^3$$



$$2 \text{ dm}^3 \text{ of H}_2 \text{ requires O}_2 = 1 \text{ dm}^3$$

$$11.2 \text{ dm}^3 \text{ of H}_2 \text{ requires O}_2 = \frac{1}{2} \times 11.2 = 5.6 \text{ dm}^3$$

$$\text{Total oxygen required} = 44.8 + 5.6$$

$$= 50.4 \text{ dm}^3$$

- 117.** What is the volume occupied by the following gases at S.T.P.?

(a) 64 g of Oxygen.

(b) 32 g of Sulphur dioxide.

(c) 44 g of Carbon dioxide.

(d) 14 g of Nitrogen.

(e) 8 g of Hydrogen.

$$(H = 1, N = 14, O = 16, S = 32, C = 12)$$

Ans : SQP 2010

(a) 32 g of O₂ at S.T.P. occupies 22.4 dm³

$$64 \text{ g of O}_2 \text{ occupies} = \frac{22.4}{32} \times 64 = 44.8 \text{ dm}^3$$

(b) 64 g of SO₂ at S.T.P. occupies 22.4 dm³

$$32 \text{ g of SO}_2 \text{ occupies} = \frac{22.4}{64} \times 32 = 11.2 \text{ dm}^3$$

(c) 44 g of CO₂ at S.T.P. occupies 22.4 dm³

$$[\text{Since, M.Wt. of CO}_2 = 12 + 32 = 44 \text{ g}]$$

(d) 28 g of N₂ at S.T.P. occupies 22.4 dm³

$$14 \text{ g of N}_2 \text{ occupies} = \frac{22.4}{28} \times 14 = 11.2 \text{ dm}^3$$

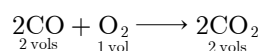
(e) 2 g of H₂ at S.T.P. occupies 22.4 dm³

$$8 \text{ g of H}_2 \text{ occupies} = \frac{22.4}{2} \times 8 = 89.6 \text{ dm}^3$$

- 118.** Calculate the volume of O₂ at S.T.P. required for the complete combustion of 100 litres of carbon monoxide at the same temperature and pressure.

Ans :

COMP 2005



From the above equation

$$2 \text{ vols of CO require O}_2 = 1 \text{ vol}$$

100 litres of CO will require O₂ at S.T.P.

$$= \frac{1}{2} \times 100 = 50 \text{ litres}$$

$$\text{Vol of O}_2 \text{ required at S.T.P.} = 50 \text{ litres.}$$

- 119.** Find the total percentage of Oxygen in Magnesium Nitrate [Mg(NO₃)₂·6H₂O] crystals.

$$(H = 1, N = 14, O = 16, Mg = 24)$$

Ans :

SQP 2001

Molecular weight of Mg(NO₃)₂·6H₂O

$$= 24 + 2 \times (14 + 48) + 6 \times 18$$

$$= 24 + 2 \times 62 + 108$$

$$= 24 + 124 + 108 = 256 \text{ g}$$

$$\text{Weight of Oxygen} = 12 \times 16 = 192 \text{ g}$$

$$\% \text{ of Oxygen} = \frac{192}{256} \times 100\%$$

$$= 75\% \text{ of Oxygen}$$

- 120.** A compound contains 87.5% by mass of Nitrogen and 12.5% by mass of Hydrogen. Determine the empirical formula of the compound.

Ans :

MAIN 2007

Elements	%	Atomic mass	Relative number of atoms	Simplest ratio
Nitrogen	87.5	14	$\frac{87.5}{14} = 6.25$	$\frac{6.25}{6.25} = 1$
Hydrogen	12.5	1	$\frac{12.5}{1} = 12.5$	$\frac{12.5}{6.25} = 2$

- 142.** A company specializing in the production of quicklime (CaO) from limestone (CaCO₃) has received a large order. To fulfill this order, the company needs to calculate the exact amount of limestone required. The production process involves heating calcium carbonate, which decomposes into calcium oxide and carbon dioxide. The company has a furnace that operates with a 95% efficiency and they want to ensure they produce exactly 280 grams of calcium oxide.

(Given, Molar mass of CaCO₃ = 100 g/mol, Molar mass of CaO = 56 g/mol, Molar mass of CO₂ = 44 g/mol, Furnace efficiency = 95%)

- Calculate the number of moles of CaO required to meet the production goal of 280 grams.
- Determine the number of moles of CaCO₃ needed, considering the furnace efficiency.
- Calculate the total mass of CaCO₃ required for the production process.
- Determine the mass of CO₂ produced as a byproduct during the production of CaO.

Ans :

(i) Moles of CaO = $\frac{280 \text{ g}}{56 \text{ g/mol}} = 5 \text{ moles}$.

(ii) Moles of CaCO₃ required
 $= \frac{5 \text{ moles}}{0.95} = 5.26 \text{ moles}$.

(iii) Mass of CaCO₃ required
 $= 5.26 \times 100 \text{ g/mol} = 526 \text{ g}$.

(iv) Mass of CO₂ produced
 $= 5 \times 44 \text{ g/mol} = 220 \text{ g}$.

- 143.** A research team is analyzing a sample of water (H₂O) taken from a glacial melt. The sample weighs 36 grams and the team wants to calculate the number of water molecules and the number of hydrogen and oxygen atoms present. Additionally. They want to know the mass of hydrogen and oxygen atoms individually to understand the composition better.

(Given, Molar mass of H₂O = 18 g/mol, Molar mass of H = 1 g/mol, Molar mass of O = 16 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of water in the 36-gram sample.
- Determine the total number of water molecules present in the sample.
- Calculate the total number of hydrogen atoms and oxygen atoms in the sample.
- Find the mass of hydrogen atoms and the

mass of oxygen atoms individually in the sample.

Ans :

(i) Moles of H₂O = $\frac{36 \text{ g}}{18 \text{ g/mol}} = 2 \text{ moles}$.

(ii) Number of water molecules
 $= 2 \times 6.022 \times 10^{23} \text{ molecules/mol}$
 $= 1.2044 \times 10^{24} \text{ molecules}$.

(iii) Number of hydrogen atoms
 $= 2 \times 2 \times 6.022 \times 10^{23} \text{ atoms}$
 $= 1.2044 \times 10^{24} \text{ hydrogen atoms}$:

Number of oxygen atoms
 $= 2 \times 6.022 \times 10^{23} \text{ atoms}$
 $= 1.2044 \times 10^{24} \text{ oxygen atoms}$.

- 144.** A biologist is studying the respiratory process in humans and needs to calculate the amount of oxygen (O₂) required for a single breath. The average adult human inhales about 0.5 liters of oxygen per breath at STP (Standard Temperature and Pressure). The biologist wants to understand how many moles of oxygen are involved, how many molecules this represents and the mass of oxygen used during each breath. This data will be used to extrapolate daily oxygen consumption.

(Given, Molar mass of O₂ = 32 g/mol, Volume of 1 mole of gas at STP = 22.4 L, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of oxygen in a single 0.5-liter breath.
- Determine the number of oxygen molecules in that breath.
- Find the mass of oxygen used in each breath.
- Extrapolate the total mass of oxygen consumed if a person takes 20,000 breaths in a day.

Ans :

(i) Moles of O₂ = $\frac{0.5 \text{ L}}{22.4 \text{ L/mol}} = 0.02232 \text{ moles}$.

(ii) Number of molecules
 $= 0.02232 \times 6.022 \times 10^{23} \text{ molecules/mol}$
 $= 1.344 \times 10^{22} \text{ molecules}$.

(iii) Mass of oxygen
 $= 0.02232 \times 32 \text{ g/mol}$
 $= 0.714 \text{ g}$.

(iv) Total mass of oxygen consumed
 $= 0.714 \text{ g} \times 20,000$
 $= 14,280 \text{ g} = 14.28 \text{ kg}$.

(ii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
N	30.43	14	2.17	1
O	69.57	16	4.34	2

Empirical formula = NO_2 Empirical formula weight = $14 + 32 = 46$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{92}{46} = 2$$

Molecular formula = $n \times$ Empirical formula
= N_2O_4 .

(iii)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
K	31.85	39	0.81	1
Cl	28.95	35.5	0.81	1
O	39.20	16	2.45	3

Empirical formula = KClO_3

Empirical formula weight = $39 + 35.5 + 48$
= 122.5

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{122.45}{122.5} = 0.99 \cong 1.$$

Molecular formula = $n \times$ Empirical formula
= KClO_3 .

(iv)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
C	40	12	3.33	1
H	6.67	1	6.67	2
O	53.33	16	3.33	1

Empirical formula = CH_2O Empirical formula weight = $12 + 2 + 16 = 30$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{60}{30} = 2$$

Molecular formula = $n \times$ Empirical formula
= $\text{C}_2\text{H}_4\text{O}_2$.

(v)

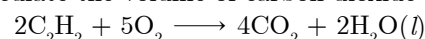
Elements	%	At. wt.	Relative number of atoms	Simplest ratio
H	3.078	1	3.078	2
P	47.668	31	1.53	1
O	49.254	16	3.07	2

Empirical formula = H_2PO_2 Empirical formula weight = $2 + 31 + 32 = 65$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{129.24}{65} = 1.98 \cong 2.$$

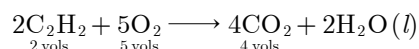
Molecular formula = $n \times$ Empirical formula
= $\text{H}_4\text{P}_2\text{O}_4$

- 125.** What volume of oxygen would be required to burn completely 400 mL of acetylene (C_2H_2) ? Also calculate the volume of carbon dioxide formed.



Ans :

MAIN 2018



According to the above equation

2 vols of C_2H_2 require $\text{O}_2 = 5\text{vols}$

400 mL of C_2H_2 require $\text{O}_2 = \frac{5}{2} \times 400$
= 1000 mL

2 vols of C_2H_2 produce $\text{CO}_2 = 4 \text{ vols}$

400 mL of C_2H_2 produce $\text{CO}_2 = \frac{4}{2} \times 400$
= 800 mL

Hence, vols of O_2 required = 1000 mLVols of CO_2 produced = 800 mL

- 126.** Calculate the percentage of the following:

- Carbon in Ethyne (C_2H_2).
- Calcium in Calcium carbonate.
- Nitrogen in Ammonia (NH_3).
- Oxygen in water (H_2O)
- Nitrogen in Urea $\{(\text{NH}_2)_2\text{CO}\}$.

Ans :

SQP 2012

- Molecular weight of Ethyne (C_2H_2)

- 136.** The gases hydrogen, oxygen, carbon dioxide, sulphur dioxide and chlorine are arranged in order of their increasing relative molecular mass. Given 8 g of each gas at S.T.P., which gas will contain the least number of molecules and which gas the most ?

Ans :

COMP 2010

Given,

$$\text{Molecular mass of H}_2 = 2$$

$$\text{Molecular mass of CO}_2 = 44$$

$$\text{Molecular mass of SO}_2 = 64$$

$$\text{Molecular mass of Cl}_2 = 71$$

$$\text{Mass of each gas} = 8 \text{ g}$$

$$\text{No. of moles of H}_2 = \frac{8}{2} = 4 \text{ moles}$$

$$\text{and no. of molecules of H}_2 = 4 \times 6.023 \times 10^{23}$$

$$= 24.092 \times 10^{23}$$

$$\text{No. of moles of CO}_2 = \frac{8}{44} = \frac{2}{11}$$

$$\text{No. of molecules of CO}_2 = \frac{2}{11} \times 6.023 \times 10^{23}$$

$$= \frac{12.046}{11} \times 10^{23}$$

$$= 1.095 \times 10^{23}$$

$$\text{No. of moles of SO}_2 = \frac{8}{64} = \frac{1}{8} = 0.125$$

$$\text{No. of molecules of SO}_2 = 0.125 \times 6.023 \times 10^{23}$$

$$= 0.753 \times 10^{23}$$

$$= 7.53 \times 10^{22}$$

$$\text{No. of moles of Cl}_2 = \frac{8}{71}$$

$$\text{No. of molecules of Cl}_2 = 8 \times 6.023 \times 10^{23}$$

$$= 0.679 \times 10^{23}$$

$$= 6.79 \times 10^{22}$$

Cl₂ has least number of molecules and H₂ has maximum number of molecules.

- 137.** How many moles are present in
 (a) 100 g of Calcium carbonate?
 (b) 16 g of Oxygen?
 (c) 12 g of Carbon dioxide?
 (d) 2.3 g of Sodium?
 (e) 80 g of Sodium hydroxide?

$$[\text{H} = 1, \text{C} = 12, \text{O} = 16, \text{Na} = 23]$$

Ans :

SQP 2011

- (a) Number of moles

$$= \frac{\text{Weight of the substance (W)}}{\text{Molecular weight (M)}}$$

$$\text{Molecular weight of CaCO}_3 = 40 + 12 + 48$$

$$= 100 \text{ g}$$

$$\text{No. of moles} = \frac{100}{100} = 1 \text{ mole}$$

$$(b) \text{ Molecular weight of Oxygen} = 16 \times 2 = 32 \text{ g}$$

$$\text{No. of moles} = \frac{16}{32} = \frac{1}{2} = 0.5 \text{ mole}$$

$$(c) \text{ Molecular weight of CO}_2 = 12 + 32 = 44 \text{ g}$$

$$\text{No. of moles} = \frac{12}{44} = 0.27 \text{ mole}$$

$$(d) \text{ No. of moles} = \frac{2.3}{23} = 0.1 \text{ mole}$$

$$(e) \text{ No. of moles} = \frac{80}{40} = 2 \text{ moles}$$

$$\text{Hence, Molecular weight of NaOH}$$

$$= 23 + 16 + 1 = 40 \text{ g}$$

- 138.** An organic compound with vapour density = 94 contains

C = 12.67%, H = 2.13% and Br = 85.11%. Find the molecular formula.

$$[\text{Atomic mass: C} = 12, \text{H} = 1, \text{Br} = 80]$$

Ans :

MAIN 2018

Element	Symbol	Atomic mass	Per-centage	Relative no. of Atoms	Simplest ratio
Carbon	C	12	12.67	$\frac{12.67}{12}$ = 1.055	$\frac{1.055}{1.055}$; 1
Hydrogen	H	1	2.13	$\frac{2.13}{1}$ = 2.13	$\frac{2.13}{1.055}$; 2
Bromine	Br	80	85.11	$\frac{85.11}{80}$ = 1.0638	$\frac{1.0638}{1.055}$; 1

$$\text{E.F.} = \text{CH}_2\text{Br}$$

Given,

$$\text{V.D.} = 94$$

$$\text{Molecular mass} = 2 \times \text{V.D.} = 2 \times 94 = 188$$

$$\text{M.F.M.} = (\text{E.F.M.}) n$$

$$188 = (94) n$$

$$n = \frac{188}{94} = 2$$

$$\text{Molecular formula} = (\text{Empirical formula}) \times n$$

$$= (\text{CH}_2\text{Br}) \times 2$$

$$= \text{C}_2\text{H}_4\text{Br}_2$$

$$\% \text{ of Oxygen} = \frac{16}{30} \times 100 = 53.33\%$$

(iii) Magnesium chloride:

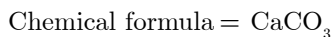


$$\text{Relative molar mass} = 24 + 71 = 95 \text{ a.m.u.}$$

$$\% \text{ of Magnesium} = \frac{24}{95} \times 100 = 25.26\%$$

$$\% \text{ of Chlorine} = \frac{71}{95} \times 100 = 74.74\%$$

(iv) Calcium carbonate:



$$\text{Relative molar mass} = 40 + 12 + 48 = 100$$

$$\% \text{ of Calcium} = \frac{40}{100} \times 100 = 40\%$$

$$\% \text{ of Carbon} = \frac{12}{100} \times 100 = 12\%$$

$$\% \text{ of Oxygen} = \frac{48}{100} \times 100 = 48\%$$

(v) Sodium peroxide:



$$\text{Relative molar mass} = 46 + 32 = 78$$

$$\% \text{ of Sodium} = \frac{46}{78} \times 100 = 58.97\%$$

$$\% \text{ of Oxygen} = \frac{32}{78} \times 100 = 41.03\%$$

131. A compound of Sodium, Sulphur and Oxygen has the following percentage composition:

Na = 29.11%, S = 40.51%, O = 30.38%. Find its empirical formula.

$$[\text{O} = 16, \text{Na} = 23, \text{S} = 32]$$

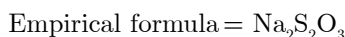
Ans :

SQP 2019

Elements	%	Atomic mass	Relative number of atoms	Simplest ratio
Sodium	29.11	23	$\frac{29.11}{23} = 1.2$	$\frac{1.2}{1.2} = 1.0$
Sulphur	40.51	32	$\frac{40.51}{32} = 1.2$	$\frac{1.2}{1.2} = 1.0$
Oxygen	30.38	16	$\frac{30.38}{16} = 1.8$	$\frac{1.8}{1.2} = 1.5$

To convert it into whole number

$$1 \times 2 = 2; 1 \times 2 = 2; 1.5 \times 2 = 3$$



132. A 2.5 g sample of hydrate of $\text{Ca}(\text{NO}_3)_2$ was heated and only 1.7 g of anhydrous salt remained. What percentage of water was in the hydrate ?

Ans :

MAIN 2021

Percentage of water in the hydrate

$$= \frac{2.5 - 1.7}{2.5} \times 100$$

$$= \frac{0.8 \times 100}{2.5} = 32$$

133. Washing soda has the formula $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. What mass of anhydrous sodium carbonate is left when all the water of crystallization is expelled by heating 57.2 g of washing soda ?

Ans :

COMP 2023



Molecular weight of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

$$= 2 \times 23 + 12 + (3 \times 16) + 10 [1 \times 2 + 16]$$

$$= 46 + 12 + 48 + 180 = 286$$

Molecular weight of Na_2CO_3

$$= (2 \times 23) + 12 + (3 \times 16)$$

$$= 46 + 12 + 48 = 106$$

286 g of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ leave $\text{Na}_2\text{CO}_3 = 106\text{g}$

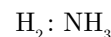
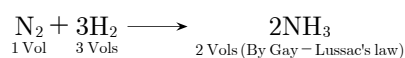
57.2 g of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ leaves Na_2CO_3

$$= \frac{106}{286} \times 57.2 = 21.2 \text{ g}$$

134. Nitrogen reacts with hydrogen to give ammonia. Calculate the volume of ammonia gas formed when nitrogen reacts with 6 litres of hydrogen. All volumes being measured at S.T.P.

Ans :

SQP 2018



$$3 : 2$$

3 litres of H_2 produces $\text{NH}_3 = 2$ litres

$$6 \text{ litres of } \text{H}_2 \text{ will produce } \text{NH}_3 = \frac{2}{3} \times 6$$

$$= 4 \text{ litres}$$

135. What is the vapour density of ethylene ? (Avogadro's Number = 6×10^{23} ; Atomic weight of C = 12, H = 1; Molar volume = 22.4 litres at S.T.P.)

Ans :

MAIN 2012

$$\text{Vapour density of ethylene} = \frac{\text{Molecular weight}}{2}$$

$$= \frac{28}{2} = 14$$

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$$= 2 \times 12 + 1 \times 2$$

$$= 24 + 2 = 26$$

$$\% \text{ of Carbon} = \frac{24}{26} \times 100 = 92.30\%$$

(b) Molecular weight of Calcium carbonate (CaCO₃)

$$= 40 + 12 + 48 = 100$$

$$\% \text{ of Calcium} = 40 \times 100 = 40\%$$

(c) Molecular weight of Ammonia (NH₃)

$$= 14 + 3 = 17$$

$$\% \text{ of Nitrogen} = \frac{14}{17} \times 100 = 82.35\%$$

(d) Molecular weight of Water (H₂O)

$$= 2 + 16 = 18$$

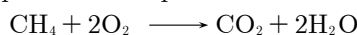
$$\% \text{ of Oxygen} = \frac{16}{18} \times 100 = 88.88\%$$

(e) Molecular weight of Urea [(NH₂)₂CO]

$$= 28 + 4 + 12 + 16 = 60$$

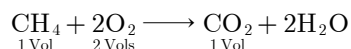
$$\% \text{ of Nitrogen} = \frac{28}{60} \times 100 = 46.66\%$$

- 127.** 80 cm³ of methane is mixed with 200 cm³ of pure oxygen at similar temperature and pressure. The mixture is then ignited. Calculate the composition of resulting mixture if it is cooled to initial room temperature and pressure.



Ans :

MAIN 2015



According to the equation :

1 vol of CH₄ reacts with 2 vols of O₂.

80 cm³ of CH₄ will react with $2 \times 80 = 160 \text{ cm}^3$ of O₂

Vol of O₂ left unreacted = $200 - 160 = 40 \text{ cm}^3$

Also, 1 vol of CH₄ produces 1 vol of CO₂.

80 cm³ of CH₄ will produce 80 cm³ of CO₂.

Vol of water produced = Negligible

Hence, the resulting mixture contains

O₂ 40 cm³, CO₂ = 80 cm³, H₂O = Negligible

- 128.** Calculate the number of atoms present in 117 g of K.

Ans :

COMP 2018

$$\begin{aligned} \text{No. of moles in 117 g of K} &= \frac{\text{Mass (g)}}{\text{Atomic mass of K}} \\ &= \frac{117}{39} = 3 \end{aligned}$$

$$\begin{aligned} \text{No. of atoms in 117 g of K} &= 3 \times 6.022 \times 10^{23} \\ &= 1.8066 \times 10^{24} \end{aligned}$$

- 129.** A gaseous hydrocarbon contains 82.76% of carbon. Given that its vapour density is 29, find its molecular formula. [C = 12, H = 1]

Ans :

SQP 2013

Symbol	Per-centage	Atomic mass	Relative ratio	Simplest ratio	Simplest whole no.
C	82.76	12	6.89	$\frac{6.89}{6.89}$ = 1	2
H	17.24	1	17.24	$\frac{17.24}{6.89}$ = 2.5	5

$$\text{E.F.} = \text{C}_2\text{H}_5$$

$$\text{E.F.M.} = 12 \times 2 + 5 \times 1$$

$$= 24 + 5 = 29$$

$$\text{V.D.} = 29$$

$$\text{M.M} = 2 \times \text{V.D.} = 2 \times 29 = 58$$

$$n = \frac{\text{M.M}}{\text{E.F.M}} = \frac{58}{29} = 2$$

$$\text{M.F.} = (\text{C}_2\text{H}_5)_2 = \text{C}_4\text{H}_{10}$$

- 130.** Calculate the percentage composition by weight of the following compounds :

(i) Calcium nitrate [Ca(NO₃)₂]

(ii) Nitric oxide (NO)

(iii) Magnesium chloride (MgCl₂)

(iv) Calcium carbonate (CaCO₃)

(v) Sodium peroxide (Na₂O₂)

Ans :

COMP 2017

(i) Calcium nitrate:

$$\text{Chemical formula} = \text{Ca(NO}_3)_2$$

$$\text{Relative molar mass} = 40 + 28 + 96$$

$$= 164 \text{ a.m.u.}$$

$$\% \text{ of Calcium} = \frac{40}{164} \times 100 = 24.39 \%$$

$$\% \text{ of Nitrogen} = \frac{28}{164} \times 100 = 17.07\%$$

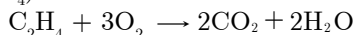
$$\% \text{ of Oxygen} = \frac{96}{164} \times 100 = 58.53\%$$

(ii) Nitric oxide: Chemical formula = NO

$$\text{Relative molar mass} = 14 + 16 = 30 \text{ a.m.u.}$$

$$\% \text{ of Nitrogen} = \frac{14}{30} \times 100 = 46.66\%$$

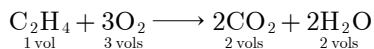
- 139.** What volume of oxygen at S.T.P. is required to affect the combustion of 11 litres of ethylene (C_2H_4) at $276^\circ C$ and 380 mm of Hg pressure ?



Ans :

COMP 2013

The balanced equation is



According to the above equation

1 vol of C_2H_4 requires $O_2 = 3$ vols at the given conditions

11 litres of C_2H_4 requires $O_2 = 3 \times 11$

$= 33$ litres at the given conditions

Vol of O_2 required at $276^\circ C$ and 380 mm of Hg pressure $= 33$ litres

To calculate vol of O_2 at S.T.P.

Given conditions

$$P_1 = 380 \text{ mm}$$

$$V_1 = 33 \text{ litres}$$

$$T_1 = 276^\circ C = 276 + 273 = 549 \text{ K}$$

At S.T.P.

$$P_2 = 760 \text{ mm}$$

$$V_2 = ?$$

$$T_2 = 0^\circ C = 0 + 273 = 273 \text{ K}$$

Applying general gas equation :

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{380 \times 33}{549} = \frac{760 \times V_2}{273}$$

$$V_2 = \frac{273}{760} \times \frac{380 \times 33}{549}$$

$$= \frac{273 \times 33}{2 \times 549} = \frac{273 \times 33}{1098}$$

$$V_2 = 8.205 \text{ litres}$$

Vol of O_2 required at S.T.P. $= 8.205$ litres

- 140.** A hydrocarbon of vapour density 15 has 80% Carbon. Calculate the molecular formula of the Hydrocarbon.

Ans :

MAIN 2017

Elements	%	At. wt.	Relative number of atoms	Simplest ratio
Carbon	80	12	$\frac{80}{12} = 6.6$	$\frac{6.6}{6.6} = 1$
Hydrogen	20	1	$\frac{20}{1} = 20$	$\frac{20}{6.6} = 3$

Empirical formula $= CH_3$

Molecular weight $= 2 \times \text{Vapour density (V.D.)}$

$$= 2 \times 15 = 30$$

Empirical formula weight $= 12 + 3 = 15$

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}}$$

$$= \frac{30}{15} = 2$$

Molecular formula $= (CH_3)_2 = C_2H_6$

CASE BASED QUESTION

- 141.** A chemist is working on a project to measure the carbon dioxide (CO_2) emissions from a small combustion engine. After running the engine for a fixed period, the chemist collects 44 grams of CO_2 in a sealed container. The goal of the experiment is to understand the quantity of CO_2 produced in terms of moles, molecules and the specific atoms involved. The chemist is also interested in comparing this data with the theoretical mass of carbon in the sample to ensure the combustion process was complete.

(Given, Molar mass of $CO_2 = 44 \text{ g/mol}$, Molar mass of C $= 12 \text{ g/mol}$, Avogadro's number $= 6.022 \times 10^{23} \text{ molecules/mol}$)

- Calculate the number of moles of CO_2 in the 44-gram sample.
- Determine the number of CO_2 molecules in the sample.
- Find the total number of oxygen atoms present in the CO_2 sample.
- Calculate the mass of carbon atoms in the 44-gram CO_2 sample and compare it to the theoretical value.

Ans :

$$(i) \text{ Moles of } CO_2 = \frac{44 \text{ g}}{44 \text{ g/mol}} = 1 \text{ mole.}$$

(ii) Number of molecules

$$= 1 \times 6.022 \times 10^{23} \text{ molecules}$$

$$= 6.022 \times 10^{23} \text{ molecules.}$$

(iii) Number of oxygen atoms

$$= 1 \times 2 \times 6.022 \times 10^{23} \text{ atoms}$$

$$= 1.2044 \times 10^{24} \text{ oxygen atoms.}$$

(iv) Mass of carbon atoms $= 1 \times 12 \text{ g} = 12 \text{ g.}$

Empirical formula = NH_2

- 121.** What is the percentage of sodium in sodium oxide?

Ans :

COMP 2009

$$\begin{aligned}\text{Na}_2\text{O M.M.} &= 2(23) + 16 \\ &= 46 + 16 = 62 \\ \% \text{ of Na} &= \frac{46}{62} \times 100 \cong 74\%\end{aligned}$$

- 122.** Determine the formula of organic compound if its molecule contains 12 atoms of carbon. The percentage composition of hydrogen and oxygen are 6.48 and 51.42 respectively.

Ans :

SQP 2010

In the organic compound

$$\text{H} = 6.48\%$$

$$\text{O} = 51.42\%$$

$$\text{C} = 100 - (\% \text{ age of H} + \% \text{ age of O})$$

$$= 100 - (6.48 + 51.42)$$

$$= 100 - 57.90 = 42.10\%$$

- (i) To calculate empirical formula of the compound.

Element	Sym-bol	Atomic mass	% age Atomic mass	Simplest Atomic ratio	Simplest Whole no. ratio
Carbon	C	42.10	$\frac{42.10}{12}$ = 3.51	$\frac{3.51}{3.21}$ = 1.09	1
Hydrogen	H	6.48	$\frac{6.48}{1}$ = 6.48	$\frac{6.48}{3.21}$ = 2	2
Oxygen	O	51.42	$\frac{51.42}{16}$ = 3.21	$\frac{3.21}{3.21}$ = 1	1

Empirical formula of the compound = $\text{C}_1\text{H}_2\text{O}_1$

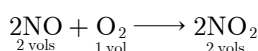
- (ii) To calculate molecular formula of the compound since one molecule of the compound contains 12 atoms of carbon,

$$\text{Molecular formula} = \text{C}_{12}\text{H}_{24}\text{O}_{12}$$

- 123.** 450 cm^3 of nitrogen monoxide and 200 cm^3 of oxygen are mixed together and ignited. Calculate the composition of the resulting mixture.

Ans :

MAIN 2011



According to the above equation

2 vols of NO require $\text{O}_2 = 1$ vol

1 vol of O_2 is used for the combustion of

NO = 2 vols.

200 cc of O_2 is used for the combustion of

NO = $200 \times 2 = 400$ cc

Vols of NO left unused = $450 - 400 = 50$ cc

Also,

1 vol of O_2 on reaction produces $\text{NO}_2 = 2$ vols

200 cc of O_2 on reaction will produce

$\text{NO}_2 = 2 \times 200 = 400$ cc

Vol of NO left unused = 50 cc

Vol of NO_2 produced = 400 cc

- 124.** The percentage composition by weight and the molecular weight of some compounds is given below. Find their empirical and molecular formula.

(i) C = 52.17%, H = 13.04%, O = 34.78%,

Mol.wt. = 46

(ii) N = 30.43%, O = 69.57%,

Mol.wt. = 92

(iii) K = 31.85%, Cl = 28.95%, O = 39.20%,

Mol.wt. = 122.45

(iv) C = 40%, H = 6.67%, O = 53.33%,

Mol.wt. = 60

(v) H = 3.078%, P = 47.668%, O = 49.254%,

Mol.wt. = 129.24

Ans :

COMP 2015

(i)

Elements	%	Atomic weight	Relative number of atoms	Simplest ratio
C	52.17	12	4.34	2
H	13.04	1	13.04	6
O	34.78	16	2.17	1

Empirical formula = $\text{C}_2\text{H}_6\text{O}$

Empirical formula weight = $24 + 6 + 16 = 46$

$$\begin{aligned}n &= \frac{\text{Molecular weight}}{\text{Empirical formula weight}} \\ &= \frac{46}{46} = 1\end{aligned}$$

Molecular formula = $n \times$ Empirical formula

= $\text{C}_2\text{H}_6\text{O}$

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- 145.** A pharmaceutical company is producing a new drug that requires a precise amount of sodium chloride (NaCl) as a reactant. The company needs to prepare 500 grams of a saline solution, which is 0.9% NaCl by mass. To ensure the correct dosage, the chemists need to calculate the exact amount of NaCl in moles and mass and also determine the number of sodium and chloride ions in the solution.

(Given, Molar mass of NaCl = 58.5 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the mass of NaCl required to prepare 500 grams of a 0.9% saline solution.
- Determine the number of moles of NaCl in the solution.
- Calculate the number of sodium ions (Na) and chloride ions (Cl) present in the solution.
- Find the mass of each ion type in the solution.

Ans :

- Mass of NaCl

$$= 0.9\% \times 500 \text{ g}$$

$$= 4.5 \text{ g.}$$
- Moles of NaCl

$$= \frac{4.5 \text{ g}}{58.5 \text{ g/mol}}$$

$$= 0.077 \text{ moles.}$$
- Number of sodium ions

$$= \text{Number of chloride ions}$$

$$= 0.077 \times 6.022 \times 10^{23}$$

$$= 4.637 \times 10^{22} \text{ ions each.}$$
- Mass of sodium ions

$$= 0.077 \times 23 \text{ g/mol}$$

$$= 1.771 \text{ g}$$
 Mass of chloride ions

$$= 0.077 \times 35.5 \text{ g/mol}$$

$$= 2.729 \text{ g.}$$

- 146.** A materials scientist is studying the synthesis of ammonia (NH_3) using the Haber process, which combines nitrogen (N_2) and hydrogen (H_2) gases. The scientist is tasked with producing 34 grams of ammonia. The process is carried out under controlled conditions to maximize yield and the scientist needs to calculate the required amounts of nitrogen and hydrogen gases in moles and grams, as well as the total number of ammonia molecules produced.

(Given, Molar mass of NH_3 = 17 g/mol, Molar mass of N_2 = 28 g/mol, Molar mass of H_2 = 2 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of NH_3 produced in the reaction.
- Determine the number of moles of nitrogen and hydrogen gases required for the reaction.
- Calculate the mass of nitrogen and hydrogen gases needed.
- Find the total number of ammonia molecules produced.

Ans :

- Moles of $\text{NH}_3 = \frac{34 \text{ g}}{17 \text{ g/mol}} = 2 \text{ moles.}$
- Moles of N_2 required

$$= 1 \times 2 = 1 \text{ mole;}$$
 Moles of H_2 required

$$= 3 \times 2 = 3 \text{ moles.}$$
- Mass of $\text{N}_2 = 1 \times 28 \text{ g/mol} = 28 \text{ g.}$
 Mass of $\text{H}_2 = 3 \times 2 \text{ g/mol} = 6 \text{ g.}$
- Number of NH_3 molecules

$$= 2 \times 6.022 \times 10^{23}$$

$$= 1.2044 \times 10^{24} \text{ molecules.}$$

- 147.** An environmental scientist is analyzing a sample of air collected from a polluted area. The sample contains 14 grams of sulfur dioxide (SO_2). The scientist needs to calculate the number of moles of SO_2 , the number of SO_2 molecules, the number of sulfur and oxygen atoms and the mass of oxygen atoms in the sample. This data will be used to assess the impact of SO_2 emissions on air quality.

(Given, Molar mass of SO_2 = 64 g/mol, Molar mass of S = 32 g/mol, Molar mass of O = 16 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of SO_2 in the sample.
- Determine the number of SO_2 molecules in the sample.
- Calculate the total number of sulfur and oxygen atoms in the sample.
- Find the mass of oxygen atoms in the sample.

Ans :

- Moles of $\text{SO}_2 = \frac{14 \text{ g}}{64 \text{ g/mol}} = 0.21875 \text{ moles.}$
- Number of SO_2 molecules

$$= 0.21875 \times 6.022 \times 10^{23}$$

CHAPTER 6

ELECTROLYSIS

SUMMARY

1. CONDUCTOR AND INSULATOR

The conductors allow the passage of electric current through them in the solid state. In conductors, the current passes by the flow of electrons.

The insulators do not allow the passage of electric current through them.

2. ELECTROLYTE

The electrolytes allow the passage of electric current through them in molten, fused or aqueous solution.

In electrolytes, the current passes by the flow of ions.

When current is passed through electrolyte, it undergoes chemical decomposition, whereas in conductor when the current is passed it gets only heated up and no new product is formed, i.e. physical change takes place.

	Conductors	Electrolytes
(i)	They are generally metals.	They are ionic compounds.
(ii)	They are solids.	They exist in fused or molten state or in aqueous solution.
(iii)	The passage of electric current through a conductor is a physical change, i.e. the conductor gets only heated up, no new product is formed.	The passage of electric current through an electrolyte is a chemical change. Electrolyte decomposes and new substances are formed.

	Conductors	Electrolytes
(iv)	The passage of electric current is by the flow of free electrons.	The passage of electric current is by the flow of ions and their discharge at the electrodes.

2.1 Type of Electrolyte

- Strong electrolyte:** The electrolytes which almost completely dissociate in their aqueous solutions or molten states and allow large amount of electricity pass through them. The solution mainly consists of free mobile ions.
- Weak electrolyte:** The electrolytes which partially or incompletely dissociate in their aqueous solutions or molten state and allow very small amount of electricity to pass through them. The solution contains both ions and molecules.
- Non-electrolyte:** The solutions which do not ionise are called as non-electrolytes.
Examples of Strong, Weak and Non-electrolytes:

Strong electrolytes	Weak electrolytes	Non-electrolytes
Strong acids: HCl , H_2SO_4 , HNO_3 .	Weak acids: CH_3COOH , HF , H_2SO_3 , H_3PO_3 , H_2CO_3	Petrol
Strong bases: NaOH , KOH	Weak bases: H_3PO_4 , NH_4OH	Sugar solution
All salts are strong electrolytes.		Liquid ammonia
		Carbon tetrachloride
		Non-polar covalent compounds.

- (ii) Determine the number of moles of carbon monoxide (CO) and hydrogen gas (H₂) needed for the reaction.
- (iii) Calculate the total number of methanol molecules produced in the process.
- (iv) Find the total mass of hydrogen atoms in the methanol produced.

Ans :

- (i) Moles of methanol (CH₃OH)
$$= \frac{160 \text{ g}}{32 \text{ g/mol}} = 5 \text{ moles.}$$
- (ii) Moles of CO required = 5 moles
Moles of H₂ required = 2×5 = 10 moles.
- (iii) Number of methanol molecules
$$= 5 \times 6.022 \times 10^{23}$$
$$= 3.011 \times 10^{24} \text{ molecules.}$$
- (iv) Mass of hydrogen atoms
$$= 10 \times 1 \text{ g/mol}$$
$$= 10 \text{ g.}$$

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$$= 1.317 \times 10^{23} \text{ molecules.}$$

(iii) Number of sulfur atoms

$$= 0.21875 \times 6.022 \times 10^{23}$$

$$= 1.317 \times 10^{23} \text{ atoms;}$$

Number of oxygen atoms

$$= 2 \times 0.21875 \times 6.022 \times 10^{23}$$

$$= 2.634 \times 10^{23} \text{ atoms.}$$

(iv) Mass of oxygen atoms

$$= 2 \times 0.21875 \times 16 \text{ g/mol} = 7 \text{ g.}$$

148. A student is studying the properties of ethanol ($\text{C}_2\text{H}_5\text{OH}$) in the laboratory. The student is provided with 46 grams of ethanol and needs to calculate various properties such as the number of moles of ethanol, the total number of molecules, the number of hydrogen atoms and the mass of carbon atoms present in the sample. This information will help the student understand the composition of ethanol and its behavior in chemical reactions.

(Given, Molar mass of $\text{C}_2\text{H}_5\text{OH} = 46 \text{ g/mol}$, Molar mass of C = 12 g/mol, Molar mass of H = 1 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of ethanol in the sample.
- Determine the total number of ethanol molecules in the sample.
- Calculate the total number of hydrogen atoms present in the sample.
- Find the mass of carbon atoms in the ethanol sample.

Ans :

(i) Moles of ethanol

$$= \frac{46 \text{ g}}{46 \text{ g/mol}} = 1 \text{ mole.}$$

(ii) Number of ethanol molecules

$$= 1 \times 6.022 \times 10^{23}$$

$$= 6.022 \times 10^{23} \text{ molecules.}$$

(iii) Number of hydrogen atoms

$$= 6 \times 6.022 \times 10^{23}$$

$$= 3.613 \times 10^{24} \text{ hydrogen atoms.}$$

(iv) Mass of carbon atoms

$$= 2 \times 12 \text{ g/mol} = 24 \text{ g.}$$

149. A nutritionist is analyzing the protein content of a food sample. The protein in the sample is composed primarily of amino acids and the nutritionist is specifically interested in the sulfur-

containing amino acid cysteine ($\text{C}_3\text{H}_7\text{NO}_2\text{S}$). The sample weighs 240 grams and the nutritionist needs to calculate the number of moles of cysteine, the total number of cysteine molecules, the number of sulfur atoms and the mass of nitrogen atoms in the sample. This data will be used to assess the nutritional value of the food.

(Given, Molar mass of $\text{C}_3\text{H}_7\text{NO}_2\text{S} = 121 \text{ g/mol}$, Molar mass of S = 32 g/mol, Molar mass of N = 14 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of cysteine in the sample.
- Determine the total number of cysteine molecules in the sample.
- Calculate the total number of sulfur atoms present in the sample.
- Find the mass of nitrogen atoms in the cysteine sample.

Ans :

(i) Moles of cysteine

$$= \frac{240 \text{ g}}{121 \text{ g/mol}} = 1.9835 \text{ moles.}$$

(ii) Number of cysteine molecules

$$= 1.9835 \times 6.022 \times 10^{23}$$

$$= 1.194 \times 10^{24} \text{ molecules.}$$

(iii) Number of sulfur atoms

$$= 1.9835 \times 6.022 \times 10^{23}$$

$$= 1.194 \times 10^{24} \text{ sulfur atoms.}$$

(iv) Mass of nitrogen atoms

$$= 1.9835 \times 14 \text{ g/mol}$$

$$= 27.769 \text{ g.}$$

150. A chemical engineer is tasked with producing methanol (CH_3OH) through the catalytic hydrogenation of carbon monoxide (CO) in an industrial process. The reaction is given by:



The engineer needs to produce 160 grams of methanol for a batch of industrial chemicals. The engineer must calculate the amount of carbon monoxide and hydrogen required, as well as the number of molecules of methanol produced and the mass of hydrogen atoms in the final product.

(Given, Molar mass of $\text{CH}_3\text{OH} = 32 \text{ g/mol}$, Molar mass of CO = 28 g/mol, Molar mass of $\text{H}_2 = 2 \text{ g/mol}$, Avogadro's number = 6.022×10^{23} molecules/mol)

- Calculate the number of moles of methanol (CH_3OH) required for the batch.

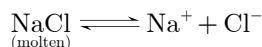
3. ELECTROLYSIS

The chemical process in which the ionic compounds in their fused, molten or aqueous solutions allow the passage of electric current, undergo simultaneous chemical decomposition leading to the discharge of ions at electrodes is called as electrolysis.

4. CELL

The two terminals of the cell are called as cathode and anode. Cathode is the negative terminal of the cell. Cations migrate towards cathode. The current leaves the electrolyte through the cathode. Anode is the positive terminal of the cell. Anions migrate towards anode. The current enters the electrolyte through the anode.

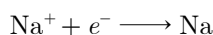
1. Electrolysis is a redox reaction. Reduction takes place at cathode and oxidation at anode. The process of reduction and oxidation take place simultaneously. Therefore electrolysis is referred to as redox reaction.



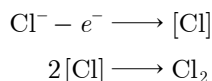
At Cathode: $\text{Na}^+ + e^- \longrightarrow \text{Na}$ (reduction)

At Anode: $\text{Cl}^- - e^- \longrightarrow [\text{Cl}]$ (oxidation)
 $2[\text{Cl}] \longrightarrow \text{Cl}_2$

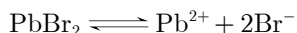
2. Reduction is the process of gain of electrons and it takes place at cathode, e.g.



3. Oxidation is the process of loss of electrons and it takes place at anode, e.g.



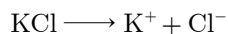
4. Molten Lead bromide is electrolysed by using inert electrodes. At cathode, lead metal is obtained whereas at anode Bromine vapours are obtained.



At Cathode: $\text{Pb}^{2+} + 2e^- \longrightarrow \text{Pb}$ (reduction)

At Anode: $2\text{Br}^- - 2e^- \longrightarrow 2[\text{Br}]$ (oxidation)
 $2[\text{Br}] \longrightarrow \text{Br}_2$

5. Electrolysis of molten Potassium chloride with inert electrodes:



At Cathode: $\text{K}^+ + e^- \longrightarrow \text{K}$ (reduction)

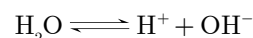
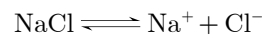
At Anode: $\text{Cl}^- - e^- \longrightarrow [\text{Cl}]$ (oxidation)
 $2[\text{Cl}] \longrightarrow \text{Cl}_2$

Whenever molten metallic chloride is electrolysed, platinum anodes are not used.

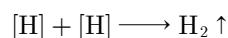
6. If the solution contains more than two cations and anions, then the preferential discharge of ions depends upon the following factors:
 - (a) Relative position of ions in the electrochemical series.
 - (b) The concentration of ions in the electrolyte.
 - (c) The nature of electrodes.
7. The series in which the cations and anions are arranged in the decreasing order of their reactivity is called as electrochemical series. The ions lying below in the electrochemical series are discharged in preference to first to the ions lying above in the electrochemical series.

Cations	Anions
K^+	SO_4^{2-}
Ca^{2+}	
Na^+	NO_3^-
Mg^{2+}	
Al^{3+}	Cl^-
Zn^{2+}	
Fe^{2+}	Br^-
Pb^{2+}	
H	I^-
Cu^{2+}	
Hg^{2+}	OH^-
Ag^+	

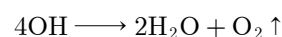
8. For example, during the electrolysis of aqueous solution of Sodium chloride, Hydrogen ions are discharged at cathode in preference to Sodium ions whereas Hydroxyl ions are discharged at anode in preference to Chloride ions as Hydrogen ion is lying below Sodium ion and Hydroxyl ion is lying below Chloride ion in the electrochemical series.



At Cathode: $\text{H}^+ + e^- \longrightarrow [\text{H}]$ (reduction)



At Anode: $\text{OH}^- + e^- \longrightarrow \text{OH}$ (oxidation)



Products at Cathode – Hydrogen, Products at Anode – Oxygen

2. Which of the following electronic configuration represents the most electropositive element?

- (a) 2,1 (b) 2,8,1
(c) 2,2 (d) 2,8,2

Ans :

SQP 2025

Thus (b) is correct option.

3. Identify one statement that holds true for electrolysis of molten lead bromide.

- (a) Silver grey metal deposits at the anode.
(b) Temperature is not maintained during electrolysis.
(c) Brown vapours of bromine are obtained at the anode.
(d) Electrolyte contains H^+ ions along with Pb^{2+} ions.

Ans :

COMP 2021

The reactions involve at different electrodes are as follow :

At cathode $Pb^{2+} + 2e^- \rightarrow Pb$

At anode $Br^- \rightarrow Br + e^-$

$Br + Br \rightarrow Br_2$

Thus (c) is correct option.

4. Solid sodium chloride does not conduct electricity as

- (a) the strength of the bond is weak
(b) it contains free ions
(c) it does not contain any free ion
(d) it contains free ions as well as molecules

Ans :

MAIN 2021

Solid sodium chloride does not conduct electricity as it does not contain any free ions.

Thus (c) is correct option.

5. Which statement about conduction of electricity is correct?

- (a) Electricity is conducted in aqueous solution by electrons.
(b) Electricity is conducted in a metal wire by ions.
(c) Electricity is conducted in a molten electrolyte by electrons.
(d) Electricity is conducted in an acidic solution by ions.

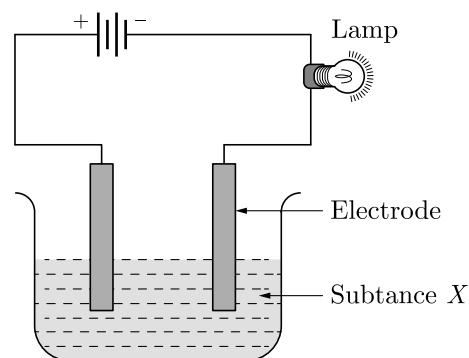
Ans :

SQP 2021

In the molten state, ions in ionic compounds are free to flow and therefore molten sodium chloride can conduct electricity.

Thus (c) is correct option.

6. In a circuit below, the lamp lights up



What could X be ?

- (a) A solution of alcohol and water
(b) A solution of sodium chloride in water
(c) Sugar solution
(d) Solid potassium chloride

Ans :

COMP 2021

A solution of sodium chloride in water makes ions and is a good conductor of electricity. Therefore, it will make the current to flow through it and the bulb will glow.

Thus (b) is correct option.

The oxidation reaction among the following is

- (a) $Fe^{3+} + 3e^- \rightarrow Fe$ (b) $Fe^{2+} - e^- \rightarrow Fe^{3+}$
(c) $Cl_2 + 2e^- \rightarrow 2Cl^-$ (d) $Cu^{2+} + 2e^- \rightarrow Cu$

Ans :

SQP 2021

Among the given reaction (b) is an example of oxidation reaction, as Fe^{2+} loses one electron to give Fe^{3+} .

Thus (b) is correct option.

8. When fused lead bromide is electrolysed we observe:

- (a) a silver grey deposit at anode and a reddish brown deposit at cathode.
(b) a silver grey deposit at cathode and a reddish brown deposit at anode.
(c) a silver grey deposit at cathode and reddish brown fumes at anode.
(d) silver grey fumes at anode and reddish brown fumes at cathode.

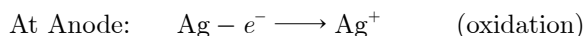
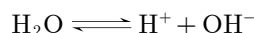
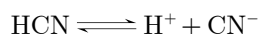
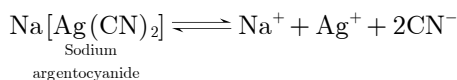
Ans :

COMP 2014

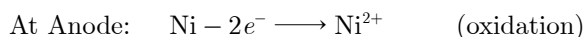
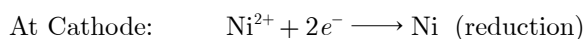
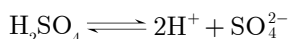
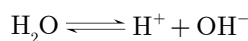
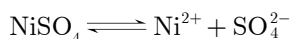
When fused Lead bromide is electrolyzed we observe a silver-grey deposit at the cathode and reddish-brown fumes at the anode.

Thus (c) is correct option.

- To electroplate a copper bell with silver:
 - Copper bell is hanged at cathode.
 - Anode is made of pure silver.
 - The electrolyte must contain silver ions. Sodium argentocyanide acidified with hydrocyanic acid is used as an electrolyte. Silver nitrate cannot be used as an electrolyte because it decomposes very rapidly and leads to the formation of uneven layer.



- Electroplating with Nickel:
 - Electrolyte used is connected Nickel sulphate solution.
 - Article to be electroplated is hanged at cathode.
 - Block of pure nickel metal is made as anode.

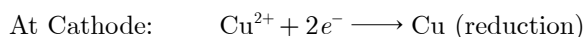
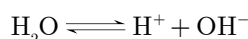
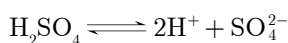
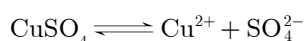


6. ELECTRO-REFINING

Electro-refining is a process in which the impurities present in the metal are removed electrolytically so as to obtain a metal with high purity.

During electro-refining of impure copper:

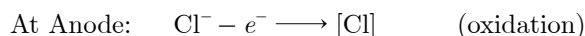
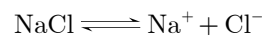
- Impure copper is hanged at anode.
- Pure strip of copper is made as cathode.
- The electrolyte is acidified copper sulphate solution.



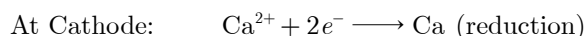
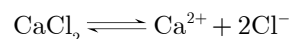
- By electro-metallurgy, highly electropositive metals like Lithium, Beryllium, Magnesium, Sodium, Potassium, Calcium and Aluminium are extracted by the electrolysis of their fused or molten

chlorides (mainly) or oxides.

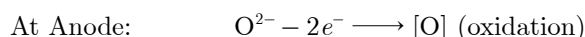
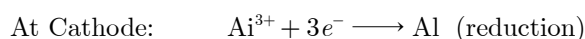
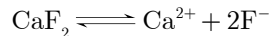
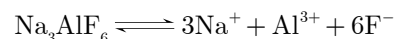
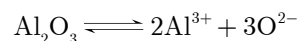
- Sodium is extracted by the electrolysis of molten Sodium chloride. Cathode used is of iron and anode used is of graphite.



- Calcium is extracted from molten Calcium chloride. Cathode used is of iron graphite.



- Aluminium is extracted from molten Alumina dissolved in molten cryolite of Carbon blocks (graphite rods) and cathode is the lining of gas carbon.



MULTIPLE CHOICE QUESTION

- An aqueous solution of copper sulphate turns colourless on electrolysis. Which of the following could be the electrodes?

P. anode: copper; cathode: copper

Q. anode: platinum; cathode: copper

R. anode: copper; cathode: platinum

(a) only P

(b) only Q

(c) only R

(d) both Q and R

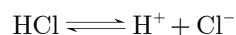
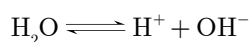
Ans :

SQP 2025

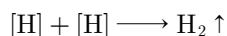
If platinum anode is used the blue colour of CuSO_4 solution fades since the blue Cu^{2+} ions which are discharged at the cathode are not replaced at the anode.

Thus (b) is correct option.

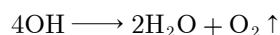
9. Electrolysis of acidulated water is considered as an example of catalysis. As catalysts only alter the rate of reaction without taking part in the reaction, so water is feebly ionized and on adding the drop of acid its ionization increases. When acidulated water or dilute hydrochloric acid is electrolysed with inert electrodes, then hydrogen is obtained at cathode and oxygen is obtained at anode in the ratio of 2 : 1 by volume respectively.



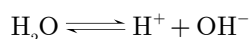
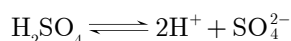
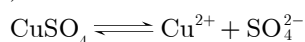
At Cathode: $\text{H}^+ + e^- \longrightarrow [\text{H}]$ (reduction)



At Anode: $\text{OH}^- + e^- \longrightarrow \text{OH}$ (oxidation)

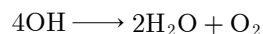


10. Electrolysis of Copper sulphate solution with Platinum (inert) electrodes:



At Cathode : $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu}$ (reduction)

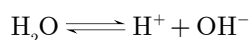
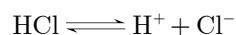
At Anode : $\text{OH}^- - e^- \longrightarrow \text{OH}$ (oxidation)



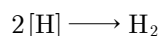
Observations:

- Size of cathode increases.
- Colour of the electrolyte slowly fades away i.e. it changes from blue to colourless.

11. During the electrolysis of concentrated hydrochloric acid, instead of hydroxyl ions, chloride ions are discharged at anode because the concentration of chloride ions is greater than that of hydroxyl ions. So, greater the concentration of ion, greater is the probability of the ion being discharged at the electrode in preference to one having lower concentration.



At Cathode: $\text{H}^+ + e^- \longrightarrow [\text{H}]$ (reduction)



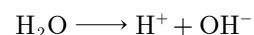
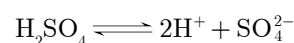
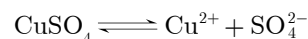
At Anode: $\text{Cl}^- + e^- \longrightarrow [\text{Cl}]$ (oxidation)



Cl^- will discharge because concentration of Cl^- is higher as compared to OH^- .

12. During the electrolysis of acidified Copper sulphate solution with Copper electrodes, the

Copper electrodes are attackable, i.e. the Copper anode takes part in the chemical reaction, as the electrode has the lower electrode potential (i.e. easily loses electron) as compared to the ions present in the electrolyte. But during the electrolysis of Copper sulphate solution with platinum electrodes, the electrodes are non-attackable, i.e. they do not enter the chemical reaction with the electrolyte. This is because the electrode is having higher reduction potential than the ions present.



At Cathode: $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu}$ (reduction)

At Anode: $\text{Cu} - 2e^- \longrightarrow \text{Cu}^{2+}$ (oxidation)

Neither Sulphate nor Hydroxyl ions are discharged but instead of that Copper anode loses electrons. During the electrolysis of acidified Copper sulphate solution with Copper electrodes, the following changes take place:

- Size of cathode increases.
- Size of anode decreases.
- The colour of electrolyte does not fade, i.e. it remains blue.

13. Electrolysis finds wider application in various fields, e.g.

- Electroplating.
- Electro-refining.
- Electro-metallurgy.

5. ELECTROPLATING

Electroplating is the coating of superior metal over the surface of inferior metal by the passage of electric current.

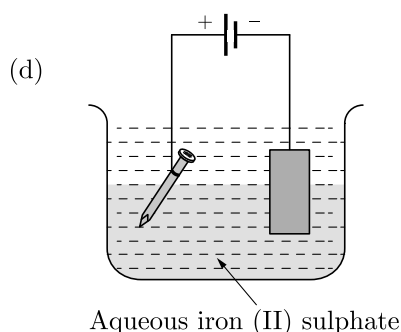
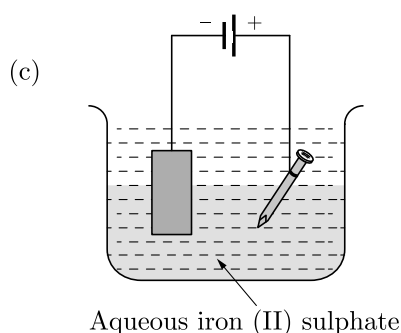
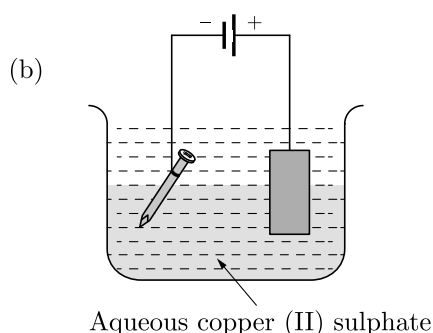
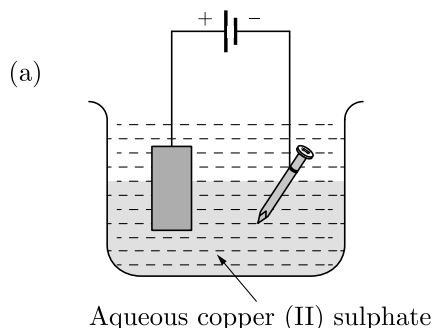
The conditions for electroplating are

- The article to be electroplated is connected at cathode.
- The electrolyte must contain the ions of the metal which is to be electroplated.
- The anode must be made of pure metal with which the article has to be electroplated.
- The article to be electroplated must be absolutely clean.
- A low current for longer duration must be passed.
- Direct current should be used and not the alternate current.

An article is electroplated in order to protect it from corrosion and to increase the physical appearance of the article.

9. Which apparatus could electroplate and iron nail with copper?

 = Copper sheet,  = Iron nail



Ans :

MAIN 2021

Thus (a) is correct option.

10. Which of the following ions will readily discharge at the anode during the electrolysis of acidulated water?

- (a) OH^- (b) SO_4^{2-}
(c) Cl^- (d) H^+

Ans :

COMP 2021

Among the given ions OH^- will readily discharge at the anode during the electrolysis of acidulated water.

Thus (a) is correct option.

11. The inert electrode used in the electrolysis of acidified water is :

- (a) Nickel (b) Platinum
(c) Copper (d) Silver

Ans :

SQP 2020

Platinum (Pt) electrodes are used in the electrolysis of H_2O because it is an inert metal and do not take part in the reaction. It just acts as a medium of electron flow between the electrolyte and the circuit. Other commonly used inert electrodes include stainless steel, graphite, etc.

Thus (b) is correct option.

12. The electrolyte used for electroplating an article with silver is:

- (a) silver nitrate solution.
(b) silver cyanide solution.
(c) sodium argentocyanide solution.
(d) nickel sulphate solution.

Ans :

SQP 2014

A metal article is to be electroplated with silver. The electrolyte selected is sodium argentocyanide. Thus (c) is correct option.

13. The particles present in strong electrolytes are:

- (a) only molecules
(b) mainly ions
(c) ions and molecules
(d) only atoms.

Ans :

MAIN 2010

The particles present in strong electrolytes are called mainly ions.

Thus (b) is correct option.

14. During ionization metals lose electrons, this change can be called:

- (a) Oxidation (b) Reduction
(c) Redox (d) Displacement

Ans :

COMP 2010

During ionization metals lose electrons this change can be called Oxidation.

Thus (a) is correct option.

15. Which of these will act as a non-electrolyte?

- (a) Liquid carbon tetrachloride
- (b) Acetic acid
- (c) Sodium hydroxide aqueous solution acid
- (d) Potassium chloride aqueous solution.

Ans :

MAIN 2011

Now among the given substances, liquid carbon tetrachloride will act as a non-electrolyte.

Thus (a) is correct option.

16. Identify the weak electrolyte from the following:

- (a) Sodium chloride solution
- (b) Dilute hydrochloric acid
- (c) Dilute sulphuric acid
- (d) Aqueous acetic acid.

Ans :

SQP 2014

The weak electrolyte is Aqueous acetic acid.

Thus (d) is correct option.

17. A compound which liberates reddish brown gas around the anode during electrolysis in its molten state is :

- (a) Sodium chloride
- (b) Copper (II) oxide
- (c) Copper (II) sulphate
- (d) Lead (II) bromide

Ans :

COMP 2010

Lead(II) bromide is the compound that liberates reddish-brown gas around the anode during electrolysis in its molten state.

Thus (d) is correct option.

18. During ionisation metals lose electrons, this change can be called :

- (a) Oxidation
- (b) Reduction
- (c) Redox
- (d) Displacement

Ans :

COMP 2010

During ionization metals lose electrons this change can be called Oxidation.

Thus (a) is correct option.

19. During the electrolysis of molten lead bromide, which of the following takes place ?

- (a) Bromine is released at the cathode
- (b) Lead is deposited at the anode
- (c) Bromine ions gain electrons
- (d) Lead is deposited at the cathode

Ans :

MAIN 2010

Electrolysis of molten Lead bromide,

At anode:



At cathode:



Thus (d) is correct option.

20. A particular solution contains molecules and ions of the solute so it is a:

- (a) weak acid
- (b) strong acid
- (c) salt solution
- (d) strong base

Ans :

SQP 2011

These are poor conductors of electricity and allow only small amounts of current to flow through them. These solutions contain ions as well as undissociated molecules. It is a weak electrolyte. Thus (c) is correct option.

21. A compound which liberates reddish brown gas around the anode during electrolysis in its molten state is:

- (a) Lead(II) bromide
- (b) Copper(II) oxide
- (c) Copper(II) sulphate
- (d) Sodium chloride

Ans :

COMP 2015

Lead(II) bromide is the compound that liberates reddish-brown gas around the anode during electrolysis in its molten state.

Thus (a) is correct option.

22. The process of separation of ions present in an ionic compound is known as :

- (a) Ionisation
- (b) Dissociation
- (c) Separation
- (d) Electrolysis

Ans :

SQP 2016

The ions that are already present in the solid component separate out when an ionic compound is dissolved in water. This process is known as dissociation.

Thus (b) is correct option.

23. Pure metal is made during electro-refining.

- (a) Cathode
- (b) Anode
- (c) Electrolyte
- (d) None of these

Ans :

MAIN 2018

In electrolytic refining, pure metal is always deposited at the cathode. The impure metal is made anode (positive terminal) and a thin rod of pure metal is made cathode (negative terminal). Thus (a) is correct option.

24. Hofmann's voltameter is used for the electrolysis of :

(a) Water (b) Sodium chloride
(c) Sodium oxide (d) Lead bromide

Ans :

COMP 2020

Hoffman's voltameter is the device used for electrolysis of water.

Thus (a) is correct option.

25. Electrolysis of lead bromide is carried out in an :

(a) Aluminium vessel (b) Clay crucible
(c) Silica crucible (d) Glass vessel

Ans :

MAIN 2022

Electrolysis of Lead bromide is done in Silica crucible.

Thus (c) is correct option.

26. Which of the following combination is true for carrying out electroplating of an object ?

(a) Direct and large current
(b) Alternating and small current
(c) Alternating and large current
(d) Direct and small current

Ans :

COMP 2018

For electroplating, we will use direct current as in direct current the direction of the current will be the same which will help them to get a deposit on the metal surface and the supply of current is also continuous. We use a small current so that the coating is done smoothly.

Thus (d) is correct option.

27. Which of the following is a weak electrolyte ?

(a) Sodium chloride (b) Benzene
(c) Sodium acetate (d) Ammonium acetate

Ans :

SQP 2013

Weak electrolyte is an electrolyte that does not completely dissociate in solution. The solution will contain both ions and molecules of the electrolyte e.g. acetic acid, carbonic acid and ammonia are all weak electrolyte.

Thus (d) is correct option.

28. Electrolysis of aqueous copper sulphate is carried by using :

(a) Copper, electrodes
(b) Copper anode graphite cathode
(c) Platinum electrodes
(d) None of these

Ans :

MAIN 2011

Electrolysis of aqueous copper sulphate uses copper electrodes to transfer copper metal from the anode to the cathode.

Thus (c) is correct option.

29. During electrolysis of sodium chloride the gas released at anode is :

(a) Chlorine (b) Hydrogen
(c) Oxygen (d) None of these

Ans :

COMP 2010

Chlorine gas is obtained at the anode during the electrolysis of molten sodium chloride.

Thus (c) is correct option.

30. The gas obtained at the cathode by passing an electric current through a dilute HCl using platinum electrodes is :

(a) Chlorine
(b) Hydrogen chloride gas
(c) Hydrogen
(d) Mixture of hydrogen and chlorine.

Ans :

SQP 2002

When passing an electric current through dilute hydrochloric acid (HCl) using platinum electrodes, hydrogen gas is produced at the cathode. The water dissociates to form oxygen and hydrogen during electrolysis, with hydrogen evolving at the cathode and oxygen at the anode.

Thus (c) is correct option.

31. Which of the following electrolyte is different from others?

(a) Ammonium hydroxide
(b) Magnesium hydroxide
(c) Copper hydroxide
(d) Potassium chloride

Ans :

MAIN 2005

It is a strong electrolyte. A strong electrolyte is a solution/solute that completely, or almost completely, ionizes or dissociates in a solution.

Thus (d) is correct option.

32. In the electrolysis of CuSO_4 solution using platinum electrodes, gas produced at anode is :

(a) Sulphuric acid (b) Oxygen
(c) Sulphur dioxide (d) Copper ions

Ans :

COMP 2010

During the electrolysis of an aqueous solution of CuSO_4 by using platinum electrodes, the copper will get deposited at the cathode and oxygen will be released at anode.

- 109.** Process of extraction of metals from its ores by electrolysis.

Ans : MAIN 2019
Electrometallurgy

- 110.** Impurities which remain behind at the bottom of the cell.

Ans : SQP 2010
Anode mud

- 111.** The type of electricity used during electrolysis.

Ans : MAIN 2014
Direct current

- 112.** The electrode connected to the negative terminal of battery.

Ans : COMP 2016
Cathode

- 113.** The process by which a particle gains or loses electrons.

Ans : SQP 2019
Ionisation

- 114.** The process by which an electrovalent compound breaks up into mobile ions.

Ans : MAIN 2011
Dissociation

- 115.** Electrolyte used in silver plating.

Ans : COMP 2015
 $K[Ag(CN)_2]$, Potassium argentocyanide solution.

- 116.** An acid used in the electrolysis of water.

Ans : SQP 2019
Sulphuric acid

- 117.** Process of formation of ions from molecules which are not in ionic state.

Ans : MAIN 2005
Ionisation

DIRECTION : Select the correct answer from the list in bracket:

- 118.** A covalent compound which in aqueous state conducts electricity. ($CuCl_2$, CS_2 , NH_3 , C_2H_4)

Ans : SQP 2010
 NH_3

- 119.** The cation discharged at the most readily. (Fe^{2+} , Cu^{2+} , Pb^{2+} , H^+)

Ans : COMP 2015
 Cu^{2+}

- 120.** The anion discharged at the anode with most difficulty. (SO_4^{2-} , Br^- , NO_3^- , OH^-)

Ans : MAIN 2016
 SO_4^{2-}

- 121.** The metallic electrode which does not take part in an electrolytic reaction. (Pt, Ag, Fe, Ni)

Ans : COMP 2017
Pt

- 122.** The ions which are discharged during electrolysis of aq. $CuSO_4$ solution using platinum electrodes. (Cu^{2+} , SO_4^{2-} , H^+ , OH^-)

Ans : MAIN 2019
 OH^-

DIRECTION : State one relevant observation for the following :

- 123.** At the Anode when aqueous copper sulphate solution is electrolysed using copper electrodes.

Ans : SQP 2015
Size of anode decreases.

- 124.** At the cathode when acidified aqueous copper sulphate solution is electrolysed with copper electrodes.

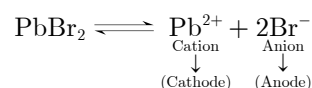
Ans : COMP 2014
Size increases.

- 125.** Electricity is passed through molten lead bromide.

Ans : SQP 2013
A shining deposit appears at cathode and reddish brown vapours evolve at anode.

- 126.** At the anode, when molten lead bromide is electrolyzed using graphite electrodes.

Ans : MAIN 2018



Ans :

SQP 2007

Water is feebly ionized and adding acid increases its ionization, making it an example of catalysis. Thus (b) is correct option.

- 40. Assertion :** Copper is obtained at the cathode during the electrolysis of Copper sulphate solution.

Reason : Copper ions gain electrons at the cathode.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

MAIN 2012

Copper ions are reduced to copper metal at the cathode by gaining electrons.

Thus (a) is correct option.

- 41. Assertion :** Electroplating requires the article to be electroplated to be connected at the anode.

Reason : The anode must be made of pure metal to be electroplated.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

COMP 2017

The article to be electroplated is connected at the cathode, not the anode.

Thus (d) is correct option.

- 42. Assertion :** During electro-refining, impurities are removed electrolytically.

Reason : Impure copper is used as the cathode.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

SQP 2013

Impure copper is used as the anode and pure copper is deposited on the cathode.

Thus (c) is correct option.

- 43. Assertion :** Sodium is extracted by the electrolysis of molten Sodium chloride.

Reason : Sodium is a highly electronegative element.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

MAIN 2009

Sodium is a highly electropositive element, not electronegative.

Thus (c) is correct option.

- 44. Assertion :** During the electrolysis of acidified Copper sulphate solution with Copper electrodes, the size of the cathode decreases.

Reason : Copper ions from the electrolyte are deposited on the cathode.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

COMP 2004

The size of the cathode actually increases because copper ions are deposited on it.

Thus (d) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name of the following :

- 45.** A salt which is a weak electrolyte.

Ans :

MAIN 2015

Ammonium acetate ($\text{CH}_3\text{COONH}_4$)

- 46.** A base which is not an alkali.

Ans :

SQP 2016

Zinc hydroxide, $\text{Zn}(\text{OH})_2$

- 47.** An inert electrode and an active electrode.

Ans :

COMP 2018

An inert electrode — Platinum

An active electrode — Copper

139. Choose A, B, C or D to match the descriptions (i) to (v). Some alphabets may be repeated.

- A. Non-electrolyte
 B. Strong electrolyte
 C. Weak electrolyte
 D. Metallic conductor
 (i) Molten ionic compound
 (ii) Carbon tetrachloride
 (iii) An aluminium wire
 (iv) A solution containing solvent molecules, solute molecules and ions formed by the dissociation of solute molecules.
 (v) A sugar solution with sugar molecules and water molecules.

Ans :

MAIN 2007

- (i) B, (ii) A, (iii) D, (iv) C, (v) A

140. Select the correct answer from the list given in brackets :

- (i) An aqueous electrolyte consists of the ions mentioned in the list, the ion which could be discharged most readily during electrolysis.
 $[\text{Fe}^{2+}, \text{Cu}^{2+}, \text{Pb}^{2+}, \text{H}^{+}]$
 (ii) The metallic electrode which does not take part in an electrolytic reaction.
 $[\text{Cu}, \text{Ag}, \text{Pt}, \text{Ni}]$
 (iii) The ion which is discharged at the anode during the electrolysis of copper sulphate solutions using copper electrodes as anode and cathode.
 $[\text{Cu}^{2+}, \text{OH}^{-}, \text{SO}_4^{2-}, \text{H}^{+}]$
 (iv) When dilute sodium chloride is electrolysed using graphite electrodes, the cation is discharged at the cathode most readily.
 $[\text{Na}^{+}, \text{OH}^{-}, \text{H}^{+}, \text{Cl}^{-}]$
 (v) During silver plating of an article using potassium argentocyanide as an electrolyte, the anode material should be $[\text{Cu}, \text{Ag}, \text{Pt}, \text{Fe}]$.

Ans :

SQP 2012

- (i) Cu^{2+} (ii) Pt (iii) Cu^{2+} (iv) H^{+} (v) Ag

DIRECTION : Answer the following :

141. What is the material for cathode and anode during the electro-refining of impure Copper?

Ans :

MAIN 2015

Cathode - Pure copper, Anode - Impure copper

142. Which electrode anode or cathode is the oxidising electrode? Why?

Ans :

SQP 2014

Anode as the process of oxidation takes place at anode.

143. Why the electrolysis of acidulated water is considered to be an example of catalysis?

Ans :

COMP 2011

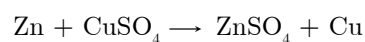
On adding acid to water, it speeds up the reaction without taking part in the reaction.

144. Can we store CuSO_4 solution in a zinc vessel ?

Ans :

SQP 2018

No, because zinc is more reactive than copper. Therefore, it will displace Cu from CuSO_4 solution.



145. What change will you observe in the electrolyte during the electrolysis of Copper sulphate solution with inert electrodes?

Ans :

MAIN 2019

The colour of the electrolyte fades, i.e. from blue it changes to colour less.

146. Why is the electrolysis of acidulated water considered an example of catalysis ?

Ans :

MAIN 2019

At the end of the electrolysis of acidulated water, the weight of sulphuric acid remains unchanged. Therefore, during the electrolysis of acidulated water, sulphuric acid behaves like a catalyst.

147. Why is it necessary to add acid to water before proceeding with the electrolysis of water ?

Ans :

COMP 2010

Pure water is a poor conductor of electricity. Acid is added to water to make it a good conductor of electricity.

148. Correct the sentence by adding word (s) :

The electrolysis of lead bromide liberates lead and bromine.

Ans :

SQP 2013

The electrolysis of molten lead bromide liberates lead and bromine.

149. How is ionic concentration related to conductivity?

Ans :

MAIN 2017

Electrical conductivity is directly proportional to the conc. of ions present. Greater the ionic conc. greater will be conductivity.

63. During electrolysis, positive ions move towards _____.

Ans : COMP 2017
cathode

64. Conducting nature of ionic compounds is due to _____.

Ans : SQP 2010
ions

65. NaCl is a poor conductor of electricity in the _____.

Ans : MAIN 2019
solid state

66. A solution of FeSO_4 _____ be kept in zinc vessel.

Ans : COMP 2000
cannot

67. Substances which conduct electricity in the solid state are generally _____.

Ans : SQP 2001
metals

68. A solution of HCl gas in water conducts electricity because of _____, but a solution of HCl gas in toluene does not conduct an electric current because _____.

Ans : MAIN 2010
ionisation, it does not ionise in toluene

69. Negative electrode is called the _____.

Ans : COMP 2018
cathode

70. Positive electrode is called the _____.

Ans : SQP 2008
anode

71. The electron releasing tendency of zinc is _____ than that of copper.

Ans : MAIN 2002
more

72. The conductivity of an electrolyte _____ with rise in temperature.

Ans : COMP 2000

increases

73. Powdered sodium chloride (common salt) does not conduct an electric current, but it does so when _____ or when _____.

Ans : MAIN 2005
present in the molten state, present in the aqueous solution

74. Zinc is _____ in the activity series than copper.

Ans : SQP 2007
higher

75. Cations are _____ ions.

Ans : COMP 2009
positively charged

76. Anions are _____ ions.

Ans : SQP 2010
negatively charged

77. Electrolyte used for electroplating with nickel is _____ . $[\text{NiSO}_4/\text{NiCl}_2/\text{Ni}(\text{OH})_2]$

Ans : MAIN 2013
 NiSO_4

78. Electrolyte used for electroplating with silver is _____ . $[\text{AgCl}_2/\text{Ag}(\text{NO}_3)_2/\text{Na}[\text{Ag}(\text{CN})_2]]$

Ans : COMP 2018
 $\text{Na}[\text{Ag}(\text{CN})_2]$

79. The compound which gives oxygen on heating is _____ . $[\text{HgO}/\text{Na}_2\text{O}/\text{CaO}]$

Ans : MAIN 2019
 HgO

80. Which of the following is a weak electrolyte _____ . [lead chloride/lead nitrate/lead acetate]

Ans : SQP 2020
Lead acetate

81. The gas obtained at the cathode by passing current through dilute HCl is _____ . [chlorine/hydrogen/hydrogen chloride]

Ans : COMP 2001
Hydrogen

82. The solid which splits up into maximum ions is _____. [sodium chloride/ammonium chloride/lead chloride]

Ans : SQP 2007

Sodium chloride

83. Electrolysis is the passage of _____ (electricity/ electrons) through a liquid or a solution accompanied by a _____ (physical / chemical) change.

Ans : MAIN 2009

Electrolysis is the passage of electricity through a liquid or a solution accompanied by a chemical change.

84. Hydrocyanic acid has formula _____ and it is a _____ acid.

Ans : COMP 2010

HCN and weak

85. The anode used in extraction of aluminium is _____. [carbon rods/gas carbon/platinum]

Ans : SQP 2013

Carbon rods

86. Pure water consists almost entirely of _____ (ions/molecules).

Ans : MAIN 2015

Pure water consists almost entirely of molecules

87. We can expect that pure water _____ (will/ will not) normally conduct electricity.

Ans : COMP 2017

We can expect that pure water will not normally conduct electricity.

88. Ionic or electrovalent compounds do not conduct electricity in their _____ state. (fused/solid)

Ans : SQP 2018

fused

89. Electrolysis of aqueous sodium chloride solution will form _____ at the cathode. (hydrogen gas/ sodium metal)

Ans : MAIN 2018

hydrogen gas

90. Copy and complete the following table which refers to two practical applications of electrolysis.

Process	Anode	Electrolyte	Cathode
Silver plating a spoon			
Purification of copper			

Ans : COMP 2003

Process	Anode	Electrolyte	Cathode
Silver plating a spoon	A bar of pure silver	Solution of potassium argento cyanide	Spoon
Purification of copper	Impure copper rod	Acidified copper sulphate solution	Thin plate of copper

91. Choosing only words from the following list, write down the appropriate words to fill in the blanks (i) to (v) below : anions, anode, cathode, cations, electrode, electrolyte, nickel, voltameter.

To electroplate an article with nickel requires an (i) _____ which must be a solution containing (ii) _____ ions. The article to be plated is placed on the (iii) _____ of the cell in which the plating is carried out. The (iv) _____ of the cell is made from pure nickel. The ions which are attracted to the negative electrode and discharged are called (v) _____.

Ans : MAIN 2007

- (i) Electrolyte
(ii) Nickel
(iii) Cathode
(iv) Anode
(v) Cations

92. To electroplate an article with nickel, it requires an (a) _____ which must be a solution containing (b) _____ ions. The article to be plated is placed as the (c) _____ of the cell in which the plating is carried out. The (d) _____ of the cell is made from pure nickel. The ions which are attracted to the negative electrode and discharged are called (e) _____.

Ans : COMP 2011

- (a) Electrolyte (b) Nickel
(c) Cathode (d) Anode
(e) Cations

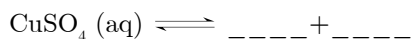
93. Molten lead bromide conducts electricity. It is called an _____. It is made up of lead _____ and bromide _____. The lead ions are _____ charged and are called _____. The bromide ions are _____ charged and are called _____.

Ans :

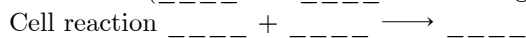
SQP 2014

electrolyte, cations, anions, positively, cations, negatively, anions

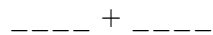
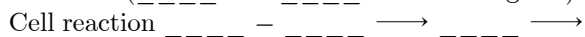
94. Complete the following using platinum electrode :



At cathode (_____ and _____ ions will migrate)

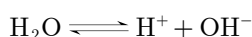
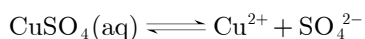


At anode (_____ and _____ ions will migrate)

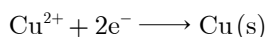


Ans :

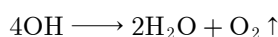
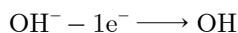
SQP 2010



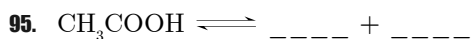
At cathode : (Cu^{2+} and H^+ ions will migrate)



At anode : (OH^- and SO_4^{2-} ions will migrate)

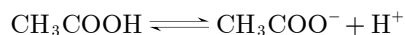


DIRECTION : Complete and balance the following reactions :



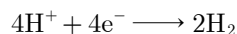
Ans :

SQP 2002



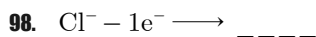
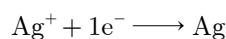
Ans :

MAIN 2011



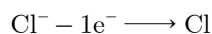
Ans :

MAIN 2015



Ans :

COMP 2009



DIRECTION : Give one word for the following :

99. Electrolytic deposition of a superior metal on a baser metal.

Ans :

MAIN 2014

Electroplating.

100. Electrode used as cathode in electro-refining of impure copper.

Ans :

SQP 2020

Thin strip of pure copper

101. Compounds which conduct electricity in molten state.

Ans :

COMP 2023

Electrovalent compounds

102. Process of formation of ions from the molecules.

Ans :

SQP 2021

Ionisation

103. Process of separation of ions present in an ionic compound.

Ans :

MAIN 2022

Dissociation

104. Agents which conduct electricity in a conductor.

Ans :

COMP 2020

Free electrons

105. Acid added during electrolysis of water.

Ans :

SQP 2015

Concentrated sulphuric acid

106. Gas accumulated in cathodic limb when water is electrolysed.

Ans :

MAIN 2012

Hydrogen

107. A thin film of a non-reactive metal over a superior metal.

Ans :

COMP 2013

Electroplating

108. Process by which impurities from metals are removed electrolytically.

Ans :

SQP 2018

Electrorefining

48. A positively charged non-metallic ion.

Ans :

MAIN 2012

Hydronium (H_3O^+) ion.

49. A non-metallic element which is a conductor of electricity.

Ans :

SQP 2016

Graphite.

50. Name the products formed at the cathode and at the anode when dilute acids (for example sulphuric acid) and alkalies (for example potassium hydroxide) are electrolysed between platinum electrodes.

Ans :

COMP 2018

H_2 is produced at cathode and O_2 is produced at anode.

51. Name the product formed at the anode during the electrolysis of acidified water using platinum electrodes.

Ans :

MAIN 2016

Oxygen

52. Name the metallic ions that should be present in the electrolyte when an article made of copper is to be electroplated with silver.

Ans :

COMP 2016

Silver ions

53. Name a substance which when dissolved in water contains :

- only ions
- ions and molecules.

Ans :

COMP 2018

- Sodium chloride
- Ammonium hydroxide

54. (i) Name the product formed at the anode during the electrolysis of acidified water using platinum electrodes.
(ii) Name the metallic ions that should be present in the electrolyte when an article made of copper is to be electroplated with silver.

Ans :

SQP 2016

- Oxygen
- Silver ions

DIRECTION : Fill in the blanks :

55. As we descend the electrochemical series containing cations, the tendency of the cations to get _____ at the cathode increases. [oxidised/reduced]

Ans :

COMP 2005

reduced

56. The _____ [higher/lower] the concentration of an ion in a solution, the greater is the probability of being discharged at its appropriate electrode.

Ans :

SQP 2005

higher

57. The metal plate through which current enters into an electrolyte is called _____ and it has _____ of electrons.

Ans :

MAIN 2019

anode, deficiency

58. The metal plate through which current leaves from an electrolyte is called _____ and it has _____ of electrons.

Ans :

COMP 2012

cathode, excess

59. The ions which discharge on the negative electrode during electrolysis _____ electrons. Thus the ions are said to be _____.

Ans :

SQP 2000

gain, reduced

60. The ions which discharge on the positive electrode during electrolysis _____ electrons. Thus the ions are said to be _____.

Ans :

MAIN 2010

lose, oxidised

61. Hydrogen and metallic ions are _____ because they _____ electrons at cathode.

Ans :

COMP 2013

cations, gain

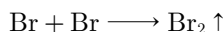
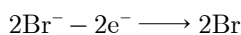
62. Non-metallic ions are _____ because they _____ electrons at anode.

Ans :

MAIN 2015

anions, lose

At Anode



At anode reddish vapours of bromine escape in air from lead bromide.

DIRECTION : Give reasons for the following:

- 127.** An aqueous solution of sodium chloride conducts electricity.

Ans :

COMP 2014

Sodium chloride is an ionic compound which dissociates completely in its aqueous solution into its free ions.

- 128.** Sodium Chloride will conduct electricity only in fused or aqueous solution state.

Ans :

SQP 2016

Sodium chloride is a solid, ionic compound, it has strong electrostatic forces of attraction. Only in the fused or aqueous solution, it forms ions which are capable of conducting electricity.

- 129.** Although copper is a good conductor of electricity, it is a non-electrolyte.

Ans :

COMP 2016

Because it does not form ions.

- 130.** In the electrolysis of acidified water dilute sulphuric acid is preferred to dilute nitric acid for acidification.

Ans :

MAIN 2019

This is because dilute nitric acid is an oxidising agent and may also produce NO.

- 131.** Ammonia is unionised in the gaseous state but in the aqueous solution is a weak electrolyte.

Ans :

SQP 2010

Ammonia is a covalent compound, therefore it is unionised in the gaseous state but in the aqueous solution it gives NH_4OH which dissociates slightly.



- 132.** A graphite anode is preferred to other inert electrodes during electrolysis of fused lead bromide.

Ans :

COMP 2011

A graphite anode is preferred to other inert electrodes during the electrolysis of fused lead

bromide because graphite is unaffected by reactive bromine vapours.

- 133.** For electroplating with silver, silver nitrate is not used as electrolyte.

Ans :

SQP 2012

This is because in this case the deposition of silver will be very fast and hence not very smooth and uniform.

- 134.** Carbon tetrachloride is liquid but does not conduct electricity.

Ans :

MAIN 2015

This is because carbon tetrachloride is a covalent compound and there are no free ions present.

- 135.** Graphite anode is preferred to platinum in the electrolysis of molten lead bromide.

Ans :

COMP 2020

Platinum anode reacts with bromine vapours to form platinum bromide.

- 136.** Although copper is a good conductor of electricity, it is a non-electrolyte.

Ans :

SQP 2016

Because copper does not contain free ions.

DIRECTION : Correct the following statement :

- 137.** Lead bromide conducts electricity.

Ans :

MAIN 2009

Molten lead bromide conducts electricity.

- 138.** Match the following column :

	Column A		Column B
1.	Acid salt	A.	Ferrous ammonium
2.	Double salt	B.	Contains only ions sulphate
3.	Ammonium hydroxide solution	C.	Sodium hydrogen sulphate
4.	Dilute hydrochloric acid	D.	Contains only molecules
5.	Carbon tetrachloride	E.	Contains ions and molecules

Ans :

COMP 2012

1. C, 2. A, 3. E, 4. B, 5. D

Thus (b) is correct option.

- 33.** Which of the following combination is true for carrying out electroplating of an object ?

- (a) Direct and large current.
- (b) Alternating and small current.
- (c) Alternating and large current.
- (d) Direct and small current.

Ans :

MAIN 2013

For electroplating, we will use direct current as in direct current the direction of the current will be the same which will help them to get a deposit on the metal surface and the supply of current is also continuous. We use a small current so that the coating is done smoothly.

Thus (d) is correct option.

- 34.** The electrolysis of acidified water is an example of :

- (a) Reduction
- (b) Oxidation
- (c) Redox reaction
- (d) Synthesis

Ans :

SQP 2019

The electrolysis of acidified water is an example of a redox reaction, which is a reaction that involves both oxidation and reduction.

Thus (c) is correct option.

ASSERTION AND REASON

- 35. Assertion :** In electrolytes, the current passes by the flow of ions.

Reason : Electrolytes allow the passage of electric current in solid states.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2008

Electrolytes allow the passage of electric current in molten, fused, or aqueous solution, not in solid states.

Thus (c) is correct option.

- 36. Assertion :** During electrolysis, a chemical change occurs.

Reason : Electrolysis involves the passage of electric current through a conductor.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2015

The passage of electric current through a conductor does not necessarily involve a chemical change, but it does during electrolysis.

Thus (b) is correct option.

- 37. Assertion :** Strong electrolytes dissociate almost completely in their aqueous solutions.

Reason : Weak electrolytes do not allow any electricity to pass through them.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2010

Weak electrolytes partially dissociate in solution and allow some electricity to pass through them. Thus (c) is correct option.

- 38. Assertion :** Electrolysis is a redox reaction.

Reason : Oxidation and reduction occur at the same electrode during electrolysis.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2020

Oxidation occurs at the anode and reduction at the cathode, not at the same electrode.

Thus (c) is correct option.

- 39. Assertion :** Electrolysis of acidulated water is an example of catalysis.

Reason : Water ionizes completely in the presence of an acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

- 150.** Which of the following substances would conduct electricity ?

(i) Tap water (ii) Dry common salt (iii) Liquid oxygen (iv) Aqueous sugar solution (v) Sulphuric acid containing 100% by mass of sulphuric acid.

Ans : COMP 2019

Tap water will conduct electric current.

- 151.** Explain why copper, though a good conductor of electricity is a non-electrolyte ?

Ans : SQP 2013

This is because copper is a metal and there are free or mobile electrons and there are no ions.

- 152.** Explain why electrolysis is an example of a redox reaction ?

Ans : MAIN 2016

During electrolysis, oxidation occurs at anode and reduction occurs at cathode.

Electrolysis is an example of a redox reaction.

- 153.** State two applications of electrolysis.

Ans : SQP 2016

- (i) Electroplating.
(ii) Electro-refining of metals.

- 154.** What is meant by the term electrolyte?

Ans : MAIN 2017

Electrolyte is an ionic compound which, in fused or molten state or aqueous solution, allows the passage of electric current through it and undergoes chemical decomposition at the same time.

- 155.** What are the particles present in a compound which is a non-electrolyte?

Ans : COMP 2018

Molecules

- 156.** If an electrolyte is described as a strong electrolyte, what does this mean?

Ans : SQP 2020

The electrolyte which allows large amount of current flow through it by completely ionising in its molten state or aqueous solution.

- 157.** State the appropriate term used for a liquid or solution which conducts electricity with accompanying chemical change.

Ans :

SQP 2004

Electrolyte

- 158.** Electrons are getting added to an element Y. Which electrode will Y migrate during the process of electrolysis ?

Ans : MAIN 2004

Anode

- 159.** What should be the physical state of Lead bromide if it is electrolysed?

Ans : COMP 2010

Molten or fused

- 160.** What particles are present in pure Lead bromide?

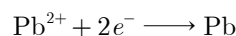
Ans : COMP 2013

Lead ions and Bromide ions

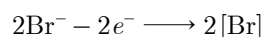
- 161.** Write the equations for the reactions which take place at the electrodes during the electrolysis of Lead bromide.

Ans : MAIN 2017

At Cathode:



At Anode:



- 162.** If HX is a weak acid, what particles will be present in its dilute solution apart from those of water ?

Ans : SQP 2018

H^{+} , X^{-} and HX molecules.

- 163.** What ions must be present in a solution used for electroplating a particular metal ?

Ans : COMP 2011

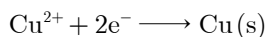
Ions of the metal.

- 164.** Explain how electrolysis is an example of a redox reaction.

Ans : MAIN 2010

During electrolysis, the anions lose electrons and cations gain electrons. Anions undergo oxidation and cations undergo reduction. Therefore, electrolysis is an example of a redox reaction.

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(Copper is deficient in electrons, it will accept two electrons and get deposited at cathode).

- (iii) Carbon tetrachloride is a non-electrolyte because it is a covalent compound, it does not ionise and hence do not conduct electricity.

215. Electrolysis is used in the purification of metals.

Name :

- The anode
- The cathode
- The electrolyte, you would used to get pure copper from a piece of impure copper.

Ans :

COMP 2020

- Impure copper is made as anode.
- A thin sheet of pure copper is made as cathode.
- Acidified copper sulphate solution.

216. Give the precautions to be taken during electroplating.

Ans :

MAIN 2023

Following precautions should be taken during electroplating :

- The surface of the article to be electroplated should be smooth and uniform. It ensures firm deposit.
- The surface should be free from oil and grease.
- The emf of the battery should not be very high.
- A smaller current should be passed for a longer period.
- The electrolyte should not get heated up during electrolysis as otherwise the deposit is neither firm nor uniform.

217. Give two examples in each case :

- Metallic conductors
- Electrolytes
- Non-electrolytes

Ans :

COMP 2014

	Substance	Examples
(a)	Metallic conductors	Copper (Cu), silver (Ag)
(b)	Electrolytes	HCl, NaOH
(c)	Non-electrolytes	Glucose, urea

218. State the reaction occurring at the anode during electrolysis of :

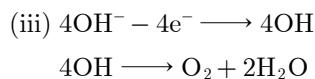
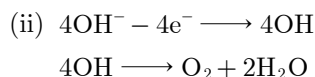
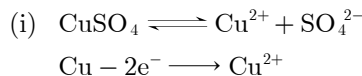
- Copper sulphate solution using a copper

anode.

- Copper sulphate solution using a platinum anode.
- Dilute sulphuric acid using a platinum anode.

Ans :

MAIN 2018



219. Explain the following :

- A solution of cane sugar does not conduct electricity but a solution of sodium chloride is a good conductor.
- During the electrolysis of an aqueous solution of NaCl, H^{+} ions are reduced at cathode and not Na^{+} ions.
- Copper is a good conductor of electricity but it is non-electrolyte.

Ans :

COMP 2015

- This is because cane sugar is a covalent compound and does not dissociate to give ions in solution. Sodium chloride is an ionic compound and dissociate to give ions in solutions. Hence, it conducts electric current.
- H^{+} ions lie far below Na^{+} ions in the electrochemical series and get discharged in preference to Na^{+} ions.
- This is because in copper there are free or mobile electrons. Cu is a non-electrolyte because it does not give ions in solution or in the molten state.

220. The following questions refer to the electrolysis of Copper sulphate solution with Copper electrode:

- Compare the change in mass of the cathode with the change in mass of the anode.
- What is seen to happen to the colour of the Copper sulphate solution if Platinum electrodes are used? Explain this observation.
- What is the practical application of the electrolysis of Copper sulphate solution? Briefly describe one such application.

Ans :

MAIN 2018

- Size of cathode increases.
Size of anode decreases.
- The colour of the solution fades.
- Electro-refining of impure Copper.

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- 172.** State one observation for the following :
Copper sulphate solution is electrolysed using copper electrodes.

Ans :

SQP 2019

When copper sulphate solution is electrolysed using copper electrodes, reddish pink deposit of copper metal takes place on cathode.

- 173.** Differentiate between the following pairs based on the information given in the brackets.

- (i) Conductor and electrolyte (conducting particles)
(ii) Cations and anions (formation from an atom)

Ans :

MAIN 2020

(i) Conductor	Electrolyte
The conducting particles in conductor are the electrons.	The conducting particles in an electrolyte are cations and anions.
(ii) Cations	Anions
Cations are formed by losing of electrons from the neutral isolated gaseous atoms.	Anions are formed by gaining of electrons by the neutral isolated gaseous atoms.

- 174.** (i) Copy and complete the following table :

	Anode	Electrolyte
Purification of copper		

- (ii) Write the equation taking place at the anode.

Ans :

COMP 2015

(i)

	Anode	Electrolyte
Purification of copper	Impure copper	Acidified copper sulphate solution

- (ii) $\text{Cu} - 2\text{e}^- \longrightarrow \text{Cu}^{2+}$

- 175.** For the electro-refining of copper

- (i) What is the cathode made up of ?
(ii) Write the reaction that takes place at the anode.

Ans :

MAIN 2018

- (i) Cathode is made-up of thin sheets of pure copper connected in parallel.
(ii) $\text{Cu} - 2\text{e}^- \longrightarrow \text{Cu}^{2+}$

Copper anode undergoes oxidation forming Cu^{2+} ions which pass into the solution.

- 176.** (i) Copy and complete the following table :
Purification of copper

	Anode	Electrolyte
Purification of copper		

- (ii) Write the equation taking place at the anode.

Ans :

SQP 2015

(i)

	Anode	Electrolyte
Purification of copper	Impure copper	Acidified CuSO_4

- (ii) At Anode : $\text{Cu} - 2\text{e}^- \longrightarrow \text{Cu}^{2+}$

Impure copper anode loses electrons to form copper ions which move to solution.

- 177.** Give appropriate scientific reasons for the following statements :

- (i) During electrolysis of molten lead bromide, graphite anode is preferred to other electrodes.
(ii) Electrolysis of molten lead bromide is considered to be a redox reaction.

Ans :

MAIN 2015

- (i) Graphite anode is preferred because bromine vapours do not react with graphite. On the other hand, even platinum electrodes are attacked by bromine vapours.

- (ii) $\text{PbBr}_2 \rightleftharpoons \text{Pb}^{2+} + 2\text{Br}^-$
Molten Cation Anion

At Cathode : $\text{Pb}^{2+} + 2\text{e}^- \longrightarrow \text{Pb(s)}$
(Reduction)

At Anode : $\text{Br}^- - \text{e}^- \longrightarrow \text{Br}$

$\text{Br} + \text{Br} \longrightarrow \text{Br}_2$ (Oxidation)

Since both reduction and oxidation occur in the same reaction, thus we can say that electrolysis of molten lead bromide is a redox reaction.

- 178.** What do you ionic by electrolysis ?

Ans :

COMP 2017

The chemical process in which the ionic compounds in fused, molten state or aqueous solution allow the passage of electric current and undergo simultaneous chemical decomposition leading to the discharge of ions at electrodes is called as electrolysis.

179. Name the solution which contain:

- (a) Only ions or mostly ions
(b) Only molecules

Ans :

SQP 2019

- (a) Any strong electrolyte
(b) Any non-electrolyte

180. What should be the physical state of the following compounds if it is to conduct electricity?

- (i) Lead bromide
(ii) Sodium chloride

Ans :

MAIN 2020

- (i) Molten or fused.
(ii) Molten or fused and in its aqueous solution.

181. What is the difference between conductivity of Cu metal and of CuSO_4 solution ?

Ans :

COMP 2023

The conductivity of Cu metal is due to the presence of free electrons whereas the conductivity of CuSO_4 is due to ions present in it.

182. Classify the following as strong electrolyte, weak electrolyte and non-electrolyte.

Carbonic acid, Magnesium hydroxide, dilute Nitric acid, Sodium hydroxide, Petrol, Sugar solution.

Ans :

SQP 2021

Strong electrolyte	Weak electrolyte	Non-electrolyte
Dilute Nitric acid, Sodium hydroxide	Carbonic acid, Magnesium hydroxide	Sugar solution, Petrol

183. An aqueous solution containing OH^- , NO_3^- , SO_4^{2-} ions. Name

- (i) the ion which will migrate towards anode.
(ii) the product obtained at anode.

Ans :

MAIN 2023

- (i) OH^-
(ii) Oxygen

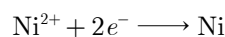
184. Write equations for the reactions taking place at cathode and at anode during the electrolysis of :

- (a) Acidified Nickel sulphate solution with Nickel electrode.
(b) Acidulated water with inert electrodes.

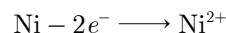
Ans :

COMP 2020

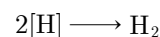
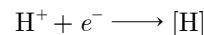
(a) Cathode:



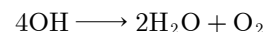
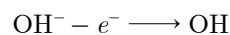
Anode:



(b) Cathode:



Anode:



185. Differentiate between the terms strong electrolyte and electrolyte (stating any two differences).

Ans :

SQP 2012

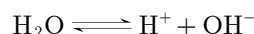
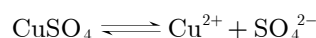
The differentiate between strong electrolyte and electrolyte are as follows :

	Strong electrolyte	Electrolyte
(a)	The electrolyte almost completely dissociates and allow the passage of an electric current.	The electrolyte partially or incompletely dissociates and a very small amount of electric current pass through them.
(b)	They contain ions only.	They contain ions and molecules.

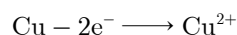
186. An aqueous copper (II) sulphate was electrolysed in the laboratory using copper electrodes. Give the equation for the reaction at the anode.

Ans :

MAIN 2013



Reaction occurring at the anode



187. What is the difference between conductivity of Cu metal and of CuSO_4 solution ?

Ans :

COMP 2017

The conductivity of Cu metal is due to the presence of free electrons whereas the conductivity of CuSO_4 is due to ions present in it.

188. Explain the following terms and also give two examples of each :

- (i) Attackable electrode.
(ii) Non - attackable electrode.

Ans :

MAIN 2019

- (i) Attackable electrode : The electrodes which enter into chemical reactions with the electrolytes are called attackable electrodes. This takes place when the electrode has a lower reduction potential than the ions present in the electrolyte.
Example : Copper, silver, nickel.
- (ii) Non-attackable electrodes : These are inert and don't enter into a chemical reaction. This is because they have a higher reduction potential than the ions present in the electrolyte.
Example : Graphite, platinum.

189. What are the conditions for good electroplating ?

Ans :

COMP 2012

Conditions for good electroplating are :

- (i) A direct current is to be used.
(ii) A low current for a longer time is to be used.
(iii) The article to be electroplated should be cleaned thoroughly.
(iv) The electrolyte must have a high concentration of the metal ions to be deposited on the article.

190. Name the ions present and the products formed at the electrodes (cathode and anode) during electrolysis of :

- (i) Molten lead bromide
(ii) Copper (II) sulphate, using platinum electrodes.

Ans :

MAIN 2014

- (i) Lead ions (Pb^{2+}) and bromide ions (Br^-). Lead (Pb) is produced at cathode and bromine (Br_2) is produced at anode.
(ii) Copper ions (Cu^{2+}), hydrogen ions (H^+), sulphate ions (SO_4^{2-}) and hydroxide ions (OH^-).
Copper is produced at cathode and oxygen (O_2) is produced at anode.

191. What is the value of α (degree of dissociation) for :

- (a) Strong electrolytes,
(b) Weak electrolytes ?

Ans :

COMP 2016

- (a) Strong electrolytes : $\alpha > 30\%$,
(b) Weak electrolytes : $\alpha < 30\%$,

192. Define :

- (a) Electroplating
(b) What are the objects of electroplating ?

Ans :

SQP 2019

- (a) Electroplating : The process of depositing a superior metal over a baser metal through the use of electric current is called electroplating.
(b) Objects of electroplating :
(i) To make the article attractive.
(ii) To protect from corrosion or rusting.
(iii) For repairing of broken articles.

193. When a dilute aqueous solution of NaCl is electrolysed between platinum electrodes, hydrogen gas is evolved at the cathode but metal sodium is not deposited. Give reason.

Ans :

MAIN 2011

Since hydrogen is much below sodium in activity series, hydrogen is discharged at the cathode in preference to sodium. Secondly, the concentration of NaCl is very less which prefers the discharge of hydrogen.

194. The "degree of dissociation of sulphurous acid 20%." What is meant by the above statement? Would you classify sulphurous acid as a strong electrolyte or a weak electrolyte ?

Ans :

COMP 2010

The degree of dissociation of sulphurous acid is 20%. It means that out of every 100 molecules only 20 molecules dissociate into ions. Sulphurous acid is a weak electrolyte. This is because its degree of dissociation is less than 30%.

195. Write the cell reactions for the following:

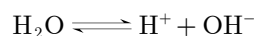
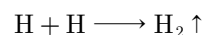
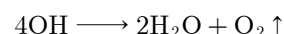
- (i) Electrolysis of conc. solution of CuSO_4 (Cu electrodes)
(ii) Dilute AgNO_3 solution using Ag anode and Cu cathode.

Ans :

SQP 2019

- (i) Conc. solution of $\text{CuSO}_4 \rightleftharpoons \text{Cu}^{2+} + \text{SO}_4^{2-}$
At cathode : $\text{Cu}^{2+} + 2\text{e}^- \longrightarrow \text{Cu}$
At anode : $\text{Cu} - 2\text{e}^- \longrightarrow \text{Cu}^{2+}$

- (ii) Dilute AgNO_3 solution

At cathode : $\text{H}^+ + 1\text{e}^- \longrightarrow \text{H}$ At anode : $4\text{OH}^- - 4\text{e}^- \longrightarrow 4\text{OH}$ 

196. Complete the following table :

Electrolyte	Cathode	Anode	Product at cathode	Product at anode
Dil. sulphuric acid	Platinum	Platinum		
CuSO ₄ solution	Copper	Copper		
CuSO ₄ solution	Platinum	Platinum		

Ans :

COMP 2012

Electrolyte	Cathode	Anode	Product at cathode	Product at anode
Dil. sulphuric acid	Platinum	Platinum	Hydrogen	Oxygen
CuSO ₄ solution	Copper	Copper	Copper	Copper anode dissolves forming Cu ²⁺ ions
CuSO ₄ solution	Platinum	Platinum	Copper	Oxygen

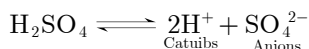
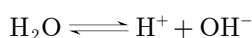
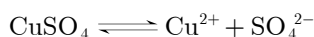
197. Write equations for the reactions taking place at the two electrodes (mentioning clearly the name of the electrode) during the electrolysis of :

- Acidified copper sulphate solution with copper electrodes.
- Molten lead bromide with inert electrodes.

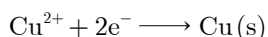
Ans :

SQP 2016

(i) Dissociation reaction :

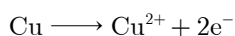


At cathode (negative terminal of battery)



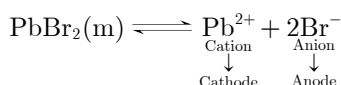
copper metal gets deposited

At anode (positive terminal of battery)

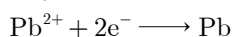


Copper metal gets converted into ions

(ii) Dissociation reaction :

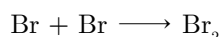


At cathode (negative terminal of battery)



Lead metal is obtained in molten state

At anode (positive terminal of battery)



THREE MARKS QUESTIONS

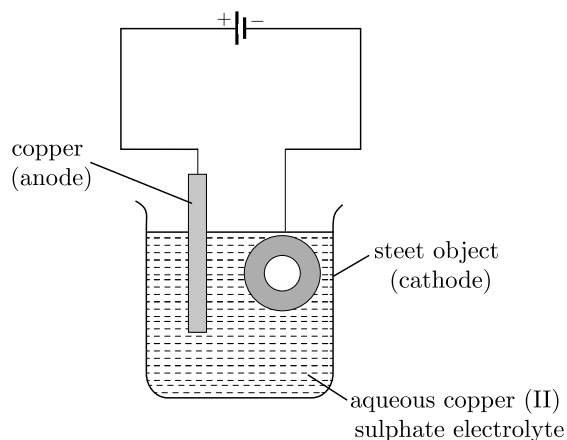
198. Electroplating steel objects with silver involves a three-step process.

Step 1 : A coating of copper is applied to the object.

Step 2 : A coating of nickel is applied to the object.

Step 3 : The coating of silver is applied to the object.

- (i) A diagram of the apparatus used for step 1 is shown.



- (a) The chemical process taking place on the surface of the object is $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu(s)}$. What is the observation seen on the surface of the object?

- (b) Explain why the concentration of copper ions in the electrolyte remains constant throughout step.

- (ii) Give two changes which would be needed in order to coat nickel onto the object in step 2.
 (iii) Write down the reaction taking place at the positive electrode

Ans :

SQP 2025

- (i) (a) reddish brown deposit/pink deposit/mass increases
 (b) As anode released Copper ions the concentration of copper ions does not

decrease

- (ii) Anode should be made up of Nickel and the electrolyte should be aq. Nickel sulphate or any salt solution of Nickel
 (iii) $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$

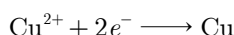
199. During the electrolysis of copper (II) sulphate solution using platinum as cathode and carbon as anode:

- (i) What do you observe at the cathode and at the anode?
 (ii) What change is noticed in the electrolyte?
 (iii) Write the reactions at the cathode and at the anode.

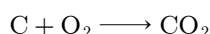
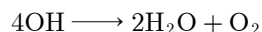
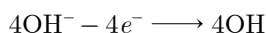
Ans :

COMP 2011

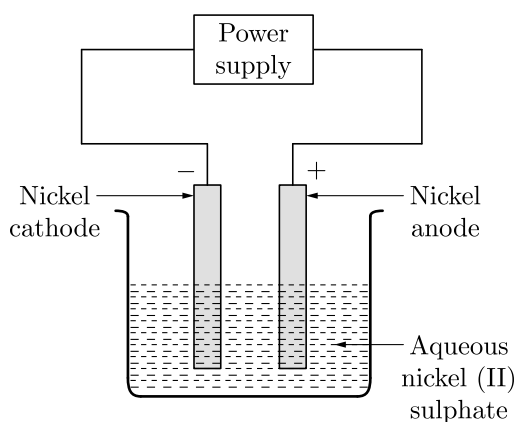
- (i) Cathode size increases and Anode-size decreases.
 (ii) The blue solution slowly fades away.
 (iii) Cathode :



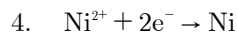
Anode :



200. An aqueous solution of nickel (II) sulphate was electrolysed using nickel electrodes. Observe the diagram and answer the questions that follow :



- (i) What do you observe at the cathode and anode respectively ?
 (ii) Name the cation that remains as a spectator ion in the solution.
 (iii) Which equation for the reaction at the anode is correct ?
 1. $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$
 2. $\text{Ni} + 2\text{e}^- \rightarrow \text{Ni}^{2+}$
 3. $\text{Ni}^{2+} \rightarrow \text{Ni} + 2\text{e}^-$



Ans :

COMP 2012 SQP 2020

- (i) Anode gets thinner because of the dissolution of nickel electrode into the solution.
 Cathode gets thicker due to deposition of nickel metal on the electrode.
 (ii) Hydrogen ion
 (iii) 1. $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$

201. Three different electrolytic cells A, B and C are connected in separate circuits. Electrolytic cell A contains sodium chloride solution. When the circuit is completed bulb in the circuit glows brightly. Electrolytic cell B contains acetic acid solution and in this case the bulb in the circuit glows dimly. The electrolytic cell C contains sugar solution and the bulb does not glow. Give a reason for each of these observations.

Ans :

SQP 2010

Cell A : Strong electrolyte (NaCl) $\longrightarrow$ Bulb glows brightly.

Cell B : Weak electrolyte (Acetic acid) $\longrightarrow$ Bulb glows dimly.

Cell C : Non-electrolyte (Sugar solution) $\longrightarrow$ Bulb doesn't glow.

202. What will you observe (a) at cathode (b) at anode (c) in electrolyte during the electrolysis of Copper sulphate solution with Copper electrodes?

Ans :

COMP 2017

- (a) At cathode - Size of cathode increases
 (b) At anode - Size of anode decreases
 (c) Electrolyte - The colour of electrolyte remains the same, i.e. blue.

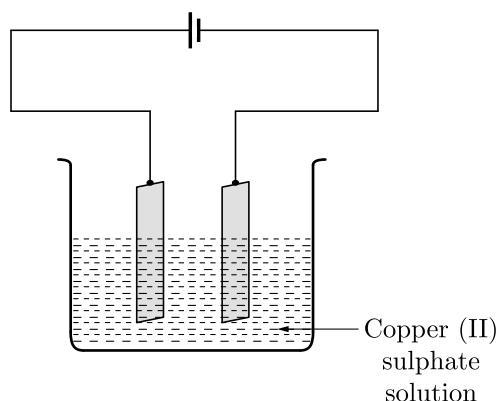
203. (a) Name the metals extracted by electrolysis.
 (b) Name the compounds from which these metals are extracted.
 (c) What is the state of the compounds from which these metals are extracted?

Ans :

SQP 2019

- (a) Sodium, Potassium, Calcium, Magnesium, etc.
 (b) These metals are extracted from their chlorides, i.e.
 Sodium - Sodium chloride
 Potassium - Potassium chloride
 Calcium - Calcium chloride
 Magnesium - Magnesium chloride
 (c) They are extracted in their fused or molten state.

- 204.** Copper sulphate solution is electrolysed using copper electrodes. Study the diagram given below and answer the questions that follow :

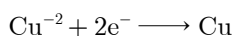


- Which electrode to your left or right is known as the oxidising electrode and why?
- Write the equation representing the reaction that occurs.
- State two appropriate observations for the above electrolysis reaction.

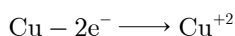
Ans :

MAIN 2013

- Left (anode; positive terminal of the battery). It is called the oxidising electrode as anions give their electrons to anode and thus undergo oxidation.
- At cathode (negative terminal of battery; rich in e^-)



At anode (positive terminal of battery ; deficient in e^-)



- (1) Blue colour of CuSO_4 solution does not fade.
- (2) Anode withers away. Loss in weight of anode is always equal to gain in weight of cathode.

- 205.** The following questions relate to the electroplating of an article with nickel :

- Name the electrode formed by the article to be plated.
- What ions must be present in the electrolyte?
- What should be the nature of the anode ?

Ans :

COMP 2020

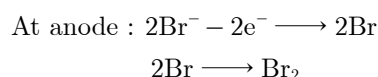
- Cathode
- Nickel ions (Ni^{2+})
- Attackable electrode.

- What should be the physical state of the lead bromide if it is to conduct electricity?
- What particles are present in pure lead bromide?
- Write the equations for the reactions which take place at electrodes during the electrolysis of lead bromide.

Ans :

SQP 2021

- Molten or dissolved (aqueous)
- Lead (Pb^{2+}) and bromide (Br^-) ions
- At cathode : $\text{Pb}^{2+} + 2e^- \longrightarrow \text{Pb}$



- 207.** Acidulated water is electrolysed in Hofmann's voltmeter to liberate two gases. In this context answer the following questions.

- Name the gases evolved at each electrode.
- What is the material used for electrodes?
- What is the ratio of gases evolved by volume?

Ans :

COMP 2010

- Cathode-Hydrogen
Anode - Oxygen
- Platinum
- $\text{H}_2 : \text{O}_2 \equiv 2 : 1$

- 208.** Name all the particles present in

- Sodium chloride solution
- Molten Sodium chloride
- Sulphurous acid

Ans :

MAIN 2015

- Sodium ions - Chloride ions
Hydrogen ions - Hydroxyl ions
Water molecules.
- Sodium ions and Chloride ions
- Hydrogen ions - Sulphite ions
Hydroxyl ions
Sulphurous acid molecule
Water molecule

- 209.** Pick out electrolytes and non-electrolytes from the following :

- Sugar solution
- dilute sulphuric acid
- fused lead bromide
- solution of sulphur in carbon disulphide
- aqueous sodium chloride solution
- solid potassium chloride
- ethyl alcohol
- acidulated water
- caustic soda solution
- petrol.

Ans :

COMP 2017

Electrolytes : Dilute sulphuric acid, fused lead

bromide, aqueous sodium chloride solution, acidulated water, caustic soda solution.

Non-electrolytes : Solution of sulphur in carbon disulphide, solid potassium chloride, ethyl alcohol, petrol, sugar solution.

210. The following questions refer to the electrolysis of copper sulphate solution with copper electrodes :

- Compare the change in mass of the cathode with the change in mass of anode.
- What happens to the colour of copper sulphate solution of platinum electrodes are used ? Explain with observation.
- What is the practical application of the electrolysis of copper sulphate solution ? Briefly describe one such application.

Ans :

SQP 2019

- The mass of cathode increases and that of anode decreases.
- If platinum electrodes are used, the colour of copper sulphate solution fades due to the deposition of copper on platinum cathode and concentration of copper ions in solution goes on decreasing.
- The practical application of electrolysis of copper sulphate solution is the refining of copper. The impure copper is made as anode and a thin sheet of pure copper is made as cathode. The electrolyte is an acidified solution of copper sulphate. On passing an electric current pure copper from anode gets deposited over cathode through the electrolyte.

211. Explain the following :

- A solution of cane sugar does not conduct electricity but a solution of sodium chloride is a good conductor.
- During the electrolysis of an aqueous solution of NaCl, H^+ ions are reduced at cathode and not Na^+ ions.
- Copper is a good conductor of electricity but it is non-electrolyte.

Ans :

MAIN 2011

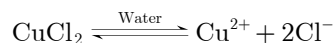
- This is because cane sugar is a covalent compound and does not dissociate to give ions in solution. Sodium chloride is an ionic compound and dissociate to give ions in solutions. Hence, it conducts electric current.
- H^+ ions lie far below Na^+ ions in the electrochemical series and get discharged in preference to Na^+ ions.

- This is because in copper there are free or mobile electrons. Cu is a non-electrolyte because it does not give ions in solution or in the molten state.

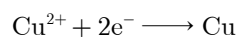
212. Describe what you would see at anode and cathode during electrolysis of copper (II) chloride, using platinum cathode and carbon anode. Write ionic equations for the reactions at anode and cathode.

Ans :

COMP 2013

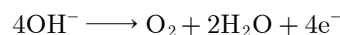


At cathode:



Copper gets deposited at cathode

At anode :



213. The following questions related to the electroplating of an article with silver :

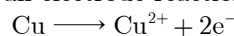
- Name the electrode formed by the article to be plated.
- What ions must be present in the electrolyte?
- What should be the nature of anode?

Ans :

SQP 2015

- Cathode
- Silver ions
- Attackable

214. (i) Here is an electrode reaction :



At which electrode (anode or cathode) would such a reaction takes place? Is this an example of oxidation or reduction?

- A solution containing magnesium ions (Mg^{2+}), iron (II) ions (Fe^{2+}) and copper ions (Cu^{2+}). On passing an electric current through this solution which ions will be the first to be discharged at the cathode ? Write the equation for the cathode reaction.
- Why is carbon tetrachloride, which is a liquid a non-electrolyte?

Ans :

MAIN 2018

- $Cu \longrightarrow Cu^{2+} + 2e^-$
This reaction takes place at anode.
This is an example of oxidation.
- Cu^{2+} (Copper ions will get discharged at cathode).
Note : An ion present lower in the electrochemical series gets discharged at the relevant electrode in preference to ions above it.

TWO MARKS QUESTIONS

165. $X - \text{HCl} \rightleftharpoons \text{H}^+ + \text{Cl}^-$ (in solution state)

$Y - \text{PbBr}_2 \rightleftharpoons \text{Pb}^{2+} + 2\text{Br}^-$ (in molten state)

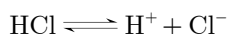
From the above reactions X or Y, identify the reaction which exhibits:

- (a) electrolytic dissociation
- (b) ionisation

Ans :

MAIN 2024

- (a) The ions are formed in molten state while in the solid state the ions are packed tightly together due to the electrostatic force between them. So, $\text{PbBr}_2 \rightleftharpoons \text{Pb}^{2+} + 2\text{Br}^-$ or reaction Y will show electrolytic dissociation.
- (b) The reaction X in the solution state gives an ionisation reaction.



166. Give appropriate scientific reasons for the following statements:

- (i) During electrolysis of molten lead bromide graphite anode is preferred to other electrodes.
- (ii) Electrolysis of molten lead bromide is considered to be a redox reaction.

Ans :

COMP 2015

- (i) Graphite is chemically inert and does not undergo chemical reaction with bromine vapours.
- (ii) Reduction takes place at cathode and oxidation takes place at anode simultaneously.

167. Classify each of the following electrolytes as strong electrolytes or weak electrolytes :

- (i) Sodium hydroxide solution
- (ii) Potassium nitrate solution
- (iii) Dilute sulphuric acid
- (iv) Acetic acid
- (v) Pure sulphuric acid
- (vi) Pure water
- (vii) Ammonia solution

Ans :

MAIN 2000

Strong electrolytes : Sodium hydroxide solution, potassium nitrate solution, dilute sulphuric acid.

Weak electrolytes : Acetic acid, pure sulphuric acid, pure water, ammonia solution.

168. Give reason why in the electroplating of an article with silver, the electrolyte sodium argento-cyanide solution is preferred over silver nitrate solution.

Ans :

SQP 2016

The rate of dissociation is high in the case of silver nitrate as it is ionic molecule and hence the plating is not smooth and uniform while sodium argento-cyanide being a complex molecule provides smooth and even plating.

169. Differentiate between electrical conductivity of copper sulphate solution and copper metal.

Ans :

COMP 2011

The Differentiate between electrical conductivity of copper sulphate solution and copper metal are as follows :

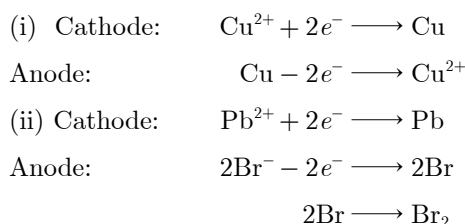
	Copper sulphate solution	Copper metal
(i)	Flow of electricity is due to movement of ions.	Flow of electricity is due to movement of electrons.
(ii)	Chemical change takes place.	Physical change takes place.

170. Write equations for the reactions taking place at the two electrodes (mentioning clearly the name of the electrode) during the electrolysis of:

- (i) Acidified copper sulphate solution with copper electrodes.
- (ii) Molten lead bromide with inert electrodes.

Ans :

SQP 2016



171. Three different electrolytic cells A, B and C are connected in separate circuits. Electrolytic cell A contains sodium chloride solution. When the circuit is completed, a bulb in the circuit glows brightly. Electrolytic cell B contains acetic acid solution and in this case the bulb in the circuit glows dimly. The electrolytic cell C contains sugar solution and the bulb does not glow. Give a reason for each of these observations.

Ans :

COMP 2016

Electrolytic cell A is a strong electrolyte.
 Electrolytic cell B is a weak electrolyte.
 Electrolytic cell C is a non-electrolyte.

221. Give one example in each case of a substance which contains

- Ions only
- Molecules only
- Both ions and molecules.

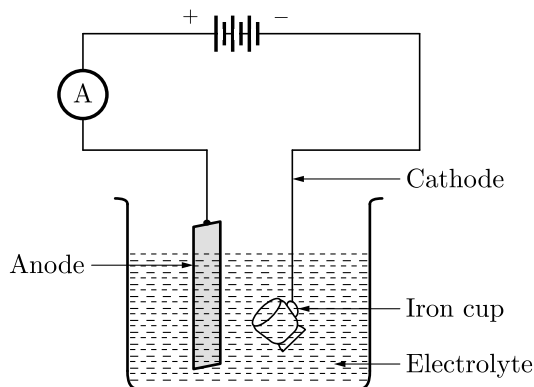
Ans :

SQP 2016

- Sodium chloride solution
- Carbon tetrachloride
- Acetic acid

FOUR MARKS QUESTIONS

222. The following sketch represents the electroplating of an iron cup with Nickel metal. Study the diagram and answer the following questions.



- During electroplating the iron cup is placed at the cathode. Why?
- Name the ion that must be present in the electrolyte.
- State one condition that is necessary to ensure that the deposit is smooth, firm and even.
- Write the reaction taking place at the cathode.
- What change would you observe at the anode?

Ans :

MAIN 2024

- The metal which is to be electroplated should always be at cathode in electroplating. Therefore, the metal ion (Ni^{2+}) in it gets reduced at the cathode and forms a layer on it.
- Cation: Ni^{2+} and anion depend upon the electrolyte taken.
- The passage of low current (or long time is a necessary condition to ensure the deposit is smooth, even and firm.
- $\text{Ni}^{2+} + 2e^- \longrightarrow \text{Ni}$

- Negatively charge ions (depends upon the electrolyte) move toward the anode but do not discharged due to nature of the electrode. But Ni losses two electrons converted into Ni^{2+} in the solution. That results anode electrode get thinner and iron nip becomes thicker over the time of electrolysis.

223. Mr. Ramu wants to electroplate his key chain with nickel to prevent rusting. For this electroplating :

- Name the electrolyte.
- Name the cathode.
- Name the anode.
- Give the reaction at the cathode.
- Give the reaction at the anode.

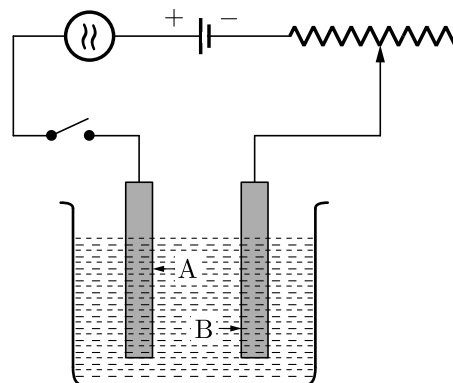
Ans :

SQP 2010

- Nickel sulphate
- Key chain
- Nickel electrode
- At cathode : $\text{Ni}^{2+} + 2e^- \longrightarrow \text{Ni(s)}$
- At anode : $\text{Ni(s)} - 2e^- \longrightarrow \text{Ni}^{2+}$

224. (i) Study the diagram given below and answer the questions that follow :

- Give the names of the electrodes A and B.
 - Which electrode is the oxidising electrode?
- (ii) A strip of copper is placed in four different colourless salt solutions. They are KNO_3 , AgNO_3 , $\text{Zn(NO}_3)_2$, $\text{Ca(NO}_3)_2$. Which one of the solutions will finally turn blue ?
- (iii) Write the equations of the reactions which take place at the cathode and anode when acidified water is electrolysed.



Ans :

COMP 2000

- (a) A is anode
B is cathode
 - (b) A
- (ii) AgNO_3

of hydrogen gas to be used in a fuel cell. The lab needs to calculate the volume of hydrogen gas produced, the total charge required and the time needed for the electrolysis process.

(Given, The reaction: $2\text{H}_2 \longrightarrow 2\text{H}_2 + \text{O}_2$, Molar volume of gas at STP = 22.4 L/mol, Faraday's constant = 96,485 C/mol, Current = 2 A)

- Calculate the number of moles of water required to produce 4 moles of hydrogen gas.
- Determine the total charge (in coulombs) required for the electrolysis.
- Calculate the volume of hydrogen gas produced at STP.
- Determine the time (in seconds) required for the electrolysis process.

Ans :

(i) Moles of H_2 = 4 moles

Moles of H_2O required = 4 moles

(ii) Charge = 4 moles of $\text{e}^- \times 96,485 \text{ C/mol}$
= 385,940 C

(iii) Volume of H_2 = $4 \times 22.4 \text{ L} = 89.6 \text{ L}$

(iv) Time = $\frac{\text{Charge}}{\text{Current}} = \frac{385,940 \text{ C}}{2 \text{ A}}$
= 192,970 s

Convert to hours: Time ≈ 53.6 hours

- 247.** A chemical plant is extracting aluminum from aluminum oxide (Al_2O_3) using the Hall-Heroult process. The process involves electrolysis at high temperatures with a molten cryolite (Na_3AlF_6) electrolyte. The plant needs to calculate the amount of aluminum produced, the total energy consumption and the cost of electricity for the process.

(Given, The reaction: $2\text{Al}_2\text{O}_3 \longrightarrow 4\text{Al} + 3\text{O}_2$, Molar mass of Al = 27 g/mol, Faraday's constant = 96,485 C/mol, Energy cost of electricity = ₹ 0.10 per kWh)

- Calculate the number of moles of Al_2O_3 required to produce 108 grams of aluminum.
- Determine the total charge (in coulombs) required for the electrolysis process.
- Calculate the total energy consumption (in kWh) if the voltage applied is 5V.
- Determine the cost of electricity for the process.

Ans :

(i) Moles of Al = $\frac{108 \text{ g}}{27 \text{ g/mole}} = 4$ moles

Moles of Al_2O_3 required = 2 moles

(ii) Charge = 4 moles of $\text{e}^- \times 96,485 \text{ C/mol}$
= 385,940 C

(iii) Energy (in joules)
= Charge (in coulombs) $\times$ Voltage
= 385,940 C $\times$ 5 V
= 1,929,700 J

Convert joules to kWh:

Energy (in kWh) = $\frac{1,929,700 \text{ J}}{3.6 \times 10^6 \text{ J/kWh}}$
 $\approx 0.536 \text{ kWh}$

(iv) Cost = Energy (in kWh) $\times$ Cost per kWh

Cost = 0.536 kWh $\times$ 10

= ₹ 5.36

- 248.** A researcher is studying the electrolysis of molten potassium chloride (KCl) to produce potassium metal (K) and chlorine gas (Cl_2). The researcher needs to determine the amount of potassium produced, the total charge required and the potential environmental impact of the chlorine gas released.

(Given, The reaction: $2\text{KCl} \longrightarrow 2\text{K} + \text{Cl}_2$, Molar mass of K = 39 g/mol, Molar mass of Cl_2 = 71 g/mol, Faraday's constant = 96,485 C/mol, Molar volume of gas at STP = 22.4 L/mol)

- Calculate the number of moles of KCl required to produce 78 grams of potassium metal.
- Determine the mass of chlorine gas (Cl_2) produced as a byproduct.
- Calculate the total charge (in coulombs) required for the electrolysis process.
- Determine the volume of chlorine gas (Cl_2) produced at STP and discuss its environmental impact.

Ans :

(i) Moles of K = $\frac{78 \text{ g}}{39 \text{ g/mol}} = 2$ moles

Moles of KCl required = 2 moles

(ii) Moles of Cl_2 produced = 1 mole

Mass of Cl_2 = $1 \times 71 \text{ g/mol}$
= 71 g

(iii) Charge = 2 moles of $\text{e}^- \times 96,485 \text{ C/mol}$
= 192,970 C

(iv) Volume of Cl_2 = $1 \times 22.4 \text{ L}$
= 22.4 L

228. Answer the following questions about electroplating of copper wire with silver :

- What ions must be present in the electrolyte?
- Of what substance must the anode be made ?
- What will be made as cathode ?
- What is the equation for the reaction which takes place at the cathode ?

Ans :

MAIN 2010

- Silver (Ag^+) ions
- Pure silver
- Copper
- $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$

229. Mr. Ramu wants to electroplate his key chain with nickel to prevent rusting. For this electroplating:

- Name the electrolyte.
- Name the cathode.
- Name the anode.
- Give the reaction at the cathode.
- Give the reaction at the anode.

Ans :

COMP 2010

- Acidified nickel sulphate solution.
- Key chain
- Pure nickel
- $\text{Ni}^{2+} + 2\text{e}^- \longrightarrow \text{Ni}$
- $\text{Ni} - 2\text{e}^- \longrightarrow \text{Ni}^{2+}$

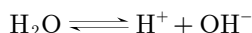
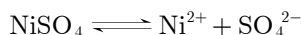
230. What are :

- Electrolytes
- Electrodes
- Electrode reactions during the electroplating of an article with :
(i) Ni, (ii) Ag ?

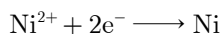
Ans :

SQP 2012

- Electroplating of article with nickel :
(a) Electrolyte : Acidified solution of nickel sulphate (NiSO_4).
(b) Electrodes :
Cathode : Cleaned article to be electroplated.
Anode : Block of pure nickel.
(c) Electrode reactions :



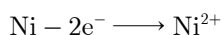
At cathode :



Ni gets deposited over the article.

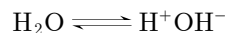
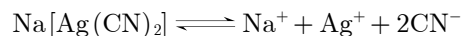
At anode :

Ni anode undergoes oxidation to give Ni^{2+} ions which pass into solution.

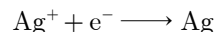


(ii) Electroplating of article with silver :

- Electrolyte : An aqueous solution of sodium argento cyanide, $\text{Na} [\text{Ag} (\text{CN})_2]$.
- Electrodes :
Cathode : Cleaned article to be electroplated.
Anode : Block or plate of pure silver.
- Electrode reactions :



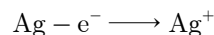
At cathode :



Ag gets deposited over the cathode.

At anode :

Ag anode undergoes oxidation forming Ag^+ ions which pass into solution.



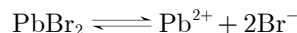
231. With respect to the electrolysis of lead bromide, answer the following questions :

- Why is the lead bromide maintained in a molten state?
- Why is the electrolytic cell made of silica?
- Name the ions present in the electrolyte.
- State what you observe at the (a) cathode (b) anode.
- Summarize the electrode reactions.

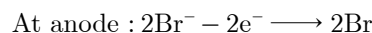
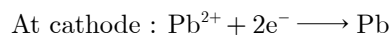
Ans :

COMP 2011

- In the molten state, the ions can move freely.
- This is because silica is heat resistant and a bad conductor of the electricity.
- Lead ions (Pb^{2+}) and bromide ions (Br^-).
- Pb is deposited as silvery white metal at cathode and Br_2 a reddish brown gas is evolved at anode.
- Dissociation of PbBr_2 :



Reactions taking place are :



Overall reaction :



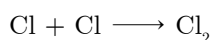
- 232.** (a) Sodium is extracted from molten sodium chloride.
(b) Aluminium is extracted from molten alumina (Al_2O_3).
For the above processes
(i) Name the cathode and anode used in

Cathode : Iron

Reactions occurring : (prominent)

At cathode : $\text{Na}^+ + \text{e}^- \longrightarrow \text{Na}$

At anode : $2\text{Cl}^- - 2\text{e}^- \longrightarrow 2\text{Cl}$



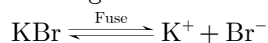
(ii) Potassium (K)

Electrolyte : Fused potassium bromide containing additional salts.

Anode : Graphite

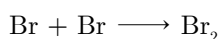
Cathode : Iron

Reactions occurring :



At cathode : $\text{K}^+ + \text{e}^- \longrightarrow \text{K}$

At anode : $2\text{Br}^- - 2\text{e}^- \longrightarrow 2\text{Br}$

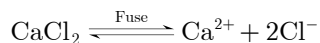


(iii) Calcium (Ca)

Electrolyte : Fused calcium chloride containing additional salts.

Anode : Graphite

Cathode : Iron



Reactions occurring :

At cathode : $\text{Ca}^{2+} + 2\text{e}^- \longrightarrow \text{Ca}$

At anode : $2\text{Cl}^- - 2\text{e}^- \longrightarrow 2\text{Cl}$



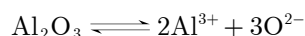
(iv) Aluminium (Al)

Electrolyte : Pure alumina (Al_2O_3) dissolved in molten cryolite, $\text{Na}_3[\text{AlF}_6]$

Anode : Carbon rods

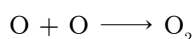
Cathode : Carbon lining

Reactions occurring :



At cathode : $\text{Al}^{3+} + 3\text{e}^- \longrightarrow \text{Al}$

At anode : $\text{O}^{2-} - 2\text{e}^- \longrightarrow \text{O}$



Al is produced at cathode and O_2 is produced at anode.

238. With reference to electroplating, answer the following :

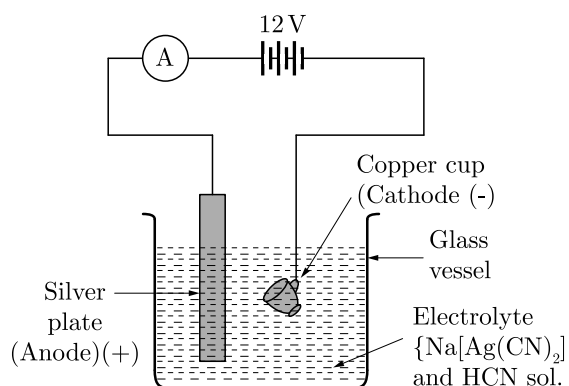
- (i) Why are articles electroplated ?
- (ii) During electroplating, explain why :
 - (a) a direct current is used.
 - (b) a small current should be used for a longer time.
 - (c) the articles to be electroplated should always be placed at the cathode.
 - (d) the anode must be made of the metal with which the article has to be plated.

Ans :

MAIN 2011

- (i) The articles are electroplated :
 - (a) to prevent articles from rusting.
 - (b) to enhance the appearance of articles.
- (ii) (a) To get a smooth coating.
- (b) This is because the thickness of the coating depends on the time for which the current is passed.
- (c) This is because the metal is always deposited at the cathode.
- (d) This is because the anode continuously dissolves and produces metal ions in the solution.

- 239.** (a) Name the cathode and anode used during electroplating of silver.
- (b) Name the electrolyte used in this process.
 - (c) Give the dissociation reactions taking place.
 - (d) Give the reactions occurring at cathode and anode.
 - (e) The overall strength of silver ions remain constant in the reaction. Why ?



Ans :

SQP 2014

- (a) Cathode : Highly cleaned article such as copper cup.
Anode : A plate or rod of silver.
- (b) Sodium argento cyanide ($\text{Na}[\text{Ag}(\text{CN})_2]$) and hydrocyanic acid (HCN).
- (c) $\text{Na}[\text{Ag}(\text{CN})_2] \rightleftharpoons \text{Na}^+ + \text{Ag}^+ + 2\text{CN}^-$
 $\text{HCN} \rightleftharpoons \text{H}^+ + \text{CN}^-$
 $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$
- (d) At cathode :
 $\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$
 At anode :
 $\text{Ag} - \text{e}^- \longrightarrow \text{Ag}^+$
- (e) Overall strength of silver ions does not change in the electrolyte as the number of Ag^+ ions entering the electrolyte is equal to the number of Ag^+ ions discharged at cathode.

	Electrical conductivity of copper sulphate solution	Electrical conductivity of copper metal
1.	Flow of electricity takes place in the molten or dissolved state.	Flow of electricity takes place in the solid state.
2.	Flow of electricity is due to the movement of ions.	Flow of electricity is due to the movement of electrons.
3.	There is chemical decomposition of the copper sulphate solution.	There is no chemical decomposition.
4.	The electrical conductivity increases with the increase in temperature.	The electrical conductivity decreases with the increase in temperature.

- (b) (i) Cathode : Reddish brown deposition of copper occurs at cathode.
Anode : Colour less gas is evolved at anode.
- (ii) On prolonged electrolysis, the blue electrolyte turns colour less.
- (iii) Cathode : $\text{Cu}^{2+} + 2\text{e}^- \longrightarrow \text{Cu}$
Anode : $\text{OH}^- - 1\text{e}^- \longrightarrow \text{OH}$



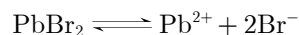
236. Give reasons for the following :

- Electrolysis of molten lead bromide is considered a reaction in which oxidation and reduction i.e., a redox reaction occurs.
- The blue colour of aqueous copper sulphate fades when it is electrolysed using platinum electrodes.
- Lead bromide undergoes electrolytic dissociation in the molten state but is a non-electrolyte in the solid state.
- Aluminium is extracted from its oxide by electrolytic reduction and not by conventional reducing agents.
- The volume of hydrogen and oxygen formed at the cathode and anode are 2 : 1 by volume respectively.

Ans :

COMP 2018

- (i) During the electrolysis of molten lead bromide,



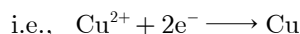
At cathode : $\text{Pb}^{2+} + 2\text{e}^- \longrightarrow \text{Pb}$

At anode : $2\text{Br}^- - 2\text{e}^- \longrightarrow 2\text{Br}$
 $\downarrow$
 Br_2

Br^- undergoes oxidation whereas Pb^{2+} undergoes reduction.

It is a redox reaction.

- (ii) During the electrolysis of an aqueous solution of CuSO_4 , using Pt electrodes, Cu^{2+} ions are discharged at cathode.

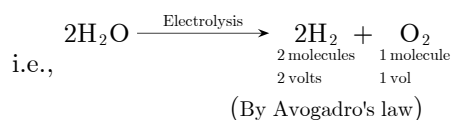


Concentration of Cu^{2+} ions goes on decreasing. Hence, the blue colour of the solution slowly fades away.

- (iii) In PbBr_2 in the solid state, there are strong electrostatic forces of attraction between Pb^{2+} and Br^- ions. The ions can't move. Hence, it is a non-electrolyte. In the molten state, the electrostatic forces of attraction between Pb^{2+} and Br^- ions are very much decreased. The ions become mobile.

It undergoes electrolytic dissociation.

- (iv) This is because aluminum is a good reducing agent and has a great affinity for oxygen and can't be reduced by reducing agent.
- (v) During the electrolysis of water, formation of 1 molecule of O_2 at anode releases four electrons which are taken up by H^+ ions forming two molecules of hydrogen.



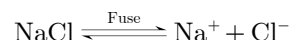
- 237.** (a) Define electro-metallurgy.
(b) Indicate electrolyte, anode, cathode, anodic and cathodic reaction during the extraction of Na, K, Ca, Al electrolytically.

Ans :

SQP 2019

- (a) Electro-metallurgy: The process of extraction of reactive metals which are higher in the electrochemical series such as sodium, potassium, calcium, aluminium from their ores through the use of electric current or electrolysis is called electrometallurgy.
- (b) Electro-metallurgy of :
- (i) Sodium (Na)

Electrolyte : Fused sodium chloride containing additional salts.



Anode : Graphite

each case.

- (ii) Summarize the electrode reactions for each of the above mentioned extractions.
- (iii) Explain why metals above zinc in the activity series of metals are extracted from their ores by electrolysis.

Ans :

SQP 2015

- (a) (i) Sodium is extracted from molten sodium chloride :
Electrodes :
Cathode : Steel
Anode : Graphite
- (ii) Reaction at electrodes :
Dissociation of molten $\text{NaCl} \rightleftharpoons \text{Na}^+ \text{Cl}^-$
At cathode : $\text{Na}^+ + \text{e}^- \longrightarrow \text{Na}$
At anode : $\text{Cl}^- - \text{e}^- \longrightarrow \text{Cl}$
- (b) (i) Extraction of aluminum :
Electrodes :
Cathode : Gas carbon
Anode : Carbon rods
- (ii) Dissociation of Al_2O_3 :
 $\text{Al}_2\text{O}_3 \rightleftharpoons 2\text{Al}^{3+} + 3\text{O}^{2-}$
Cathode : $2\text{Al}^{3+} + 6\text{e}^- \longrightarrow 2\text{Al}$
Anode : $3\text{O}^{2-} - 6\text{e}^- \longrightarrow 3\text{O}$
 $3\text{O} + 3\text{O} \longrightarrow 3\text{O}_2$
- (iii) This is because oxides of these metals are very stable and cannot be decomposed by heat or reducing agents.

233. State the electrode reaction at the anode during the electrolysis of :

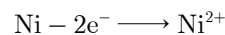
- (i) Aqueous copper sulphate using platinum electrodes
- (ii) Acidified water
- (iii) Aqueous nickel sulphate solution using nickel anode
- (iv) Pure alumina $[\text{Al}_2\text{O}_3]$
- (v) Fused lead bromide.

Ans :

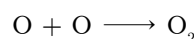
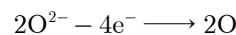
COMP 2018

Electrode reaction occurring at anode during the electrolysis of :

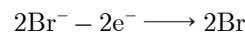
- (i) Aqueous copper sulphate using Pt electrodes:
 $4\text{OH}^- - 4\text{e}^- \longrightarrow 4\text{OH}$
 $4\text{OH} \longrightarrow \text{O}_2 + 2\text{H}_2\text{O}$
- (ii) Acidified water :
 $4\text{OH}^- - 4\text{e}^- \longrightarrow 4\text{OH}$
 $4\text{OH} \longrightarrow \text{O}_2 + 2\text{H}_2\text{O}$
- (iii) Aqueous NiSO_4 solution using nickel anode:



- (iv) Pure alumina :



- (v) Fused lead bromide :



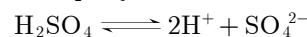
234. With reference to the electrolysis of acidulated water, answer the following :

- (i) Explain why distilled water is a non-electrolyte.
- (ii) What is the electrolytic cell called ?
- (iii) State what would you observe at the :
(a) anode, (b) cathode.
- (iv) Summarize the electrode reactions.

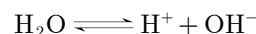
Ans :

SQP 2019

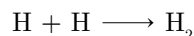
- (i) Distilled water is a covalent compound. In the absence of ions it does not conduct electricity.
- (ii) Hofmann's voltmeter.
- (iii) O_2 is liberated at anode and H_2 is liberated at cathode.
- (iv) Dissociation of H_2SO_4 :



Dissociation of H_2O :

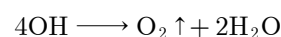


At cathode : $\text{H}^+ + \text{e}^- \longrightarrow \text{H}$

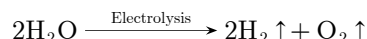


H_2 is produced at cathode.

At anode : $\text{OH}^- - \text{e}^- \longrightarrow \text{OH}$



Overall reaction :



- 235.** (a) Differentiate between electrical conductivity of copper sulphate solution and copper metal.
- (b) During the electrolysis of copper (II) sulphate solution using platinum as cathode and carbon as anode :
- (i) What do you observe at the cathode and at the anode ?
 - (ii) What change is noticed in the electrolyte ?
 - (iii) Write the reactions at the cathode and at the anode.

Ans :

MAIN 2016

- (a) The differentiate between electrical conductivity copper sulphate solution and copper metal are as follows:

240. (a) Complete the table giving (i) ions present (ii) products at the electrodes during electrolysis:

	Substance	Ions present	Product at	
			Cathode	Anode
1.	Molten lead bromide			
2.	Copper (II) sulphate using copper electrodes			

- (b) Name a substance which when dissolved in water contains (i) only ions (ii) ions and molecules.
 (c) Electrolysis is used in the purification of metals. Name (i) the anode (ii) the cathode and (iii) the electrolyte you would use to get pure copper from a piece of impure copper.

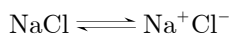
Ans :

COMP 2017

(a)

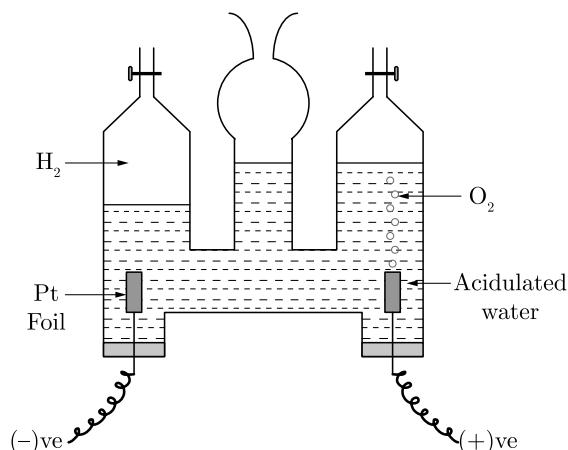
	Substance	Ions present	Product at	
			Cathode	Anode
1.	Molten lead bromide	$\text{Pb}^{2+}, \text{Br}^-$	Lead is deposited on cathode	Bromine
2.	Copper (II) sulphate using copper electrodes	$\text{Cu}^{2+}, \text{SO}_4^{2-}, \text{H}^+, \text{OH}^-$	Copper is deposited at the cathode	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ i.e., copper from anode gets dissolved in the solution.

- (b) (i) Sodium chloride when dissolved in water contains only ions.



- (ii) Acetic acid
 (c) (i) Anode $\longrightarrow$ Impure copper
 (ii) Cathode $\longrightarrow$ Pure copper
 (iii) Electrolyte : Acidulated and saturated copper sulphate solution.

241.



- (a) What is the name of this apparatus ?
 (b) Why is the water acidulated ?
 (c) Compare the volume of hydrogen and oxygen liberated at the different electrodes.
 (d) Give the cell reactions in the form of ionic equations :
 (i) at cathode
 (ii) at anode
 (e) Why is sulphate ion not discharged at the anode ?
 (f) Would you consider graphite a conductor or an electrolyte ? Explain.

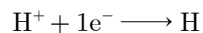
Ans :

MAIN 2019

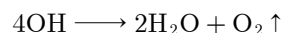
- (a) Hofmann's voltameter
 (b) To make it a good conductor of electricity.
 (c) Hydrogen : Oxygen is 2 : 1
 (d) $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

$\begin{array}{cc} \text{Cation} & \text{Anion} \\ \downarrow & \downarrow \\ \text{Cathode} & \text{Anode} \end{array}$

(i) At Cathode



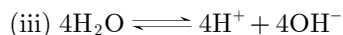
(ii) At Anode



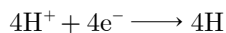
- (e) Because concentration of hydroxide ion is much more than sulphate ions.
 (f) Conductor because it conducts electricity without being decomposed.

242. Give the products of electrolysis in each case. (Also, give ionic equations)

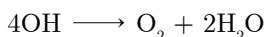
- (a) Molten lead bromide using platinum electrodes.



At cathode :



At anode :



225. Name the product at cathode and anode during the electrolysis of :

- Molten Lead bromide with inert electrodes.
- Molten Sodium chloride with inert electrodes.
- Acidified Copper sulphate solution with inert electrodes.
- Acidulated water with inert electrodes.
- Dilute Hydrochloric acid with inert electrodes.
- Concentrated Hydrochloric acid with inert electrodes.

Ans :

SQP 2005

	Cathode	Anode
(a)	Lead metal	Bromine vapours
(b)	Sodium metal	Chlorine gas
(c)	Copper	Oxygen
(d)	Hydrogen	Oxygen
(e)	Hydrogen	Oxygen
(f)	Hydrogen	Chlorine

226. (a) State the observations at the anode and at the cathode during the electrolysis of:

- fused lead bromide using graphite electrodes.
- copper sulphate solution using copper electrodes.

(b) Select the ion in each case, that would get 'selectively discharged from the aqueous mixture of the ions listed below:

- SO_4^{2-} , NO_3^- and OH^-
- Pb^{2+} , Ag^+ and Cu^{2+}

Ans :

COMP 2017

- At anode :
Dark reddish brown fumes of bromine evolve at the anode.
At cathode :
Greyish white metal lead is formed on the cathode.
 - At anode :

Anode decreases in size due to the formation of copper ions.

At cathode :

Reddish brown copper is deposited.

- OH^-
 - Ag^+

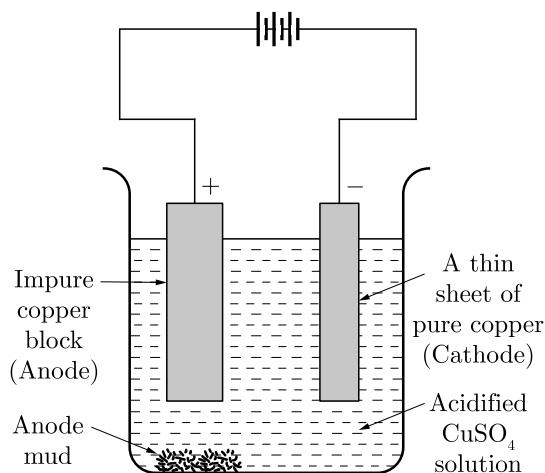
227. Define electrorefining of metals. Describe the electrorefining of copper.

Ans :

MAIN 2019

Electrorefining of metals : The process of refining the impure metal through the use of electric current or electrolysis is called electrorefining of metals.

Electrorefining of copper :

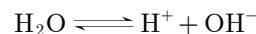
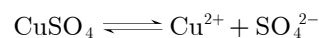


During the electro-refining of copper :

Electrolyte : An acidified solution of CuSO_4 .

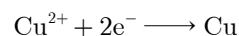
Cathode : Thin sheet of pure Cu.

Anode : Impure copper block passing an electric current, the reactions taking place are :



At cathode :

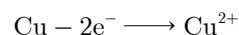
Cu^{2+} ions are discharged at cathode.



Copper gets deposited over cathode.

At anode :

Copper anode undergoes oxidation forming Cu^{2+} ions which pass into solution.



The mass of anode goes on decreasing.

The insoluble impurities like gold, silver settle below anode as anode mud. The soluble impurities pass into solution.

CASE BASED QUESTION

243. A student is conducting an experiment to understand the electrolysis process using molten sodium chloride (NaCl). The setup involves inert electrodes and a power source to initiate the electrolysis. The objective of the experiment is to produce sodium metal (Na) and chlorine gas (Cl₂). The student needs to calculate various parameters to analyze the efficiency of the experiment and understand the underlying chemistry.

(Given, The chemical equation for the electrolysis of molten NaCl: $2\text{NaCl} \longrightarrow 2\text{Na} + \text{Cl}_2$, Molar mass of Na = 23 g/mol, Molar mass of Cl₂ = 71 g/mol, Avogadro's number = 6.022×10^{23} molecules/mol)

- (i) Calculate the number of moles of NaCl required to produce 46 grams of sodium (Na).
- (ii) Determine the mass of chlorine gas (Cl₂) produced when 46 grams of sodium is obtained.
- (iii) Calculate the total number of sodium atoms produced in the electrolysis.

Ans :

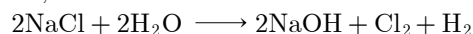
$$\begin{aligned} \text{(i) Mass of Na} &= \frac{\text{Mass of Na}}{\text{Molar mass of Na}} \\ &= \frac{46 \text{ g}}{23 \text{ g/mol}} = 2 \text{ moles} \end{aligned}$$

Since 2 moles of NaCl produce 2 moles of Na, the number of moles of NaCl required = 2 moles.

- (ii) 2 moles of NaCl produce 1 mole of Cl₂.
Mass of Cl₂ produced = $1 \times 71 \text{ g/mol} = 71 \text{ g}$.
- (iii) Number of sodium atoms
 $= 2 \times 6.022 \times 10^{23}$
 $= 1.2044 \times 10^{24}$ atoms.

244. A company is considering the large-scale production of sodium hydroxide (NaOH) through the electrolysis of aqueous sodium chloride solution, also known as the chloralkali process. The company wants to determine the feasibility and environmental impact of the process, particularly focusing on the amount of chlorine gas produced as a byproduct.

(Given, The reaction :



Molar mass of NaOH = 40 g/mol, Molar mass of Cl₂ = 71 g/mol, Molar volume of gas at STP = 22.4 L/mol, Faraday's constant = 96,485 C/mol)

- (i) Calculate the amount of NaCl (in moles) required to produce 80 grams of NaOH.
- (ii) Determine the mass of chlorine gas (Cl₂) produced as a byproduct.
- (iii) Calculate the total charge (in coulombs) required for the electrolysis process.
- (iv) Determine the volume of chlorine gas (Cl₂) produced at STP.

Ans :

$$\text{(i) Moles of NaOH} = \frac{80 \text{ g}}{40 \text{ g/mol}} = 2 \text{ moles}$$

Moles of NaCl required = 2 moles

- (ii) Moles of Cl₂ produced = 1 mole

Mass of Cl₂ = $1 \times 71 \text{ g/mol} = 71 \text{ g}$

$$\begin{aligned} \text{(iii) Charge} &= 2 \text{ moles of } e^- \times 96,485 \text{ C/mol} \\ &= 192,970 \text{ C} \end{aligned}$$

$$\text{(iv) Volume of Cl}_2 = 1 \times 22.4 \text{ L} = 22.4 \text{ L}$$

245. An electroplating company is electroplating a copper object with a thin layer of silver using an electrolytic cell. The company needs to calculate the amount of silver required, the time needed for electrolysis and the current required to achieve a uniform coating of silver.

(Given, Molar mass of Ag = 108 g/mol, Density of silver = 10.5 g/cm³, Thickness of the silver layer = 0.01 cm, Area of the object = 100 cm², Faraday's constant = 96,485 C/mol)

- (i) Calculate the volume of silver required for the coating.
- (ii) Determine the mass of silver required for the coating.
- (iii) Calculate the number of moles of silver needed.
- (iv) Determine the total charge (in coulombs) required to deposit the silver.

Ans :

$$\begin{aligned} \text{(i) Volume} &= \text{Area} \times \text{Thickness} \\ &= 100 \text{ cm}^2 \times 0.01 \text{ cm} = 1 \text{ cm}^3 \end{aligned}$$

$$\begin{aligned} \text{(ii) Mass} &= \text{Volume} \times \text{Density} \\ &= 1 \times 10.5 \text{ g/cm}^3 = 10.5 \text{ g} \end{aligned}$$

$$\text{(iii) Moles of Ag} = \frac{10.5 \text{ g}}{108 \text{ g/mol}} = 0.0972 \text{ moles}$$

$$\begin{aligned} \text{(iv) Charge} &= 0.0972 \times 96,485 \text{ C/mol} \\ &= 9,379 \text{ C} \end{aligned}$$

246. A laboratory is conducting an experiment to produce hydrogen gas through the electrolysis of water. The aim is to produce a specific amount

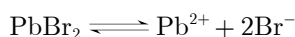
- (b) Acidified water using platinum electrodes.
 (c) CuSO_4 solution using platinum electrodes.
 (d) CuSO_4 solution using copper electrodes.
 (e) Dil. NaCl solution using platinum or graphite electrodes.
 (f) Concentrated NaCl solution using platinum electrodes.

Ans :

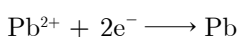
SQP 2012

Electrolysis of :

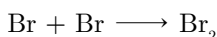
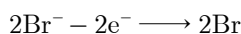
- (a) Molten lead bromide using platinum electrodes :



At cathode :

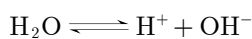
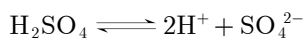


At anode :

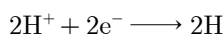


Lead is produced at cathode and Br_2 is 'produced at anode.

- (b) Acidified water using platinum electrodes :
 (water contains some sulphuric acid)

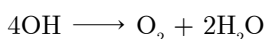
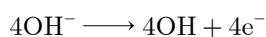


At cathode :



H_2 is produced at cathode.

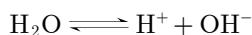
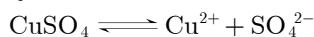
At anode :



OH^- ions are discharged in preference to SO_4^{2-} ions.

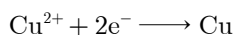
O_2 is produced at anode.

- (c) CuSO_4 solution using platinum electrodes :



At cathode :

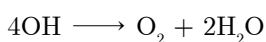
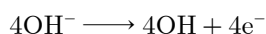
Cu^{2+} ions are discharged in preference to H^+ ions.



Copper gets deposited over cathode.

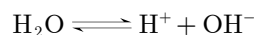
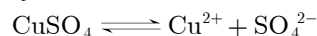
At anode :

OH^- ions are discharged in preference to SO_4^{2-} ions.



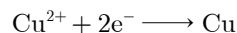
O_2 is produced at anode.

- (d) CuSO_4 solution using copper electrodes :



At cathode :

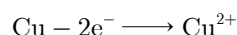
Cu^{2+} ions are discharged in preference to H^+ ions.



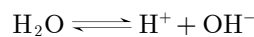
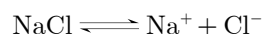
Copper gets deposited over cathode.

At anode :

Copper anode undergoes oxidation producing Cu^{2+} ions which pass into solution.

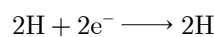


- (e) Dil. NaCl solution using platinum electrodes
 (or graphite) :



At cathode :

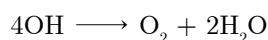
H^+ ions are discharged in preference to Na^+ ions.



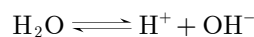
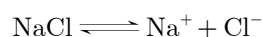
H_2 is produced at cathode.

At anode :

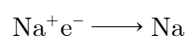
OH^- ions are discharged in preference to Cl^- ions.



- (f) Concentrated NaCl solution using platinum electrodes :

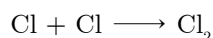
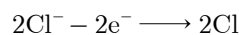


At cathode :



[Since conc. of Na^+ ions is much more than that of H^+ ions]

At anode :



[Since conc. of Cl^- ions is much more than that of OH^- ions. Na is produced at cathode and Cl_2 is produced at anode.

NODIA

Environmental impact : Chlorine gas is toxic and can cause significant environmental and health hazards if not properly contained or neutralized.

- 249.** An industrial process involves the extraction of magnesium (Mg) from magnesium chloride (MgCl_2) through electrolysis. The company needs to calculate the production of magnesium, the total charge required and the energy cost for the process.

(Given, The reaction: $\text{MgCl}_2 \longrightarrow \text{Mg} + \text{Cl}_2$, Molar mass of Mg = 24 g/mol, Molar mass of Cl_2 = 71 g/mol, Faraday's constant = 96,485 C/mol, Energy cost of electricity = ₹ 12 per kWh)

- Calculate the number of moles of MgCl_2 required to produce 48 grams of magnesium.
- Determine the mass of chlorine gas (Cl_2) produced as a byproduct.
- Calculate the total charge (in coulombs) required for the electrolysis process.
- Determine the cost of electricity for the process.

Ans :

$$(i) \text{ Moles of Mg} = \frac{48 \text{ g}}{24 \text{ g/mol}} = 2 \text{ moles}$$

$$\text{Moles of MgCl}_2 \text{ required} = 2 \text{ moles}$$

$$(ii) \text{ Moles of Cl}_2 \text{ produced} = 1 \text{ mole}$$

$$\begin{aligned} \text{Mass of Cl}_2 &= 1 \times 71 \text{ g/mol} \\ &= 71 \text{ g} \end{aligned}$$

$$(iii) \text{ Charge} = 2 \text{ moles of e}^- \times 96.485 \text{ C/mol} = 192,970 \text{ C}$$

$$\begin{aligned} (iv) \text{ Energy (in joules)} &= \text{Charge (in coulombs)} \times \text{Voltage} \\ \text{Assuming a voltage of 5V:} \\ \text{Energy} &= 192,970 \text{ C} \times 5 \text{ V} \\ &= 964,850 \text{ J} \end{aligned}$$

Convert to kWh:

$$\begin{aligned} \text{Energy (in kWh)} &= \frac{964.850 \text{ J}}{3.6 \times 10^6 \text{ J/kWh}} \\ &= 0.268 \text{ kWh} \end{aligned}$$

$$\begin{aligned} \text{Cost} &= 0.268 \text{ kWh} \times 12 \\ &= ₹ 3.22 \end{aligned}$$

- 250.** A researcher is investigating the electrolysis of copper(II) sulfate (CuSO_4) solution using inert platinum electrodes. The aim is to determine the amount of copper deposited, the change in

the color of the solution and the total energy consumption.

(Given, The reaction: $\text{CuSO}_4 \longrightarrow \text{Cu}^{2+} + \text{SO}_4^{2-}$)

- At Cathode : $\text{Cu}^{2+} + 2\text{e}^- \longrightarrow \text{Cu}$
 , Molar mass of Cu = 63.5 g/mol, Faraday's constant = 96,485 C/mol, Voltage applied = 3V)
- Calculate the number of moles of copper(II) sulfate required to deposit 63.5 grams of copper.
 - Determine the total charge (in coulombs) required to deposit the copper.
 - Calculate the total energy consumption (in kWh) for the electrolysis process.
 - Explain the change in the color of the solution during the electrolysis.

Ans :

$$(i) \text{ Moles of Cu} = \frac{63.5 \text{ g}}{63.5 \text{ g/mol}} = 1 \text{ mole}$$

$$\text{Moles of CuSO}_4 \text{ required} = 1 \text{ mole}$$

$$(ii) \text{ Charge} = 1 \times 96,485 \text{ C/mol} = 96,485 \text{ C}$$

$$\begin{aligned} (iii) \text{ Energy (in joules)} &= \text{Charge (in coulombs)} \times \text{Voltage} \\ \text{Energy} &= 96.485 \text{ C} \times 3 \text{ V} = 289,455 \text{ J} \end{aligned}$$

Convert to kWh:

$$\begin{aligned} \text{Energy (in kWh)} &= \frac{289,455 \text{ J}}{3.6 \times 10^6 \text{ J/kWh}} \\ &\approx 0.0804 \text{ kWh} \end{aligned}$$

- (iv) As copper(II) ions (which give the solution its blue color) are reduced and deposited as copper metal on the cathode, the concentration of Cu^{2+} ions decreases, leading to the fading of the blue color of the solution.

- 251.** A chemical engineer is working on the extraction of lithium (Li) from lithium chloride (LiCl) using molten salt electrolysis. The engineer needs to determine the amount of lithium produced, the total energy consumption and the environmental impact of the chlorine gas released.

(Given, The reaction: $2\text{LiCl} \longrightarrow 2\text{Li} + \text{Cl}_2$, Molar mass of Li = 7 g/mol, Molar mass of Cl_2 = 71 g/mol, Faradays constant = 96,485 C/mol, Voltage applied = 4V)

- Calculate the number of moles of LiCl required to produce 14 grams of lithium.
- Determine the mass of chlorine gas (Cl_2) produced as a byproduct.
- Calculate the total energy consumption (in kWh) for the electrolysis process.
- Discuss the potential environmental impact of

	Metals	Non-Metals
7.	Metals are ductile, i.e. can be drawn into wires except Mercury Zinc, arsenic, antimony and bismuth.	Non-metals are generally non-ductile.
8.	Metals are good conductors of heat and electricity except bismuth and tungsten.	Non-metals are poor conductors of heat and electricity except two allotropic modifications of carbon - graphite and gas carbon.
9.	Metals are usually insoluble in liquid solvents. If any metal dissolves in liquid solvent then always a chemical change takes place, i.e. like dissolution of Gold and Platinum in Aqua regia. $2K + 2H_2O \rightarrow 2KOH + H_2$	Non-metals readily dissolve in liquid solvents like Sulphur is soluble in Carbon disulphide or Ethyl alcohol.
10.	Metals easily form amalgams and alloys.	Non-metals do not form amalgams or alloys (Except carbon which is a constituent of steel)
11.	Metals are monoatomic, i.e. each molecule has only one atom.	The molecules of non-metals are mainly diatomic or polyatomic. i.e. having two or more than two atoms in each molecule e.g., Oxygen, Nitrogen are diatomic. Phosphorus is tetraatomic. Sulphur is octatomic.
12.	Metals are sonorous, i.e. they produce sound on being struck except sodium and potassium.	Non-metals are non-sonorous, i.e. they do not produce any sound on being struck.

	Metals	Non-Metals
13.	Metals have high tensile strength, i.e. it can bear a lot of strain without breaking except zinc, arsenic, antimony, mercury, bismuth and gallium.	Non-metals do not have tensile strengths except cotton fibre (an allotrope of carbon) is as tensile as steel.

(b) Chemical differences :

	Metals	Non-Metals
1.	Metals have 1, 2 or 3 electrons in their valence shell.	Non-metals have 5, 6 or 7 electrons in their valence shell.
2.	Metals readily lose their valence electrons and form cation. Thus these are electropositive in nature. Metal $Na - e^- \rightarrow Na^+$ $K - e^- \rightarrow K^+$ $Mg - 2e^- \rightarrow Mg^{2+}$ $Ca - 2e^- \rightarrow Ca^{2+}$ $Al - 3e^- \rightarrow Al^{3+}$	Non-metals readily gain or share valence electrons and form anion. Thus these are electronegative in nature. Non-metal $F + e^- \rightarrow F^{-1}$ $O + 2e^- \rightarrow O^{-2}$ $N + 3e^- \rightarrow N^{-3}$ $Cl + e^- \rightarrow Cl^{-1}$ $S + 2e^- \rightarrow S^{-2}$ $P + 3e^- \rightarrow P^{-3}$
3.	During electrolysis metals are obtained at cathode. $NaCl \rightleftharpoons Na^+ + Cl^-$ Cathode : $Na^+ + e^- \rightarrow Na$ Sodium ions migrate towards cathode and undergo the process of reduction to form sodium metal.	During electrolysis non-metals are obtained at anode. Anode: $Cl^- - e^- \rightarrow Cl$ $2[Cl] \rightarrow Cl_2$ Chloride ions migrate towards anode and undergo the process of oxidation to form chlorine.
4.	Metals usually form basic oxides except Zinc oxide, Aluminium oxide, Beryllium oxide, Stanous oxide, Lead oxide are amphoteric oxides.	Non-metals usually form acidic oxides except Water, Carbon monoxide, Nitrous oxide and Nitric oxide are neutral oxides.

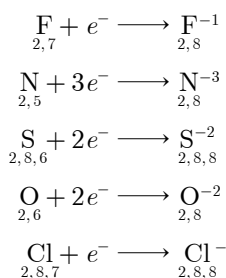
CHAPTER 7

METALLURGY

SUMMARY

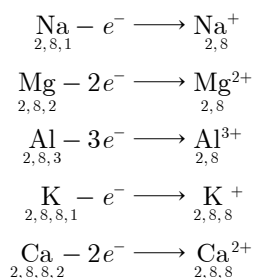
1. NON-METALS

The elements which are having 5, 6 or 7 valence electrons and cannot be drawn into wires or beaten into sheets are non-lustrous, are poor conductors of heat and electricity and form acidic or neutral oxides are called non-metals. Non-metals are electron acceptors and can form negatively charged particles called anions. For example: Non-metals gain electrons to complete their octet and get converted to negatively charged particles known as anions.



2. METALS

The elements which are having 1, 2 or 3 valence electrons, can be drawn into wires, beaten into sheets, are lustrous, are good conductors of heat and electricity and form basic oxides are called as metals. Metals are electron donors and can form positively charged particles called cations. For example: Metals lose valence electrons to achieve stable configuration and thus they form positively charged particles known as cations.



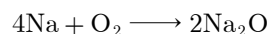
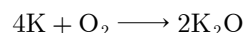
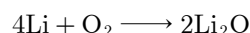
Metals like Gold, Copper, Platinum, etc. occur in free state or native state as they are unreactive in nature.

In the periodic table the metals are present in groups 1 and 2 (highly electro-positive elements). Transition elements in the middle of the periodic table are metals. The metallic character (tendency to lose electrons) increases as we move down the group therefore metals are also present at the bottom of every group in the periodic table.

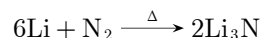
2.1 Alkali Metal

Elements of group IA are called as alkali metal. The members of this group are Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Caesium (Cs) and Francium (Fr).

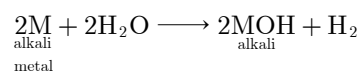
(i) **Reaction of alkali metals with air :** Lithium, sodium and potassium react with oxygen at normal temperature to form their respective oxides.



Lithium reacts with nitrogen to form lithium nitride.



(ii) **Reaction of alkali metals with water :** These metals on reaction with cold water form soluble bases called alkali. Alkali metals react with cold water to form their respective hydroxides with the liberation of hydrogen. The reaction of alkali metals with cold water is highly vigorous, exothermic and proceeds with explosion.

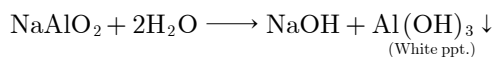


(General equation)

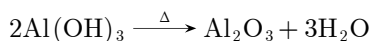
Where M can be Li, Na, K etc.



In second step, Sodium aluminate solution is diluted with water, it gets hydrolysed to give white precipitate of Aluminium hydroxide, which is filtered, washed and dried.

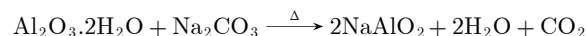


In third step, the dried Aluminium hydroxide is heated to high temperature, so as to obtain pure Alumina.

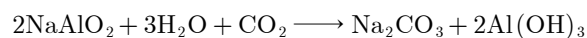


9.2 Purification of Bauxite by Hall's Process

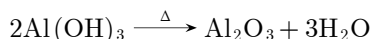
In first step, Bauxite is fused with Sodium carbonate on heating, then it forms Sodium aluminate which is cooled and then ground to a fine powder.



In second step, the fine powder is dissolved in water and filtered. The filtrate contains Sodium aluminate (water soluble) and the insoluble impurities are filtered out. Then carbon dioxide is passed through the filtrate, when Aluminium hydroxide gets precipitated out. It is filtered, washed and dried.



In third step, Aluminium hydroxide is heated to high temperature to get pure Alumina.

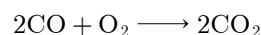
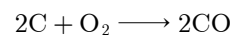
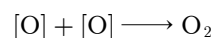
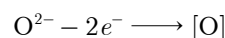
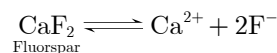
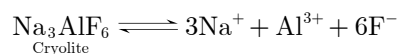
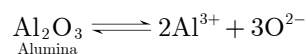


Aluminium oxide obtained as a result of concentration of ore, which is a very stable compound and thus, it cannot be reduced by common reducing agents like coke, hydrogen, carbon monoxide, ammonia etc. It can only be reduced electrolytically. The electrolytic process for the extraction of pure aluminium from aluminium oxide is called Hall's Heroult's process. In this, the inner carbon lining of the cell serves as cathode and the block of carbon dipped in electrolyte serves as anode.

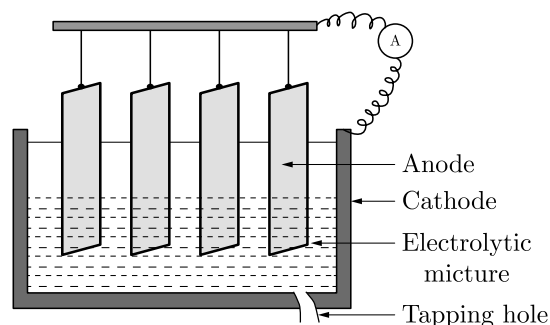
The electrolyte used is a mixture of pure molten alumina, cryolite and fluorspar.

1. Cryolite and fluorspar are added to pure alumina:
 - (a) Cryolite reduce the melting point or fusion temperature from 2050°C to 950°C of pure alumina.
 - (b) Cryolite increase the electrical conductivity of the electrolyte. This helps in saving electricity.
 - (c) Fluorspar increases the mobility of ions in the flux as it act as a solvent.

2. The Carbon anodes are periodically replaced because they get oxidized to Carbon dioxide'
3. The electrolytic mixture is covered with coke or sawdust so as to prevent the loss of heat by radiation'
4. The following reactions take place :



Molten aluminium metal being heavier settles down at the bottom and is removed from the tapping hole provided at the bottom of the electrolytic cell.



10. ALLOY

Alloys are the homogeneous mixture of two metals or metal with non-metal mixed together in fused state.

Alloys are made to modify appearance, increase strength, colour, reactivity, etc. An alloy of metal with mercury is called as an amalgam.

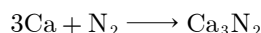
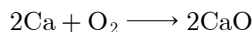
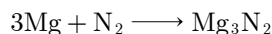
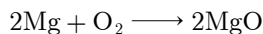
Alloys are made to change the property of their constituents to achieve specific objective e.g., Steel, Bronze, Brass, Duralumin, Fuse metal, solder.

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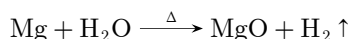
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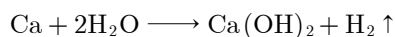
- (a) Reaction of alkaline earth metals with air: Magnesium and calcium show no reaction with air at ordinary temperature however on burning they form their respective oxides and nitrides.



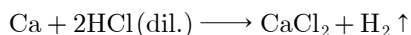
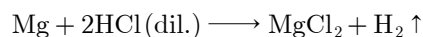
- (b) Reaction of alkaline earth metals with water: Magnesium reacts very slowly with water to liberate hydrogen gas.



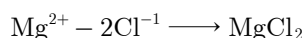
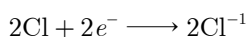
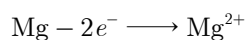
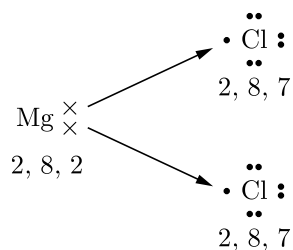
Calcium reacts vigorously with cold water to liberate hydrogen gas.



- (c) Reaction of alkaline earth metals with acid: Magnesium and calcium react less vigorously with dil. HCl to liberate hydrogen gas.



- They have low melting point and boiling point. The melting point and boiling point are more than the alkali metals.
- They are harder than alkali metals.
- Alkaline earth metals being highly electropositive (less than alkali metals) undergo ionic bond formation.

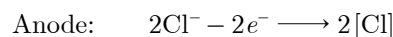
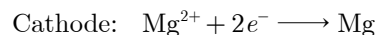
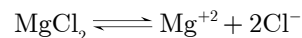


- Alkaline earth metals are strong reducing agents.
- Alkaline earth metals displace hydrogen on reaction with dilute acids.



The reactivity increases on moving down the group.

- Alkaline earth metals are obtained by the electrolysis of their fused or molten chloride. During the electrolysis, metals are obtained at cathode.



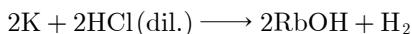
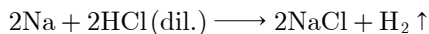
3. DIFFERENCES BETWEEN METALS AND NON-METALS

(a) Physical differences :

	Metals	Non-Metals
1.	Metals are generally solids except Mercury which exists in liquid state at room temperature. Gallium and Caesium exist in liquid state at 30°C.	Non-metals are generally gases, sometimes solids like Carbon, Sulphur and Phosphorus. Bromine is a liquid non-metal.
2.	Metals have high density except Sodium and Potassium.	Non-metals have low density except diamond.
3.	Metals are hard except Sodium and Potassium which are very soft and can be easily cut with the help of knife.	Non-metals are generally soft except diamond, an allotrope of carbon which is the hardest naturally occurring known substance.
4.	Metals have high melting point and boiling point except Sodium, Potassium, Gallium etc.	Non-metals have low melting point and boiling point except Boron, Silicon and Carbon.
5.	Metals are lustrous, i.e. they have shining surface when freshly cut.	Non-metals are non-lustrous except Iodine and Graphite-allotrope of carbon.
6.	Metals are malleable, i.e. can be beaten into sheets except Mercury, Zinc, arsenic, antimony and bismuth.	Non-metals are non-malleable, from a powdery mass.



- (iii) Reaction of alkali metals with acids: Sodium and potassium reacts with dil. HCl explosively to liberate Hydrogen gas.

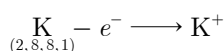
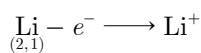
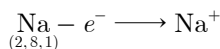
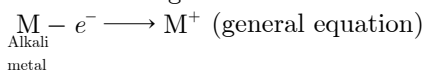


All elements of this group have one electron in their valence shell hence, their valency is +1.

Characteristics of Alkali Metals :

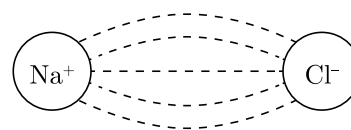
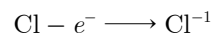
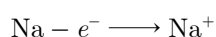
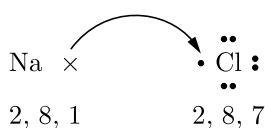
The general characteristics of alkali metals are as follows:

1. They are highly reactive elements and does not occur in free state.
2. They have one electron in their valence shell. Thus, they lose electrons and get converted to uni-positive ions called cation. These elements have lowest ionization energy in their respective periods thus, they easily lose electrons and get converted to cation.

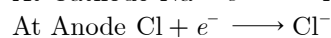
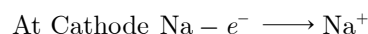
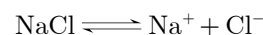


3. They are stored under kerosene because they easily react with oxygen and water vapour to form their oxides and hydroxides. The reactivity increases on moving down the group.
4. Alkali metals have low melting point and boiling point.
5. They can be easily cut with the help of knife. Freshly cut metal imparts a silvery appearance, but after sometime the metal gets tarnished due to the formation of oxide layer.
6. Alkali metals being highly electropositive elements undergo ionic bond formation with non-metals.

For example: Formation of sodium chloride is by the ionic bond.



7. Alkali metals are strong reducing agents.
8. Alkali metals displace hydrogen on reaction with dilute acids. However, this reaction is highly vigorous and exothermic.
9. Alkali metals are obtained by the electrolysis of their fused or molten chlorides.



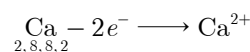
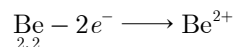
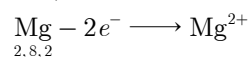
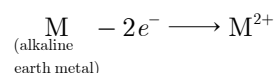
Alkali metals are obtained at cathode during electrolysis.

2.2 Alkaline Earth Metals

Elements of group IIA are called as alkaline earth metals. The members of this group are Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and Radium (Ra).

The elements of these group are having two electrons in their valence shell thus, they get converted to di-positive ion.

For example :

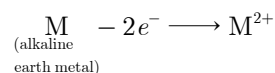


Characteristics of Alkaline Earth Metals :

The general characteristics of alkaline earth metals are:

1. They are highly reactive elements and therefore does not occur in free state.
2. They have two electrons in their valence shell thus in order to complete their octet the alkaline earth metals lose electrons and get converted to dipositive cation. These elements have low ionization energy (But more than the alkali metals)

General equation



3. They are less reactive than alkali metals. They react with Oxygen and Water vapour on heating.

	Metals	Non-Metals
5.	Metals form ionic chlorides and they act as strong electrolytes.	Non-metals form covalent chlorides. They are non-electrolytes.
6.	Metals are reducing agents, i.e. electron donors.	Non-metals are oxidizing agents i.e. electron acceptors.
7.	Metals generally do not react with Hydrogen. In case if it forms hydrides like NaH, KH they are highly unstable.	Non-metals form stable hydrides like Water, Ammonia, Methane, etc.
8.	Active metals react with dilute acids to liberate Hydrogen (Except dilute nitric acid) $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ $\text{Fe} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2$	Non-metals do not react with either dilute Hydrochloric acid or dilute Sulphuric acid.

4. ACTIVITY SERIES

The series in which the metals are arranged in the decreasing order of their reactivity is called as activity series.

Activity Series : Relative Reactivities of Metals

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	Reactivity increases
Zn	Zinc	
Fe	Iron	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive
Pt	Platinum	

Therefore, Potassium is placed at the top as it is most reactive element and Gold is placed at the bottom as it is the least reactive element.

The main features of activity series are:

- Metals lying above in activity series can displace the metals lying below from their salt solutions.
- Metals lying above hydrogen are more electro-positive than the metals lying below hydrogen.
- Metals lying below hydrogen do not displace hydrogen from water and dilute acids.
 - Sodium, Potassium, Calcium, Beryllium, Magnesium, Lithium are extracted by the electrolysis of their fused chlorides. Their oxides are not reduced by Carbon, Hydrogen or Carbon monoxide.
 - Oxides of Zinc, Copper, Lead and Iron are reduced by Carbon or Carbon monoxide or Hydrogen.



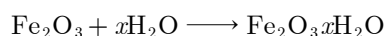
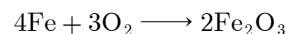
CORROSION

Loss of metal layer by layer by the action of impurities (may be atmospheric gases) is referred to as corrosion.

Corrosion in the case of iron is referred as Rusting of iron. It is slow conversion of iron into its hydrated oxide, in the presence of air and moisture. The hydrated oxide so formed has a reddish brown colour.

6. RUST

The reddish brown layer is commonly called as Rust. Which is chemically hydrated ferric oxide ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$).



(x , is any whole number)

The essential condition for the process of rusting is the presence of

- Oxygen
- Moisture

In the absence of anyone of the above the

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the chlorine gas produced during the process.

Convert to hours: Time $\approx$ 10.72 hours

Ans :

$$(i) \text{ Moles of Li} = \frac{14 \text{ g}}{7 \text{ g/mol}} = 2 \text{ moles}$$

Moles of LiCl required = 2 moles

$$(ii) \text{ Moles of Cl}_2 \text{ produced} = 1 \text{ mole}$$

$$\begin{aligned} \text{Mass of Cl}_2 &= 1 \times 71 \text{ g/mol} \\ &= 71 \text{ g} \end{aligned}$$

$$(iii) \text{ Charge} = 2 \text{ moles of e}^- \times 96,485 \text{ C/mol} \\ = 192,970 \text{ C}$$

Energy (in joules) = Charge $\times$ Voltage

$$\begin{aligned} \text{Energy} &= 192,970 \text{ C} \times 4 \text{ V} \\ &= 771,880 \text{ J} \end{aligned}$$

Convert to kWh:

$$\begin{aligned} \text{Energy (in kWh)} &= \frac{771,880 \text{ J}}{3.6 \times 10^6 \text{ J/kWh}} \\ &= 0.214 \text{ kWh} \end{aligned}$$

- (iv) Chlorine gas is highly toxic and can cause severe environmental and health problems. It must be carefully managed and neutralized to prevent harm to the environment and human health.

252. A metallurgist is refining impure copper by electrolysis. The impure copper is used as the anode and a pure copper ship is used as the cathode. The aim is to calculate the amount of pure copper deposited, the total charge required and the time needed for the electrolysis.

(Given, The reaction at the cathode: $\text{Cu}^{2+} + 2\text{e}^- \longrightarrow \text{Cu}$, Molar mass of Cu = 63.5 g/mol, Faraday's constant = 96,485 C/mol, Current applied = 5 A)

- Calculate the number of moles of Cu^{2+} ions required to deposit 127 grams of copper.
- Determine the total charge (in coulombs) required to deposit the copper.
- Calculate the time (in seconds) required for the electrolysis process.

Ans :

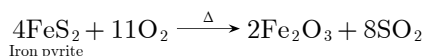
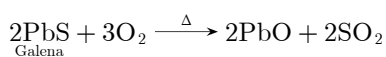
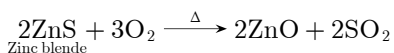
$$(i) \text{ Moles of Cu} = \frac{127 \text{ g}}{63.5 \text{ g/mol}} = 2 \text{ moles}$$

$$(ii) \text{ Charge} = 2 \times 96,485 \text{ C/mol} \\ = 192,970 \text{ C}$$

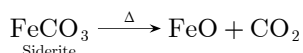
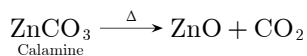
$$(iii) \text{ Time} = \frac{\text{Charge}}{\text{Current}} = \frac{192,970 \text{ C}}{5 \text{ A}} \\ = 38,594 \text{ s}$$

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- During crushing or grinding, huge lumps of ore are crushed to a fine powder.
- The process of removal of gangue impurities from the ore is called as Concentration. The ore can be concentrated by the following named processes:
 - Froth floatation process is used to concentrate sulphide ores.
 - Electromagnetic separation is used to concentrate Iron ores.
 - Gravity separation is used to concentrate most of the ores except sulphide ores.
 - Chemical method by using NaOH for purifying Bauxite.
- The concentrated ore is subjected to either Roasting or Calcination.
- The purpose of both Roasting and Calcination is
 - to convert ore into oxide.
 - the ore becomes light and porous.
 - the volatile impurities are driven off.
 - to remove moisture from the ore.
- Roasting is done for Sulphide ores. Roasting is the process of heating of concentrated ore in the sufficient supply of air or Oxygen.



- Calcination is done for Hydroxide and Carbonate ores. Calcination is the process of concentrated heating of ore in the absence of air or oxygen.



- Metallic oxide is reduced either by electrolysis or by using reducing agents like Carbon monoxide, Carbon, Hydrogen, etc.



The differences between Roasting and Calcination can be summarized as

	Roasting	Calcination
(i)	It is the process of heating of concentrated ore in the presence of air or oxygen.	It is the process of heating the concentrated ore in the absence of air or oxygen.

	Roasting	Calcination
(ii)	It is usually done for sulphide ore.	It is usually done for carbonate ores and hydroxide ores.
(iii)	Volatile impurities of sulphur dioxide are removed.	Impurities of moisture and carbon dioxide are removed.

- Extraction of metal from a concentrated ore: Reduction of metallic oxide to the metal.

Method of Reduction	Metals
Electrolytic refining By coke By carbon monoxide or hydrogen. By thermal decomposition.	Potassium, sodium, calcium, magnesium, aluminium. Zinc, iron, lead and copper. Iron, lead and coppers. Mercury and silver.

- The metals which are obtained after reduction are not absolutely pure, they contain certain impurities. The impurities are removed by electrolytic refining, liquation, distillation and oxidation.

Metals	Methods of Refining
Zinc Lead and Tin Iron	Distillation Liquation Oxidation Electrolytic-refining

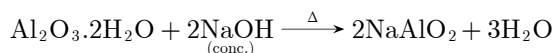
9. CONVERSION OF BAUXITE INTO ALUMINA OR PURIFICATION OF ORE

The most common ore of Aluminium is Bauxite, $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.

Bauxite is purified either by Baeyer's process or Hall's process. These two processes are the chemical processes for the concentration of ore.

9.1 Purification of Bauxite by Baeyer's Process

In first step, powdered Bauxite is mixed with concentrated sodium hydroxide solution. Bauxite being amphoteric dissolves in concentrated Sodium hydroxide solution to form soluble Sodium aluminate leaving behind ferric oxide unreacted. On filtration, Sodium aluminate is collected as filtrate and the impurities are left behind.



process of rusting will not take place. This can be demonstrated with the help of the following experiments.

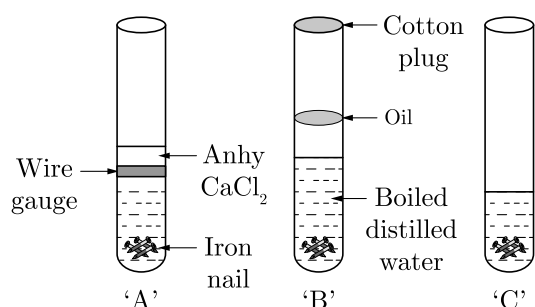
Example -

Take three test-tubes A, B and C.

In test-tube 'A' put some iron nails and then put a wire gauge and on the wire gauge place some anhydrous CaCl_2 and keep it for few days.

In test-tube 'B' put some iron nails and to it add boiled water add a layer of oil to it and plug the end of test-tube with the help of cotton. Keep the arrangement undisturbed for few days.

In test-tube 'C' put some iron nails and to it add water and leave it open. Keep the arrangement undisturbed for few days.



The following observations were made

- In test-tube 'A', the iron nails do not undergo rusting as there was absence of moisture.
- In test-tube 'B', the iron nails do not undergo rusting as there was absence of oxygen layer of oil prevents the entry of air.
- In test-tube 'C', the iron nails undergo rusting as there was the presence of both oxygen and moisture.

Thus, from the above experiments it can be concluded that for the process of rusting both oxygen and moisture are required. In the absence of any one component the rusting will not take place.

Rusting of iron can be prevented by

- Greasing
- Oiling
- Painting
- Galvanization: The coating of thin uniform layer of zinc over the surface of iron is called as galvanization.
- Electroplating

7. METAL

Most of the metals are found in the combined state in the form of compounds. The compounds are in the form of sulphates, sulphides, oxides, halides, carbonates, etc.

Most of the metals occur in the combined state in the form of ores.

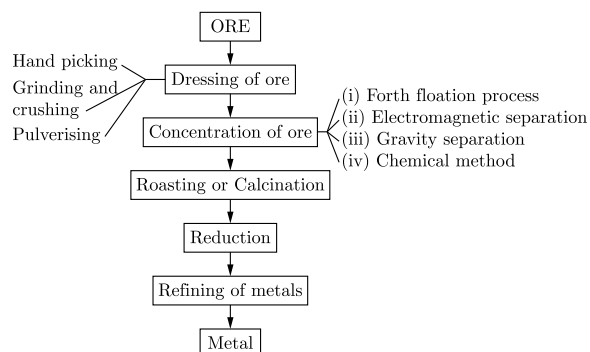
Compounds	Ores	Formulae
Sulphides	Zinc blende	ZnS
	Galena	PbS
	Iron pyrites	FeS_2
	Copper pyrites	CuFeS_2
	Cinnabar	HgS
Halides	Rock salt	NaCl
	Fluorspar	CaF_2
	Cryolite	Na_3AlF_6
Carbonates	Calamine	ZnCO_3
	Siderite	FeCO_3
	Limestone	CaCO_3
	Magnesite	MgCO_3
	Dolomite	$\text{CaCO}_3 \cdot \text{MgCO}_3$
Oxides	Haematite	Fe_2O_3
	Bauxite	$\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$

- Minerals are the naturally occurring compounds of a metal.
- Ores are the naturally occurring compounds of a metal from which metals are extracted cheaply, profitably and conveniently.
- The unwanted earthy impurities associated with the ore is called as Gangue or Matrix.
- Flux is a chemical substance which is added with the charge to remove the gangue or matrix in the form of fusible slag.
- The fusible product formed when flux reacts with gangue during the extraction of metals is called as Slag.

8. METALLURGY

Metallurgy is the process of extracting pure metal from its ore by physical or chemical means.

The processes involved, during metallurgy are:



Name of Alloy	Constituents	Uses
Bronze	Cu, Zn and Sn	For making statues, coins, utensils, medals.
Brass	Cu and Zn	For making electrical fitting, utensils, statues, bearing, electrical appliances.
Dural	Al, Cu, Mn, Mg	For making bodies of aircrafts.
Fuse-metal	Pb and Sn	For making fuse wire.
Steel	Fe and C	For making tools, automobiles, appliances, railways, building material.
Solder	Pb and Sn	Welding and soldering.

MULTIPLE CHOICE QUESTION

1. Copper, Zinc and Tin are the metals alloyed to form:
- (a) Duralumin (b) Brass
(c) Bronze (d) Solder

Ans :

MAIN 2024

There are two types of solders which are commonly used. First one is soft solder which is an alloy of tin(Sn) and lead(Pb). The other one is a hard solder which is an alloy of Copper(Cu) and Zinc(Zn).

Thus (d) is correct option.

2. The compound that is not a constituent of the electrolytic mixture used in the Hall-Heroult's process is:
- (a) Al_2O_3 (b) NaAlO_2
(c) Na_3AlF_6 (d) CaF_2

Ans :

MAIN 2024

NaAlO_2 is not the compound used in the electrolytic mixture of Hall-Heroult's process.

Thus (b) is correct option.

3. A mineral from which the metal can be extracted economically and conveniently is known as:
- (a) Matrix (b) Ore
(c) Flux (d) Alloy

Ans :

MAIN 2024

Ores are naturally occurring minerals that contain a high concentration of the desired metal or metals, along with other elements and compounds, to make their extraction economically viable.

Thus (b) is correct option.

The ore of aluminium is

- (a) calamine (b) haematite
(c) magnetite (d) cryolite

Ans :

COMP 2022

Bauxite is the main ore of aluminium. Other ores of aluminium are cryolite and corundum.

Thus (d) is correct option.

5. Which one of the following is not true of metals:
- (a) Metals are good conductors of electricity
(b) Metals are malleable and ductile
(c) Metals form non-polar covalent compounds
(d) Metal will have 1 or 2 or 3 electrons in their valence shell.

Ans :

MAIN 2010

Metals form non-polar covalent compounds is not true about metals.

Thus (c) is correct option.

6. The metals zinc and tin are present in the alloy :
- (a) Solder (b) Brass
(c) Bronze (d) Duralumin

Ans :

SQP 2013

Alloy is a combination of two or three metals. The Combination of zinc and tin is present in the alloy, bronze.

Thus (c) is correct option.

7. Aluminium powder is used in thermite welding because :
- (a) it is a strong reducing agent
(b) it is a strong oxidising agent
(c) it is corrosion resistant
(d) it is a good conductor of heat

Ans :

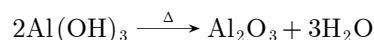
COMP 2014

Aluminum powder is used in thermite welding because it's a strong reducing agent and has a higher affinity for oxygen than iron. Thermite welding is a chemical welding process that uses

112. Heating of Aluminium hydroxide.

Ans :

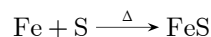
SQP 2012



113. Heating of Iron with Sulphur.

Ans :

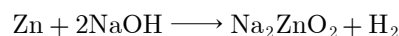
MAIN 2016



114. Reaction of Zinc with hot concentrated Sodium hydroxide.

Ans :

COMP 2023



115. Reduction of Zinc oxide.

Ans :

SQP 2020



116. Reduction of Ferric oxide by Aluminium powder.

Ans :

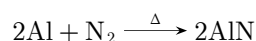
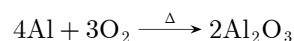
MAIN 2003



117. Burning of Aluminium in air.

Ans :

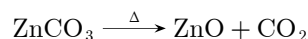
COMP 2007



118. Calamine is heated.

Ans :

SQP 2011



119. Zinc is placed in a Ferrous sulphate solution.

Ans :

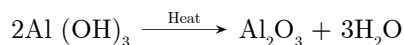
MAIN 2020



120. Write the equation for the action of heat on aluminium hydroxide.

Ans :

COMP 2019

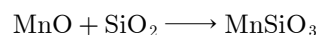


DIRECTION : Complete and balance the following equations:

121. $\text{MnO} + \text{SiO}_2 \longrightarrow$

Ans :

COMP 2016



122. $\text{S} + \text{O}_2 \xrightarrow{\text{Heat}}$

Ans :

SQP 2012



123. $\text{Zn} + \text{S} \xrightarrow{\text{Heat}}$

Ans :

MAIN 2008



124. $\text{FeO} + \text{O}_2 \xrightarrow{\text{Heat}}$

Ans :

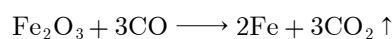
SQP 2004



125. $\text{Fe}_2\text{O}_3 + \text{CO} \longrightarrow$

Ans :

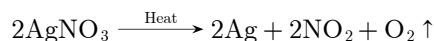
COMP 2017



126. $\text{AgNO}_3 \xrightarrow{\text{Heat}}$

Ans :

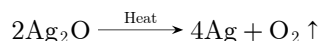
COMP 2001



127. $\text{Ag}_2\text{O} \xrightarrow{\text{Heat}}$

Ans :

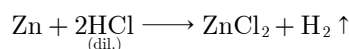
SQP 2005



128. $\text{Zn} + \text{HCl} \longrightarrow$

Ans :

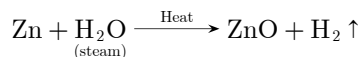
MAIN 2009



129. $\text{Zn} + \text{H}_2\text{O} \xrightarrow{\text{Heat}}$

Ans :

COMP 2013



130. $\text{Zn} + \text{O}_2 \xrightarrow{\text{Heat}}$

Ans :

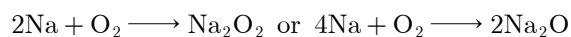
MAIN 2019



131. $\text{Na} + \text{O}_2 \longrightarrow$

Ans :

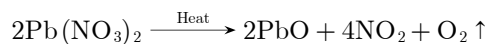
SQP 2006



132. $\text{Pb}(\text{NO}_3)_2 \xrightarrow{\text{Heat}}$

Ans :

SQP 2009



17. Impure iron is purified by the process of
 (a) oxidation (b) reduction
 (c) redox (d) None of these

Ans :

MAIN 2014

Iron is extracted by smelting i.e. the extraction of usable metal from oxidized iron ore.

Thus (a) is correct option.

18. Chemically rust is
 (a) $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ (b) Fe_2O_3
 (c) $\text{Fe}_3\text{O}_4 \cdot x\text{H}_2\text{O}$ (d) Fe_3O_4

Ans :

COMP 2015

Chemically, rust is hydrated iron(III) oxide, with the chemical formula $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$. Rust is formed when iron corrodes, or oxidizes slowly, in the presence of air and moisture. The rusting process can be seen as a flaky, reddish-brown layer that crumbles easily into a powder.

Thus (a) is correct option.

19. Which of the following pair of metals is rendered passive on reaction with concentrated nitric acid?
 (a) Cu, Zn (b) Zn, Al
 (c) Mg, Fe (d) Fe, Al

Ans :

MAIN 2019

Metals like iron, aluminium, cobalt and nickel become passive when treated with pure concentrated nitric acid. It is due to the formation of an extremely thin layer of insoluble metallic oxide (passivity) which stops the reaction.

Thus (d) is correct option.

ASSERTION AND REASON

20. **Assertion :** Alkali metals do not form dipositive ions.

Reason : After loss of one electron alkali metals achieve stable electronic configuration of noble gases.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
 (b) Both assertion and are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

SQP 2025

The alkali metals after loss of one electron achieve

stable configuration of inert gases. The removal of second electron requires very high energy.

Hence, alkali metals do not form dipositive ions.

Thus (a) is correct option.

21. **Assertion :** Non-metals are poor conductors of heat and electricity.

Reason : Non-metals have 1, 2, or 3 electrons in their valence shell.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
 (b) Both assertion and are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

MAIN 2010

Non-metals are poor conductors, but they have 5, 6, or 7 electrons in their valence shell, not 1, 2, or 3.

Thus (c) is correct option.

22. **Assertion :** Alkali metals are highly reactive and do not occur in the free state.

Reason : Alkali metals have high melting and boiling points.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
 (b) Both assertion and are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

COMP 2005

Alkali metals are highly reactive and do not occur in the free state, but they have low melting and boiling points.

Thus (c) is correct option.

23. **Assertion :** Alkaline earth metals are less reactive than alkali metals.

Reason : Alkaline earth metals have higher ionization energy compared to alkali metals.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
 (b) Both assertion and are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

MAIN 2012

Alkaline earth metals are less reactive due to their higher ionization energy compared to alkali metals.

Thus (a) is correct option.

49. Metallic oxides which are reduced by Aluminium.

Ans : SQP 2005

Ferric oxide, Chromium oxide

50. Alloy of Copper and Zinc.

Ans : COMP 2007

Brass

51. The most common ore of Zinc.

Ans : MAIN 2009

Zinc blende

52. The formula of slag.

Ans : SQP 2002

CaSiO_3

53. The chemical name of slag.

Ans : MAIN 2008

Calcium silicate

54. The metals added to steel to make it stainless steel.

Ans : MAIN 2015

Chromium and Nickel

55. The major impurity associated with Iron obtained from blast furnace.

Ans : SQP 2019

Carbon

56. Metal which is rendered passive on reaction with concentrated Nitric acid.

Ans : COMP 2013

Iron

57. A metal which reacts reversibly with steam.

Ans : MAIN 2018

Iron

58. Gas obtained when Zinc blende is roasted.

Ans : COMP 2011

Sulphur dioxide

59. Two metals which are amphoteric in nature.

Ans : SQP 2015

Aluminium, Zinc

60. The process by which Zinc is purified.

Ans :

COMP 2012

Distillation

61. Name an acid with which iron is rendered passive.

Ans : SQP 2015

Concentrated nitric acid.

62. Name the gas evolved on reaction of Aluminium with boiling concentrated caustic alkali solution.

Ans : MAIN 2010

Hydrogen

63. Name the most common ore of the metal aluminum from which the metal is extracted. Write the chemical formula of the ore.

Ans : COMP 2018

Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$)

64. Name the process by which impure ore of aluminum gets purified by using concentrated solution of an alkali.

Ans : SQP 2018

Baeyer's process

65. Name a non-metal that has a metallic lustre and sublimes on heating.

Ans : SQP 2004

Iodine

66. Name a metal which is found abundantly in the earth's crust.

Ans : MAIN 2011

Aluminium

67. Name the process used for the enrichment of sulphide ore.

Ans : COMP 2011

Froth floatation process

68. A metal other than zinc which displaces copper from copper (II) sulphate solution.

Ans : SQP 2012

Magnesium

69. The black powdery substance used for the reduction of Zinc oxide during its extraction.

Ans : MAIN 2020

Coke

nature, while non-metals form acidic oxides.
Thus (b) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following :

- 31.** The substance prepared by adding other metals to a base metal in appropriate proportions to obtain certain desirable properties.

Ans : COMP 2020

Alloys

- 32.** The method used to separate ore from gangue by preferential wetting.

Ans : SQP 2016

Froth floatation

- 33.** The process used to purify alumina by electrolytic reduction.

Ans : MAIN 2022

The process used to purify alumina by electrolytic reduction is Hoope's process.

- 34.** Name the gas evolved on reaction of Aluminium with boiling concentrated caustic alkali solution.

Ans : COMP 2012

Hydrogen

- 35.** A metal present in cryolite other than sodium.

Ans : MAIN 2012

Aluminium

- 36.** A metal which is unaffected by dilute or concentrated acids.

Ans : SQP 2012

Platinum

- 37.** A metal which exists in liquid state at room temperature.

Ans : COMP 2012

Mercury

- 38.** A liquid non-metal.

Ans : SQP 2014

Bromine

- 39.** Allotropic modification of Carbon and good conductor of electricity.

Ans : MAIN 2017

Graphite

- 40.** Sulphide ore of Mercury.

Ans : COMP 2019

Cinnabar

- 41.** Bonding present in metallic chlorides.

Ans : SQP 2021

Ionic bonding

- 42.** The process of removal of Gangue from ore.

Ans : MAIN 2023

Concentration

- 43.** A naturally occurring compound of metal from which metal is extracted cheaply, profitably and conveniently.

Ans : COMP 2010

Ore

- 44.** The process by which Sulphide ores are concentrated.

Ans : MAIN 2015

Froth floatation process

- 45.** The process of heating of ore in the presence of air.

Ans : SQP 2017

Roasting

- 46.** The process by which impurities are removed from Iron obtained from blast furnace.

Ans : COMP 2019

Oxidation

- 47.** The most common ore of Aluminium.

Ans : MAIN 2000

Bauxite

- 48.** The electrode at which Aluminium is obtained during electrolysis.

Ans : COMP 2001

Cathode

- 24. Assertion :** Rusting of iron can be prevented by galvanization.

Reason : Galvanization involves the coating of iron with a layer of zinc.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2008

Galvanization involves coating iron with zinc, which prevents rusting by protecting it from moisture and air.

Thus (a) is correct option.

- 25. Assertion :** The activity series of metals arranges them in the order of decreasing reactivity.

Reason : Metals higher in the activity series can displace metals lower in the series from their salt solutions.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

MAIN 2004

The activity series correctly arranges metals by reactivity and more reactive metals can displace less reactive ones from their compounds.

Thus (a) is correct option.

- 26. Assertion :** Sodium is obtained at the cathode during the electrolysis of molten Sodium chloride.

Reason : Sodium ions gain electrons at the anode during electrolysis.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2002

Sodium ions gain electrons at the cathode, not the anode.

Thus (c) is correct option.

- 27. Assertion :** Zinc can be extracted by the reduction of its oxide using carbon.

Reason : Zinc oxide is less stable and can be easily reduced by carbon.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

COMP 2010

Zinc oxide is less stable and can be reduced by carbon to extract zinc.

Thus (a) is correct option.

- 28. Assertion :** Alloys are made to modify the properties of metals.

Reason : Alloying can increase strength, change color and improve reactivity.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

MAIN 2016

Alloys are created to improve various properties such as strength, color and reactivity.

Thus (a) is correct option.

- 29. Assertion :** Aluminium is extracted from Bauxite using the Hall-Héroult process.

Reason : Aluminium oxide is reduced by coke in this process.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2001

Aluminium oxide is reduced electrolytically, not by coke, in the Hall-Héroult process.

Thus (c) is correct option.

- 30. Assertion :** Metals generally form basic oxides.

Reason : Non-metals generally form acidic oxides.

- (a) Both assertion and reason are true and reason is the correct explanation of reason.
- (b) Both assertion and are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

COMP 2018

Metals form basic oxides due to their electropositive

- 70.** The substance is an alloy of Zinc, Copper and Tin.

Ans : MAIN 2011
Bronze

- 71.** The process of coating of iron with zinc.

Ans : SQP 2005
Galvanisation

- 72.** An alloy of lead and tin that is used in electrical circuits.

Ans : MAIN 2015
Solder

- 73.** An ore of zinc containing its sulphide.

Ans : COMP 2008
Zinc blende

- 74.** A metal oxide that can be reduced by hydrogen.

Ans : MAIN 2015
Copper oxide

- 75.** Name an alloy of :

- (i) Lead used in electrical wiring or electrical work in joining metals.
(ii) Copper in electrical appliances or household vessels.

Ans : COMP 2009
(i) Solder
(ii) Brass

DIRECTION : Fill in the blank from the choices given in bracket :

- 76.** An alloy used to make statues is _____ (bronze, brass, fuse metal)

Ans : COMP 2020
Bronze

- 77.** Metals are good _____ (oxidizing agents/reducing agents) because they are electron _____ (acceptors/donors).

Ans : SQP 2010
Reducing agents, donors

- 78.** Aluminium powder, a constituent of paints, prevents _____. (heat radiation/formation of rust/conduction of electric current).

Ans : MAIN 2015
Formation of rust

- 79.** Aluminium is utilized in cooking utensils since it is _____. (a good conductor of electricity/bright in appearance/a good conductor of heat).

Ans : SQP 2017
a good conductor of heat

- 80.** Transmission wires are made of aluminium, since aluminium is _____. (corrosion resistant/a good conductor of heat/a good conductor of electricity).

Ans : MAIN 2011
a good conductor of electricity

- 81.** Aluminium is an important constituent metal in duralumin since it is _____. (a good conductor of heat/unaffected by food acids/light).

Ans : COMP 2019
light

- 82.** A thermite mixture contains iron (III) oxide and aluminium, in which _____ (aluminium/iron (III) oxide) is in a higher ratio in the mixture.

Ans : SQP 2011
aluminium

- 83.** In a thermite mixture, aluminium _____ (oxidises/reduces) iron (III) oxide.

Ans : MAIN 2017
reduces

- 84.** Steel is an alloy of _____ and Carbon.

Ans : COMP 2019
pure iron

- 85.** During termite welding _____ acts as a reducing agent.

Ans : SQP 2023
aluminium

- 86.** Brass is an alloy of _____ and Zinc.

Ans : MAIN 2021
copper

- 87.** Bronze is an alloy of _____ and Copper.

Ans : COMP 2020
tin

an exothermic reaction to create heat energy. In this process, aluminum powder and iron oxide are mixed in a specific weight ratio and react to form aluminum oxide and iron.

Thus (a) is correct option.

8. The main ore used for the extraction of iron is:

- (a) Haematite (b) Calamine
(c) Bauxite (d) Cryolite

Ans :

SQP 2014

The main ore used to extract iron is hematite, which is the most abundant iron ore mineral. Hematite is a red oxide that crystallizes in a hexagonal system and can be found in many geological conditions around the world.

Thus (a) is correct option.

9. The number of electrons present in the valence shell of a halogen is :

- (a) 1 (b) 3
(c) 5 (d) 7

Ans :

MAIN 2014

Halogens have seven valence electrons in their outermost electron shell. These electrons are in two different types of orbitals, s and p, with two electrons in the s orbital and five in the p orbital. Thus (d) is correct option.

10. The reason for using Aluminium in the alloy duralumin is :

- (a) Aluminium is brittle.
(b) Aluminium gives strength.
(c) Aluminium brings lightness.
(d) Aluminium lowers melting point.

Ans :

COMP 2019

The reason for using aluminum in the alloy duralumin is that aluminum gives strength and aluminum brings lightness.

Thus (c) is correct option.

11. This metal is a liquid at room temperature.

- (a) Potassium (b) Zinc
(c) Gold (d) Mercury

Ans :

SQP 2011

Mercury (Hg) is the only metal that is liquid at room temperature because it has a low melting point of -39°C .

Thus (d) is correct option.

12. The major impurity present in iron is

- (a) calcium (b) sodium
(c) carbon (d) phosphorus

Ans :

COMP 2019

The major impurity in pig iron is graphite, an allotrope of Carbon.

Thus (c) is correct option.

13. The two main metals in Bronze are:

- (a) Copper and zinc
(b) Copper and lead
(c) Copper and nickel
(d) Copper and tin

Ans :

COMP 2013

Bronze is mainly an alloy of copper and tin. Bronze is primarily made up of copper and tin is present in lesser proportions. Instead of tin other metals, non-metals and metalloids are also mixed with copper.

Thus (d) is correct option.

14. Which of the following metallic oxides cannot be reduced by normal reducing agents?

- (a) Magnesium oxide
(b) Copper (II) oxide
(c) Zinc oxide
(d) Iron (III) oxide

Ans :

SQP 2014

Magnesium oxide (MgO) and aluminum oxide are metallic oxides that cannot be reduced by normal reducing agents.

Thus (a) is correct option.

15. The main purpose of Roasting and Calcination is to convert

- (a) ore into metal
(b) ore into oxide
(c) ore into metallic carbonate
(d) None of these

Ans :

MAIN 2016

The primary purpose of both calcination and roasting is to convert carbonate and sulfide ores into oxides, making them easier to process and extract metals from.

Thus (b) is correct option.

16. Identify the metallic oxide which is amphoteric in nature :

- (a) Calcium oxide (b) Zinc oxide
(c) Barium oxide (d) Copper(II) oxide

Ans :

SQP 2011

Zinc oxide is an amphoteric oxide as it reacts with both acids and alkalis to give salt and water.

Thus (b) is correct option.

- (i) Y
- (ii) 3
- (iii) acidic, basic
- (iv) poor
- (v) lose, reducing

DIRECTION : State whether the following statements are True or False.

98. Metals gain electrons and get converted to cations.

Ans : COMP 2010
False

99. Non-metals lose electrons and get converted to anions.

Ans : MAIN 2015
False

100. Metals collect at cathode.

Ans : SQP 2017
True

101. Aluminium reacts both with acids and alkalies.

Ans : COMP 2019
True

102. Solder is a metal.

Ans : MAIN 2015
False

DIRECTION : Give appropriate scientific reasons for the following statement :

103. Zinc oxide can be reduced to zinc by using carbon but aluminium oxide cannot be reduced by a reducing agent.

Ans : COMP 2015

Zinc oxide can be reduced to zinc by using carbon but aluminium oxide cannot be because of the following reasons :

- (a) Aluminium oxide has a very high melting point.
- (b) Aluminium has a high affinity for oxygen so it doesn't lose its oxygen easily.

104. Give reasons for the following :

- (i) Aluminium is used for making foils.
- (ii) Aluminium sheets are used on roof top.
- (iii) Aluminium is used in flash bulbs.

(iv) Aluminium is used for making packaging container.

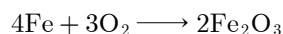
Ans : COMP 2010

- (i) It is highly malleable, hence, lesser weight of the metal can be beaten into bigger sheets which gives less weight to the substance packed and further cost is reduced.
- (ii) It is used on roof top because most of the heat falling on the roof is reflected, as a result interior remains cool.
- (iii) Due to its property to emit white light, aluminium powder is used in flash light bulbs for indoor photography.
- (iv) Aluminium has low density, is light and as a result transportation becomes easier in light weight containers.

DIRECTION : Write balanced chemical equations for the following :

105. Iron is exposed to moist air

Ans : COMP 2005



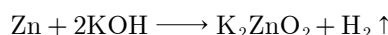
106. Iron is added to copper sulphate solution

Ans : SQP 2007



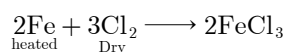
107. Zinc is boiled with caustic potash solution

Ans : MAIN 2009



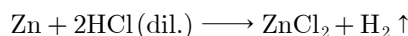
108. Dry chlorine is passed over heated iron

Ans : COMP 2012



109. Zinc pieces are added to dilute hydrochloric acid.

Ans : SQP 2015



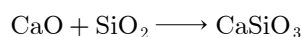
110. The reduction of Ferric oxide.

Ans : MAIN 2002



111. Formation of slag inside the blast furnace.

Ans : COMP 2008



88. Steel is converted to stainless steel by adding _____ and _____.

Ans : SQP 2011
chromium, nickel

89. The chemical compound present in Zinc blende is _____.

Ans : COMP 2015
zinc sulphide

90. Sulphide ores are concentrated by _____.

Ans : SQP 2018
froth floatation process

91. The most common ore of Aluminium is _____.

Ans : MAIN 2019
bauxite

92. Iron ores are concentrated by _____.

Ans : COMP 2012
electromagnetic separation

93. _____ is a non-metal which sublimes on heating.

Ans : MAIN 2016
iodine

94. Complete and balance the following equation :
 $\text{Al} + \text{NaOH} + \text{_____} \rightarrow$

Ans : SQP 2019
 $2\text{Al} + 2\text{NaOH} + 2\text{H}_2\text{O} \longrightarrow 2\text{NaAlO}_2 + 3\text{H}_2\uparrow$

DIRECTION : Complete the missing statements :

95. Metals are _____ while non-metals are poor conductors of heat. Metals are malleable while non-metals are _____. Metals form positive ions while non-metals form _____. Non-metals form acidic oxides while metals form _____.

Ans : SQP 2014
Good conductors, brittle, negative ions, basic oxides.

96. Fill in the blanks in the following list:

Common name	Chemical name	Formula
(i) Cryolite		
(ii)	Calcium oxide	

Ans :

MAIN 2019

Common name	Chemical name	Formula
(i) Cryolite	Sodium-aluminium fluoride (complex fluoride)	$\text{Na}_3[\text{AlF}_6]$
(ii) Quicklime	Calcium oxide	CaO

DIRECTION :

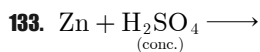
	X	Y
Normal Electronic Configuration	2, 8, 7	2, 8, 2
Nature of oxide	Dissolves in water and turns blue litmus red	Very low solubility in water. Dissolves in hydrochloric acid
Tendency for oxidising and reducing reactions	Tends to oxidise elements and compounds	Tends to act as a reducing agent
Electrical and Thermal conductivity	Very poor electrical conductor Poor thermal conductivity	Good Electrical conductor Good Thermal conductor
Tendency to form alloys and amalgams	No tendency to form alloys	Forms alloys

97. Using the information above, complete the following:

- _____ is the metallic element.
- Metal atoms tend to have a maximum of _____ electrons in the outermost energy level.
- Non-metallic elements tend to form _____ oxides while metals tend to form _____ oxides.
- Non-metallic elements tend to be _____ conductors of heat and electricity.
- Metals tend to _____ electrons and act as _____ agents in their reactions with elements and compounds.

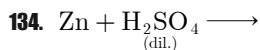
Ans :

COMP 2012



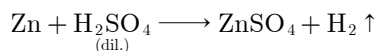
Ans :

COMP 2011



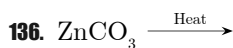
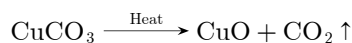
Ans :

MAIN 2008



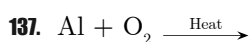
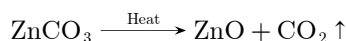
Ans :

SQP 2021



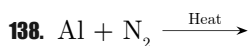
Ans :

COMP 2003



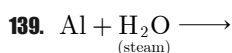
Ans :

SQP 2009



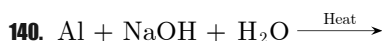
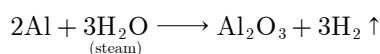
Ans :

MAIN 2017



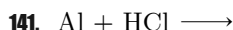
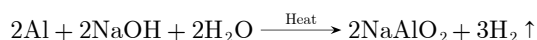
Ans :

COMP 2020



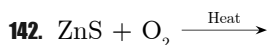
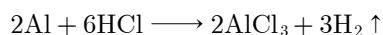
Ans :

SQP 2000



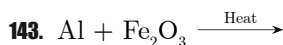
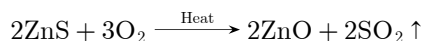
Ans :

MAIN 2014



Ans :

COMP 2019



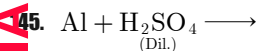
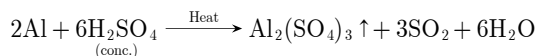
Ans :

SQP 2010



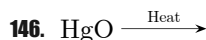
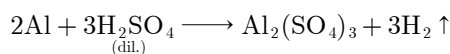
Ans :

MAIN 2002



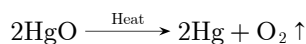
Ans :

SQP 2009



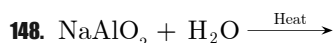
Ans :

COMP 2017



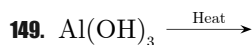
Ans :

MAIN 2006



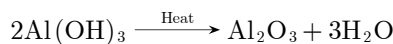
Ans :

SQP 2001



Ans :

MAIN 2009



Ans :

COMP 2023



DIRECTION : Answer the following :

151. State one observation for the following:
Zinc nitrate crystals are strongly heated.

Ans :

COMP 2012

Zinc nitrate crystals decompose to give reddish brown coloured gas which turns freshly prepared acidified ferrous sulphate solution brown black.

152. Give the chemical name and formula of cryolite.

Ans :

SQP 2014

The chemical name of cryolite is Sodium-aluminium fluoride and its formula is $\text{Na}_3[\text{AlF}_6]$.

- 153.** What do you observe when carbon monoxide is passed over heated copper oxide ?

Ans : MAIN 2011

Black powdery mass changes to pinkish metal.

- 154.** State two ways by which rusting can be prevented?

Ans : COMP 2015

By painting and galvanisation rusting can be prevented.

- 155.** State two necessary conditions for rusting.

Ans : SQP 2017

The presence of oxygen and moisture are two necessary conditions for rusting.

- 156.** Why is aluminium used in flash bulbs ?

Ans : MAIN 2023

Aluminium burns in oxygen producing intense white light. This property makes it suitable for flash bulbs.

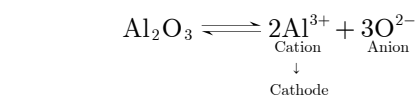
- 157.** What is added to steel to make it stainless steel ?

Ans : SQP 2001

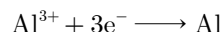
Chromium and Nickel

- 158.** Write the equation for the formation of aluminum at the cathode during the electrolysis of alumina.

Ans : MAIN 2018



Cathode



- 159.** Explain why it is preferable to use a number of graphite electrodes as anode instead of a single electrode, during the above electrolysis.

Ans : SQP 2016

As they get oxidized to CO_2 .

- 160.** To protect iron from rusting it is coated with a thin layer of zinc. Name this process.

Ans : MAIN 2004

Galvanisation

- 161.** Which particular property of cast iron makes it unsuitable for the construction of bridges ?

Ans : COMP 2004

Hardness and brittleness.

- 162.** Write the chemical formulae of one main ore of iron and aluminium.

Ans : SQP 2011

Iron Haematite $\rightarrow \text{Fe}_2\text{O}_3$

Aluminium Bauxite $\rightarrow \text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$

- 163.** Write the constituents of electrolyte for the extraction of aluminium.

Ans : MAIN 2015

Constituents of electrolyte for the extraction of aluminium :

(i) Pure molten alumina $\rightarrow 20\%$

(ii) Cryolite $\rightarrow 60\%$

(iii) Fluorspar $\rightarrow 20\%$

- 164.** Match the properties and uses of alloys in List 1 with the appropriate answer from List 2.

	List 1		List 2
1.	The alloy contains Cu and Zn, is hard, silvery and is used in decorative articles.	A.	Duralumin
2.	It is stronger than Aluminium, light and is used in making light tools.	B.	Brass
3.	It is lustrous, hard, corrosion resistant and used in surgical instruments.	C.	Bronze
4.	Tin lowers the melting point of the alloy and is used for soldering purpose.	D.	Stainless steel
5.	The alloy is hard, brittle, takes up polish and is used for making statues.	E.	Solder

Ans : COMP 2012

1. - B, 2. - A, 3. - D, 4. - E, 5. - C

TWO MARKS QUESTIONS

- 165.** The following questions relate to the extraction of Aluminium by electrolysis.

- (i) Name the other aluminium containing compound added to alumina.
 (ii) Give a balanced equation for the reaction that takes place at the cathode.

Ans :

SQP 2025

- (i) Cryolite
 (ii) $\text{Al}^{+3} + 3\text{e}^- \rightarrow \text{Al}$

166. Match the following Column A with Column B.

	Column A		Column A
(i)	Aluminium	1.	Covalent compound
(ii)	Sulphuric acid	2.	Carbonate ore
(iii)	Calcination	3.	Hall Heroult's process
(iv)	Calcium Chloride	4.	Contact Process
(v)	Carbon tetrachloride	5.	Electrovalent compound

Ans :

SQP 2025

- (i) 3
 (ii) 4
 (iii) 2
 (iv) 5
 (v) 1

167. Name the alloy which is made up of:

- (i) Copper, Zinc and Tin
 (ii) Lead and Tin

Ans :

SQP 2025

- (i) Bronze
 (ii) Solder

168. Name the main metal used in making of alloys given below:

- (a) Duralumin
 (b) Stainless steel

Ans :

MAIN 2024

- (a) Duralumin is an alloy of aluminium (Al), copper (Cu), manganese (Mn) and magnesium (Mg).
 (b) Stainless steel is an alloy of iron (Fe) and chromium (Cr).

169. Choose the correct answer from the list given below:

Zinc blende, C_2H_2 , Calamine, Haematite

- (a) The ore which can be concentrated by magnetic separation.
 (b) Empirical formula of Ethyne.

Ans :

MAIN 2024

- (a) The ore which can be concentrated by magnetic separation is Hematite.
 (b) The empirical formula of ethyne is C_2H_2 .

170. State the relevant reason for the following :

- (i) Concentrated alkali is used for the concentration of bauxite ore.
 (ii) Fused alumina is reduced to aluminium by electrolysis.

Ans :

MAIN 2022

- (i) Concentrated alkali is used for the concentration of bauxite ore because bauxite is soluble only in hot concentrated alkali (like NaOH), while impurities are insoluble, they can be easily filtered.
 (ii) Fused alumina is reduced to aluminium by electrolysis, since alumina is highly stable. It is not reduced by reducing agents.

171. State one use of the given alloys :

- (i) Magnalium
 (ii) Duralumin

Ans :

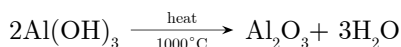
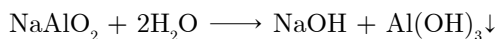
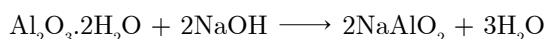
SQP 2022

- (i) Use of magnalium.
 Used in aircraft and automobile parts.
 (ii) Use of duralumin.
 Used in pressure cookers.

172. Baeyer's process is used to concentrate bauxite ore to alumina. Give balanced chemical equations for the reaction taking place for its conversion from bauxite to alumina.

Ans :

COMP 2020



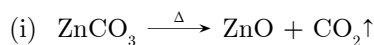
Baeyer's process is used to concentrate bauxite ore to alumina by treating it with sodium hydroxide.

173. State one relevant observation for each of the following reactions :

- (i) Zinc carbonate is heated strongly.
 (ii) Sulphide ore is added to a tank containing oil and water and then stirred or agitated with air.

Ans :

MAIN 2020



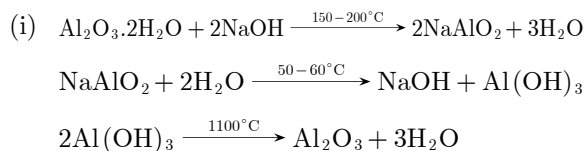
When zinc carbonate is heated a residue is

used ?

- (iii) Write an equation for the reaction which takes place at the anode during the extraction of aluminium by the electrolytic process.
- (iv) Mention one reason for the use of aluminium in thermite welding.

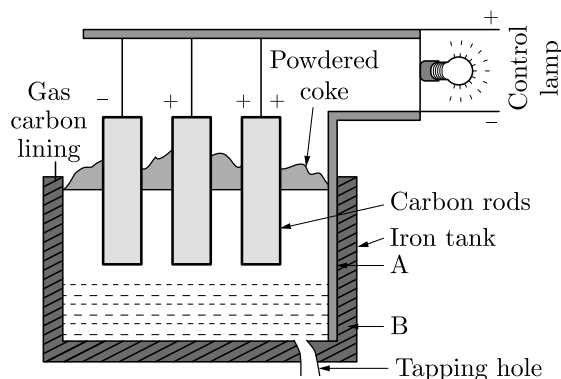
Ans :

COMP 2010



- (ii) Cryolite is used in the molten state to dissolve purified alumina.
- (iii) $3\text{O}^{2-} - 6\text{e}^- \longrightarrow 6\text{O}$
 $6\text{O} \longrightarrow 3\text{O}_2$
- (iv) Because of greater affinity for oxygen as compared to iron.

200. (a) Name the element extracted by the given process and also name the process.
- (b) Give the function of three components of electrolyte.



- (c) Why is electrolyte covered with coke ?
- (d) What does glowing of indicator lamp indicate?
- (e) Give the electrolytic reaction taking place at cathode.

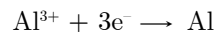
Ans :

COMP 2005

- (a) Aluminium, Hall and Herault's process.
- (b) (i) Alumina (Al_2O_3) $\rightarrow$ main aluminium yielding compound.
- (ii) Cryolite [Na_3AlF_6] $\rightarrow$ acts as a solvent and lowers the fusion temperature from 2050°C to 950°C .
- (iii) Fluorspar (CaF_2) $\rightarrow$ acts as a solvent and increases the conductivity of electrolytic mixture.
- (c) A layer of powdered coke is sprinkled over

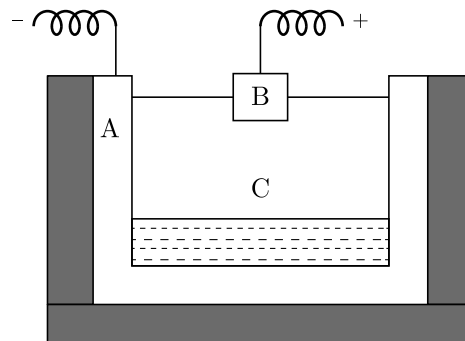
the surface of the electrolyte mixture. This reduces the heat loss by radiation and prevents carbon anode from burning in air.

- (d) An indicator lamp glows as soon as the concentration of the alumina in the electrolytic bath falls below the minimum required level. More alumina is added to compensate the loss and to keep the process continuous.
- (e) At cathode : (Negative terminal of the electrode)



Aluminium formed sinks to the bottom of the tank and is periodically tapped off.

201. The following is a sketch of an electrolytic cell used in the extraction of aluminium :



- (i) What is the substance of which the electrodes A and B are made ?
- (ii) At which electrode (A or B) is the aluminium formed ?
- (iii) What are the two aluminium compounds in the electrolyte C ?
- (iv) Why is it necessary for electrode B to be continuously replaced ?

Ans :

SQP 2019

- (i) A and B are made of carbon.
 $A \rightarrow$ (Cathode) $\rightarrow$ gas carbon.
 $B \rightarrow$ (Anode) $\rightarrow$ carbon rod.
- (ii) Aluminium is formed at cathode (A) in the molten state which can be taken out through a tapping hole.
- (iii) Cryolite (Na_3AlF_6): Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$)
- (iv) Oxygen is given off at anode where it reacts with carbon to form carbon monoxide. The hot CO further burns to form CO_2 . As a result, the anode gets worn out and have to be replaced from time to time.

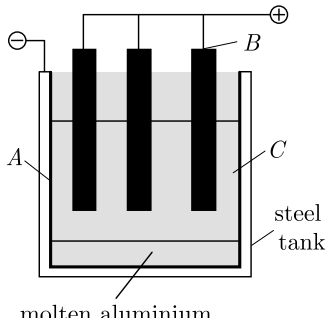
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metals or non-metals mixed in a molten state.

- Light and strong or high tensile strength.
- Expands on cooling.

THREE MARKS QUESTIONS

- 182.** Given below in column A is a schematic diagram of the electrolytic reduction of alumina. Identify the parts labelled as A, B and C with the correct options from the Column B.

Column A	Column B
	1. Platinum
	2. Anode
	3. Cathode
	4. Electrolyte mixture
	5. Bauxite

Ans :

SQP 2025

- A – Cathode
B – Anode
C – Electrolytic mixture

- 183.** Name an alloy of (i) aluminium used in aircraft construction. (ii) lead used in electrical wiring or electrical work in joining metals. (iii) copper used in electrical appliances or household vessels.

Ans :

MAIN 2015

- Duralumin
- Solder
- Brass

- 184.** The following questions are related to Iron:
- Name the acid with which iron is rendered passive.
 - Name an alloy of Iron and Carbon.
 - Name the process by which Iron ore is concentrated.

Ans :

COMP 2017

- Concentrated nitric acid
- Steel
- Electromagnetic separation

- 185.** (i) Name an oxide which forms salts when it reacts both with acids and alkalies.

- Calcium, Copper, Lead, Aluminium, Zinc, Chromium, Magnesium, Iron. Choose the major metals that make the following alloys :
(a) Stainless steel
(b) Brass.

Ans :

MAIN 2019

- Zinc oxide (ZnO)
- (a) Iron, Chromium
(b) Copper, Zinc

- 186.** Give the chemical formula of :

- Bauxite
- Cryolite
- Sodium aluminate

Ans :

SQP 2019

- $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
- Na_3AlF_6
- NaAlO_2

- 187.** Answer the following questions based on the extraction of aluminium from alumina by Hall-Heroult's Process :

- What is the function of cryolite used along with alumina as the electrolyte ?
- Why is powdered coke sprinkled on top of the electrolyte ?
- Name the electrode, from which aluminium is collected.

Ans :

COMP 2019

- Cryolite acts as a solvent and lower the fusion temperature from 2050°C to 950°C .
- A layer of powdered coke is sprinkled over the surface of the electrolyte to reduce the heat loss by radiation and prevent the carbon rod from burning in air.
- Cathode

- 188.** For each of the substance listed below, describe the role played in the extraction of aluminium.

- Cryolite
- Sodium hydroxide
- Graphite.

Ans :

MAIN 2015

- Cryolite acts as a solvent for molten alumina, which reduces the melting point or fusion temperature of pure alumina.
- Sodium hydroxide dissolves pure alumina to form soluble sodium aluminate.
- Graphite acts as anode.

formed which is yellow when hot and white when cold.

- (ii) When sulphide ore is added to a tank containing oil and water and then stirred or agitated with air. The sulphide ore dissolves in the froth and get separated.

174. How many valence electrons are present in :

- (i) metals
(ii) non-metals ?

Ans :

COMP 2021

- (i) 1 to 3
(ii) 4 to 7

175. List 1 contains metal alloys, 1, 2, 3, 4 and 5 and the list 2 contains their uses A, B, C, D and E.

List 1	Metal/Alloy	List 2	Uses
1.	Aluminium	A	Steel-making
2.	Lead	B	Aeroplane wings
3.	Brass	C	Galvanising
4.	Iron	D	Radiation shield
5.	Zinc	E	Electric fitting

Copy and complete the following table, writing down the letter for correct use of each metal alloy. An answer may be used once. The first is done for you.

Metal	1	2	3	4	5
Use	B				

Ans :

COMP 2002

Metal	1	2	3	4	5
Use	B	D	E	A	C

176. Why are cryolite and fluorspar added to pure alumina ?

Ans :

SQP 2009

- (i) To reduce the melting point of alumina.
(ii) To increase the electrical conductivity.
(iii) Cryolite acts as a solvent.

177. What is the special property of :

- (i) Duralumin
(ii) Type metal ?

Ans :

MAIN 2023

- (i) Duralumin is light but as strong as steel. It is highly ductile. It is hard and resistant to corrosion.
(ii) Type metal has low melting point. It easily casts and expands on solidification.

178. Aluminium cannot be extracted by the reduction of its ores by carbon". Explain briefly.

Ans :

COMP 2000

We know that aluminium is a strongly electro-positive metal. So its ore, alumina (Al_2O_3) cannot be reduced by carbon during the extraction of aluminium. Moreover, carbon immediately combines with aluminium to yield aluminium carbide (Al_4C_3).

179. Explain why:

- (i) In the electrolysis of alumina using the Hall Heroult's Process the electrolyte is covered with powered coke.
(ii) Iron sheets are coated with zinc during galvanization.

Ans :

MAIN 2015

- (i) To prevent the loss of heat by radiation.
(ii) To prevent iron from rusting.

180. State the property of the metal being utilized in the following:

Use of metal	Property
Zinc in Galvanization	
Aluminium in Thermite welding	

Ans :

SQP 2010

Use of metal	Property
Zinc in Galvanization	Electropositive nature (due to which it imparts protection to the substance on which it is coated)
Aluminium in Thermite welding	High affinity for oxygen

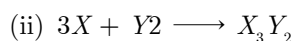
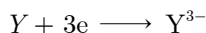
181. What is an alloy? An alloy usually has some property which makes it particularly useful. What is the special property of

- (i) Duralumin
(ii) Type metal

Ans :

SQP 2013

An alloy is a homogeneous mixture of two or more



FOUR MARKS QUESTIONS

195. The following questions refer to the extraction of Aluminium and Iron from their ores:

- Name the principal ore from which
 - Iron and
 - Aluminium are extracted.
- What is the most important chemical process in the extraction of any metal? State how the essential step is carried out in the extraction?
- Aluminium ores both contain impurities. Explain briefly how these impurities are removed in each case.

Ans :

MAIN 2007

- Iron - Haematite
 - Aluminium - Bauxite
- In case of Al it is reduced electrolytically.

$$Al_2O_3 \longrightarrow 2Al^{3+} + 3O^{2-}$$

Cathode : $Al^{3+} + 3e^- \longrightarrow Al$
- Impurities in Aluminium ore are removed by Baeyer's process. In this process, Bauxite is heated with Sodium hydroxide to get soluble Sodium aluminate which on hydrolysis gives Aluminium hydroxide, which on igniting, gives pure Alumina

- 196.** (i) Give the name and formula of the ore of Zinc.
 (ii) Write equations for the following steps in the extraction of Zinc :
 - Roasting of ore
 - Reduction of Zinc compound which is the product of the above reaction.
 (iii) What, in addition to a Zinc compound, is put into the blast furnace ?
 (iv) State one large scale use of Zinc.

Ans :

COMP 2007

- Zinc blend - ZnS
- $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$
 - $ZnO + C \longrightarrow Zn + CO$
- Carbon
- Galvanization

197. Match the alloys given in column I to the uses given in column II :

	Column I		Column II
(i)	Duralumin	A.	Electrical fuse
(ii)	Solder	B.	Surgical instruments
(iii)	Brass	C.	Aircraft body
(iv)	Stainless Steel	D.	Decorative articles

Ans :

MAIN 2019

- Duralumin $\rightarrow$ Aircraft body
- Solder $\rightarrow$ Electrical fuse
- Brass $\rightarrow$ Decorative articles
- Stainless steel $\rightarrow$ Surgical instruments

198. The following is an extract from 'Metals in the Service of Man, Alexander and Street/Pelican 1976. Alumina (aluminium oxide) has a very high melting point of over $2000^\circ C$ so that it cannot readily be liquefied. However, conversion of alumina to aluminium and oxygen, by electrolysis, can occur, when it is dissolved in some other substance :

- Which solution is used to react with bauxite as a first step in obtaining pure aluminium oxide ?
- The aluminium oxide for the electrolytic extraction of aluminium is obtained by heating aluminium hydroxide. Write the equation for this reaction.
- Name the element which serves both as the anode and the cathode in the extraction of aluminium.
- Write the equation for the reaction that occurs at the cathode during the extraction of aluminium by electrolysis.
- Give the equation for the reaction which occurs at the anode when aluminium is purified by electrolysis.

Ans :

SQP 2007

- Sodium hydroxide
- $2Al(OH)_3 \xrightarrow{\Delta} Al_2O_3 + 3H_2O$
- Carbon
- Cathode (Negative Terminal) – (Inner lining of tank) – (rich in e^-)

$$Al^{3+} + 3e^- \longrightarrow Al$$
- $Al - 3e^- \longrightarrow Al^{3+}$

199. Aluminium is extracted from its chief ore, bauxite.

- Write three balanced equations for the purification of bauxite by Baeyer's process.
- Name a chemical used for dissolving Al_2O_3 . In which state of subdivision is the chemical

189. The following questions relate to the extraction of aluminium by electrolysis:

- Name the other aluminium containing compound added to alumina and state its significance.
- Give the equation for the reaction that takes place at the cathode.
- Explain why is it necessary to renew the anode periodically.

Ans :

SQP 2013

- Cryolite acts as a solvent for pure alumina. It decreases the melting point or fusion temperature of pure alumina from 2050°C to 950°C .
- $\text{Al}^{3+} + 3e^{-} \longrightarrow \text{Al}$
- Nascent oxygen attacks carbon anodes, they gradually oxidized to carbon dioxide.

190. The following questions are relevant to the extraction of Aluminium:

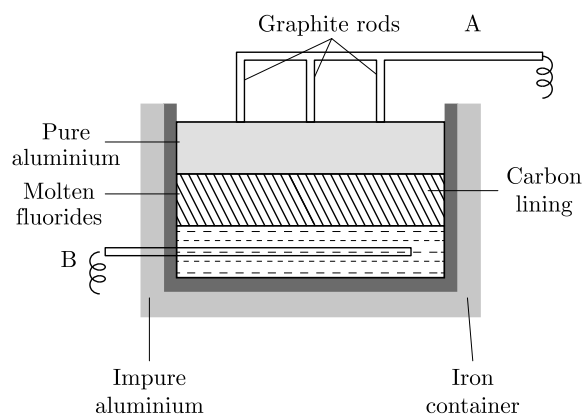
- State the reason for addition of caustic alkali to bauxite ore during purification of bauxite.
- Give a balanced chemical equation for the above reaction.
- Along with cryolite and alumina, another substance is added to the electrolyte mixture. Name the substance and give one reason for the addition.

Ans :

COMP 2012

- Bauxite dissolves in caustic alkali to form soluble sodium meta aluminate whereas the impurities remain unreacted is left behind and is removed by filtration.
- $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} + 2\text{NaOH} \longrightarrow 2\text{NaAlO}_2 + 3\text{H}_2\text{O}$
- Fluorspar increases the electrical conductivity of the mixture.

191. The sketch below illustrates the refining of aluminium by Hoope's process.



- Which of *A* and *B* is the cathode and which one is the anode?
- What is the electrolyte in the tank?
- What material is used for the cathode?

Ans :

SQP 2009

- A* are graphite rods and they act as cathode *B* act as anode.
- Impure aluminium.
- Carbon.

192. What is the difference between calcination and roasting ?

Ans :

COMP 2011

	Roasting	Calcination
(a)	Ore is heated in the presence of air.	Ore is heated in the absence of air.
(b)	Used generally for sulphide ores. Hence, SO_2 gas is given off. $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2 \downarrow$ (White in one line)	Used generally for carbonate ores. Hence, CO_2 gas is given off. $\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$
(c)	Volatile impurities are removed as oxides.	Moisture, organic impurities and volatile impurities are removed.

193. Name an alloy of :

- Aluminium, used in aircraft construction.
- Lead, used in electrical work in joining metals.
- Copper, in electrical appliances or household vessels.

Ans :

COMP 2010

- Duralumin (Al = 95%, Cu = 4%, Mn = 0.5%, Mg = 0.5%)
- Solder (Sn = 50% to 60%, Pb = 50% to 40%)
- Brass (Cu = 60% to 80%, Zn = 40% to 20%)

194. Element *X* is a metal with a valency 2. Element *Y* is a non-metal with a valency 3.

- Write equations to show how *X* and *Y* form ions.
- If *Y* is a diatomic gas, write the equations for the direct combination of *X* and *Y* to form a compound.

Ans :

SQP 2019

- $\text{X} - 2e^{-} \longrightarrow \text{X}^{2+}$

CASE BASED QUESTION

202. A company is focused on extracting aluminum from bauxite, lead from galena and silver from argentite. They are refining their processes to improve efficiency and reduce environmental impact. Additionally, they are exploring methods to prevent corrosion during storage and transport. Their goal is to ensure the metals' durability in various environments.

- (i) Which process is used to extract aluminum from bauxite?
- (ii) What by-product is formed during the roasting of lead sulfide?
- (iii) What coating method is used to prevent corrosion of metals?
- (iv) Which element is added to steel to increase its corrosion resistance?

Ans :

- (i) Electrolysis.
- (ii) Sulfur.
- (iii) Galvanization.
- (iv) Chromium.

203. The company is also considering the recycling of scrap metals as a way to further reduce environmental impact and lower production costs. They are particularly interested in the recycling of aluminum, which is highly energy-efficient compared to primary extraction. Moreover, they are researching advanced alloys that incorporate recycled metals without compromising the material's strength and durability. The company's long-term plan includes developing sustainable practices that integrate both advanced extraction technologies and recycling methods to meet the growing global demand for metals.

- (i) Which process is highly energy-efficient for obtaining aluminum compared to primary extraction?
- (ii) What is the primary benefit of recycling aluminum in metal production?
- (iii) What is the company researching to incorporate recycled metals without compromising strength?
- (iv) What is the company's long-term goal in terms of metal production?

Ans :

- (i) Recycling.
- (ii) Energy efficiency.
- (iii) Advanced alloys.

(iv) Sustainable practices.

204. A research lab is developing new materials for use in electronic devices. They are focusing on metals like copper, gold and aluminum due to their excellent electrical conductivity and corrosion resistance. Copper is widely used for wiring and circuit boards, gold for connectors due to its superior corrosion resistance and aluminum for lightweight components. The lab is also experimenting with alloys to enhance the durability and efficiency of these metals in high-performance electronics. Additionally, they are investigating methods to recycle and reuse these materials to reduce waste and lower production costs.

- (i) Which metal is commonly used in electronic wiring due to its excellent electrical conductivity?
- (ii) Which metal is preferred for connectors in electronics due to its superior corrosion resistance?
- (iii) Which metal is used for lightweight components in electronic devices?
- (iv) What is the lab investigating to reduce waste and lower production costs?

Ans :

- (i) Copper.
- (ii) Gold.
- (iii) Aluminum.
- (iv) Recycling.

205. In addition to their work on metals and alloys, the research lab is also exploring the integration of advanced materials like graphene and conductive polymers into electronic devices. These materials offer unique properties, such as flexibility, transparency and high conductivity, which could revolutionize the design and functionality of future electronics. The lab aims to create components that are not only more efficient but also environmentally friendly, by reducing reliance on traditional metals and minimizing electronic waste. Their goal is to develop next-generation electronics that are both high-performing and sustainable.

- (i) Which advanced material is the lab exploring for its flexibility and high conductivity?
- (ii) Which property makes conductive polymers attractive for electronic devices?
- (iii) What is the lab's goal in developing next-generation electronics?

- (iv) Which materials are being integrated to reduce reliance on traditional metals?

Ans :

- (i) Graphene.
- (ii) Flexibility.
- (iii) Sustainability.
- (iv) Conductive polymers.

206. The research lab is also addressing the challenge of thermal management in electronic devices. As electronic components become more powerful, they generate more heat, which can affect performance and longevity. The lab is testing various cooling solutions, including heat sinks made from advanced alloys, thermal interface materials. With improved conductivity and innovative designs that enhance airflow. Additionally, they are exploring the use of phase-change materials that absorb heat and release it gradually, keeping devices cool under heavy usage. These solutions are critical for maintaining the reliability and efficiency of high-performance electronics in demanding environments.

- (i) What challenge is the lab addressing related to electronic device performance?
- (ii) What are heat sinks made from to improve cooling in electronic devices?
- (iii) What material is being explored to absorb and gradually release heat?
- (iv) What is the purpose of improving thermal management in electronic devices?

Ans :

- (i) Thermal management.
- (ii) Advanced alloys.
- (iii) Phase-change materials.
- (iv) Maintaining reliability.

207. A pharmaceutical company is developing a new line of metal-based drugs for treating various diseases, including cancer and rheumatoid arthritis. These drugs use metals such as platinum, gold and zinc, known for their therapeutic properties. Platinum compounds, for example are effective in chemotherapy while gold compounds are used in treating rheumatoid arthritis due to their anti-inflammatory properties. Zinc is crucial for immune function and wound healing. The company is also focused on optimizing the delivery systems for these drugs to ensure they target affected cells while minimizing side effects. They are exploring the use of nanoparticles and other advanced delivery mechanisms to enhance

the efficacy and safety of these metal-based therapies.

- (i) Which metal is commonly used in chemotherapy drugs?
- (ii) Which metal compound is used to treat rheumatoid arthritis due to its anti-inflammatory properties?
- (iii) Which metal is important for immune function and wound healing?
- (iv) What technology is the company exploring to improve drug delivery and minimize side effects?

Ans :

- (i) Platinum.
- (ii) Gold.
- (iii) Zinc.
- (iv) Nanoparticles.

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CHAPTER 8

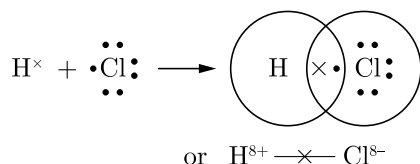
HYDROGEN CHLORIDE

SUMMARY

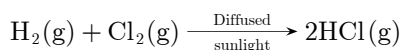
1. HYDROGEN CHLORIDE

Hydrogen chloride gas is neither combustible nor it is a supporter of combustion. It extinguishes a burning splinter.

It is a polar covalent compound.

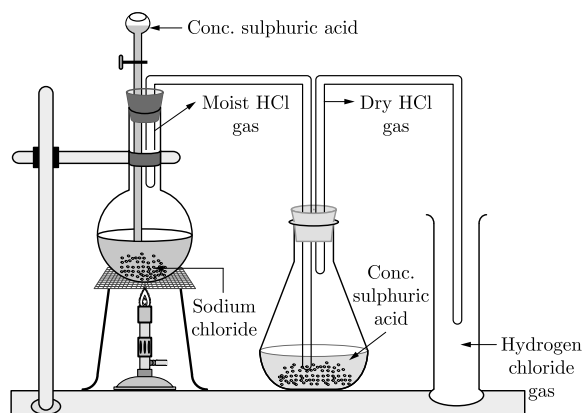


It is synthesised from its elements in the presence of diffused sunlight.



1.1 Hydrogen Chloride Preparation

Hydrogen chloride is prepared in laboratory by the reaction of sodium chloride with concentrated sulphuric acid.

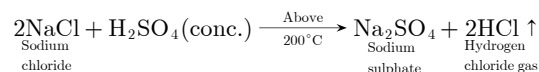
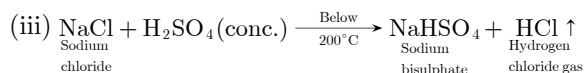


Laboratory preparation of hydrogen chloride gas

- (i) Reactants used for the preparation of hydrogen chloride gas are sodium chloride and concentrated sulphuric acid. Sodium chloride is preferred over other metallic chlorides as it

is easily available and cheaply.

- (ii) Condition of the reaction: The temperature should be maintained below 200°C .



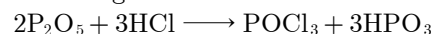
- (iv) Procedure: Take some sodium chloride (common salt) in a round bottom flask and set-up the apparatus as shown in figure 1. Pour concentrated sulphuric acid. On heating the mixture gently, HCl gas is evolved.

- (v) Precautions observed during the laboratory preparation of hydrogen chloride gas:

(a) The reaction mixture should not be heated beyond 200°C as above 200°C , a sticky mass of sodium sulphate is formed which sticks to glass apparatus and is difficult to remove.

(b) Fuel is wasted if heated above 200°C and glass apparatus must crack.

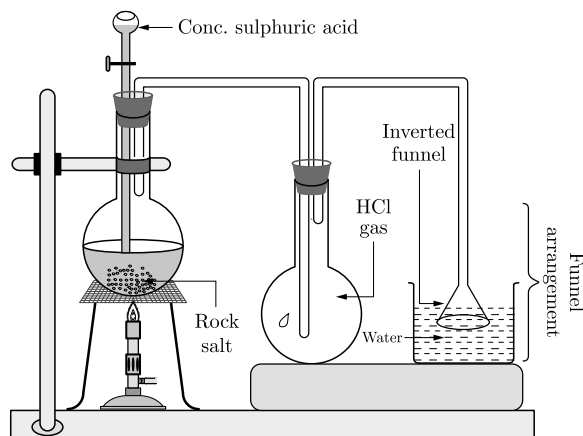
- (vi) Collection: Before collection, hydrogen chloride gas is dried by passing through concentrated sulphuric acid. It is not dried by passing through phosphorous pentaoxide and calcium oxide as both of these drying agents undergo chemical reaction with hydrogen chloride gas.



Dry hydrogen chloride gas is collected in by a gas jar upward displacement of air as the gas is heavier than air and it is not collected over water as it is highly or extremely soluble in water. Therefore, it forms hydrochloric acid.

- (vii) Identification: In order to know that the gas jar is filled with hydrogen chloride gas, bring a glass rod dipped in ammonium hydroxide near its mouth. If dense white fumes appear immediately, then it shows that the gas jar is filled with hydrogen chloride gas.

Hydrogen chloride gas is dissolved in water with the help of special arrangement called funnel arrangement to prevent the back suction of water and gives greater surface area for the absorption of the gas.



Preparation of hydrochloric acid using funnel arrangement.

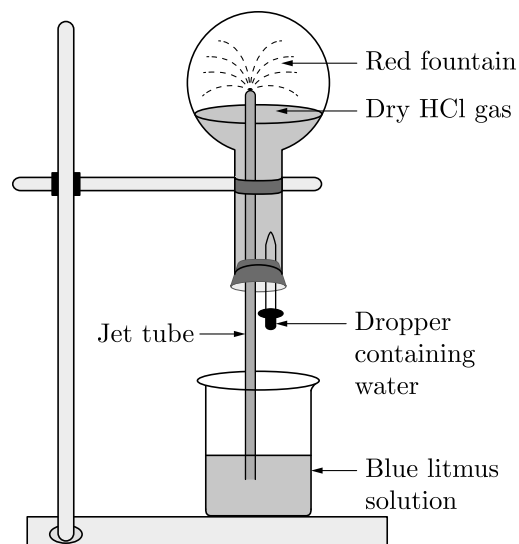
1.2 Physical Properties of Hydrogen

The physical properties of hydrogen chloride gas are as follows :

1. It is a colour less gas having pungent suffocating smell which gives dense fumes in moist air.
2. It is highly or extremely soluble in water. The extreme solubility of hydrogen chloride gas can be demonstrated by fountain experiment.

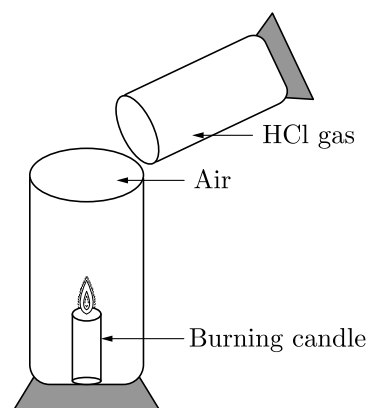
Fountain experiment: We take a dry round bottom flask filled with dry HCl and arrange the apparatus as shown in the figure. Fix a rubber stopper having two holes on the mouth of the flask. Pass a jet tube through one hole and a dropper containing a few drops of water through another hole. Put the end of the jet tube in a beaker containing blue litmus solution. When we press the dropper, we observe that blue litmus enters the jet tube with a great force and forms a red fountain. This is because on pressing, the water from the dropper goes in the flask and HCl gas present in the flask get dissolved due to its high solubility in water, thereby lowering the inside pressure. The higher outside pressure pushes the blue litmus solution inside through the jet tube due to which it turns red as HCl gas is acidic in nature.

NODIA



Fountain experiment to demonstrate extreme solubility of HCl gas

3. Hydrogen chloride gas is heavier than air, We take a jar with burning candle as shown in fig. We take another jar full of HCl gas and pour it into the jar of burning candle. We observe that the candle extinguishes. It is because of HCl gas, being heavier, forces out the air in the jar and occupies the lower portion of the jar.

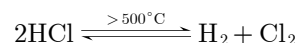


Showing Hydrogen chloride gas is heavier than air

1.3 Chemical Properties of Hydrogen

The chemical properties of hydrogen chloride gas are as follows :

1. Hydrogen chloride gas is neither combustible nor it is a supporter of combustion. It extinguishes a burning splinter.
2. Hydrogen chloride gas thermally decomposes to give hydrogen and Chlorine.



3. Metals lying above hydrogen in the metal

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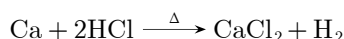
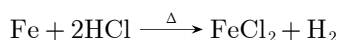
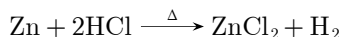
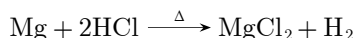
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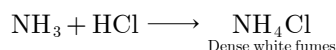
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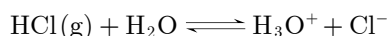
activity series displace hydrogen when heated with hydrogen chloride gas.



4. Hydrogen chloride gas reacts with ammonia to give dense white fumes of ammonium chloride.



5. Hydrogen chloride gas is a polar covalent compound which on dissolving in water produces ions.
6. Hydrogen chloride gas on dissolving in water produces strong mono-basic acid (hydrochloric acid).



7. Dry hydrogen chloride gas and liquefied hydrogen chloride gas has no effect on litmus, showing the neutral (non-acidic) character of the dry gas.
8. Liquefied hydrogen chloride gas does not allow the electric current to pass through it, showing the covalent nature of the gas.

2. HYDROCHLORIC ACID

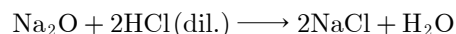
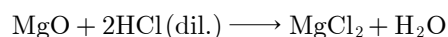
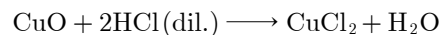
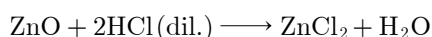
In laboratory, Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water. But, if hydrogen chloride gas is directly absorbed in water, it leads to back suction. Therefore, the gas is dissolved in Water with the help of funnel arrangement in order to prevent the back suction of water which also provides maximum area for the absorption of hydrogen chloride gas.

Dilute hydrochloric acid is a typical acid. So, it undergoes the following reactions:

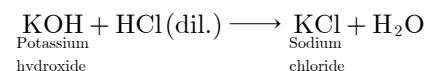
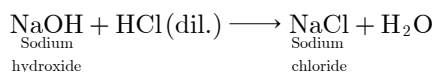
- (a) Reaction with indicator: Dilute solution of hydrochloric acid is strongly acidic and it shows characteristic colours with indicators.

Indicator	Colour change
Blue litmus	Red
Phenolphthalein	Colourless
Methyl orange	Red or pink

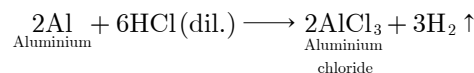
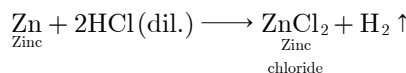
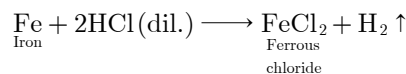
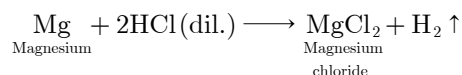
- (b) Reaction with metallic oxides: On reaction with metallic oxides dilute Hydrochloric acid forms salt and water.



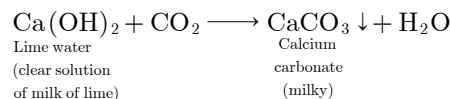
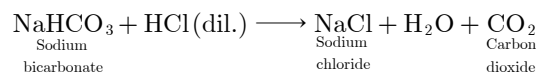
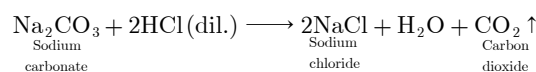
- (c) Reaction with bases: On reaction with bases, dilute HCl undergoes neutralisation reaction to form salt and water.



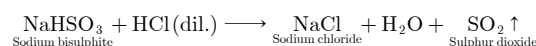
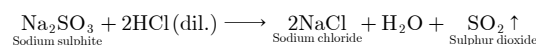
- (d) Reaction with metals: Dilute Hydrochloric acid reacts with active metals to liberate a colourless and odourless gas which burns with a popping sound.



- (e) Reaction with metallic carbonates and bicarbonates: Dilute hydrochloric acid reacts with metallic carbonates and bicarbonates to liberate colourless and odourless gas which turns lime water milky showing that the gas evolved is carbon dioxide.



- (f) Reaction with metallic sulphites and bisulphites: Dilute hydrochloric acid reacts with metallic sulphites and bisulphites to liberate a colourless gas having burning sulphur smell which turns acidified potassium dichromate from orange to green and potassium permanganate solution from purple to colourless, i.e. it decolourises, showing that the gas evolved is sulphur dioxide.



acid (HCl) and concentrated nitric acid (HNO_3) in a ratio of 3 parts hydrochloric acid to 1 part nitric acid by volume.

Thus (d) is correct option.

8. Name the experiment which demonstrates that hydrogen chloride is very soluble in water.

- (a) Fountain experiment
- (b) Catalytic reduction of hydrogen chloride
- (c) Catalytic oxidation of ammonia
- (d) Bosch process

Ans :

MAIN 2023

The experiment illustrated above is known as the 'Fountain experiment'. It demonstrates that hydrogen chloride is highly soluble in water.

Thus (a) is correct option.

9. The type of bond present between hydrogen and chlorine in hydrogen chloride.

- (a) Pure Ionic Bond
- (b) Pure Covalent Bond
- (c) Hydrogen Bond
- (d) Metallic Bond

Ans :

COMP 2011

Bond between hydrogen and chlorine in HCl is polar covalent in nature.

Thus (b) is correct option.

10. What must be added to sodium chloride to obtain hydrogen chloride?

- (a) Dil. sulphuric acid
- (b) Conc. nitric acid
- (c) Dil. nitric acid
- (d) Conc. sulphuric acid

Ans :

SQP 2015

Sodium chloride and sulphuric acid are used as the main reactants for the production of hydrogen chloride gas.

Thus (d) is correct option.

11. A colourless solution which gives a precipitate with HCl

- (a) Aqua regia
- (b) NH_4Cl
- (c) AgNO_3
- (d) Zn

Ans :

MAIN 2018

Dilute Hydrochloric acid reacts with AgNO_3 and thus forms the white precipitate of AgCl . Thus, a colorless solution which gives a white precipitate with HCl is AgNO_3 (Silver Nitrate).

Thus (c) is correct option.

12. A compound which on reaction with HCl leaves a yellow residue behind.

- (a) AgCl
- (b) $\text{Na}_2\text{S}_2\text{O}_3$
- (c) Conc. H_2SO_4
- (d) MnO_2

Ans :

SQP 2021

Thus (c) is correct option.

13. $\text{NH}_4\text{Cl(s)}$ is heated in a test tube. Vapours are brought in contact with red litmus paper, which changes to blue and then to red. It is because of

- (a) greater diffusion of NH_3 than HCl
- (b) formation of NH_3 and HCl
- (c) formation of NH_4OH and HCl
- (d) greater diffusion of HCl than NH_3

Ans :

SQP 2019

Ammonium chloride decomposes to form ammonia and hydrogen chloride gas. Ammonia diffuses faster than hydrogen chloride because its light. Ammonia is basic and thus red litmus paper turns blue, while hydrogen chloride is acid, thus blue litmus turns red.

Thus (a) is correct option.

14. combines with unreactive metals like gold a, platinum.

- (a) Nascent Oxygen [O]
- (b) Nascent Iodine [I]
- (c) Nascent Nitrogen [O]
- (d) Nascent Chlorine [Cl]

Ans :

MAIN 2021

Nascent Chlorine combines with unreactive metals like gold a, platinum.

Thus (d) is correct option.

15. A constant boiling mixture which boils without any change in composition.

- (a) Aqua Regia
- (b) Heterogeneous reaction
- (c) Azeotrope
- (d) Homogeneous reaction

Ans :

COMP 2012

A constant boiling mixture that boils without any change in composition is called an azeotrope. An azeotrope is a liquid mixture of two or more substances that have a constant boiling point and the same composition in their vapor as in their liquid. During distillation, azeotropes behave as if they were a pure compound. The components of an azeotropic mixture cannot be separated by fractional distillation.

Thus (c) is correct option.



3. Hydrochloric acid is extensively used in the manufacture of dyes, drugs, paints and preparation of aqua-regia.
4. It is used in calico printing industry, tanning industry, etc.

MULTIPLE CHOICE QUESTION

1. The aim of the Fountain Experiment is to prove that :
 - (a) HCl turns blue litmus red.
 - (b) HCl is denser than air.
 - (c) HCl is highly soluble in water.
 - (d) HCl fumes in moist air.

Ans :

COMP 2010

The experiment that demonstrates the solubility of water in Hydrogen Chloride is the Fountain experiment. The Fountain Experiment is a demonstration where a round-bottomed flask of large size having a soluble gas like Hydrogen chloride is placed upside down and connected to water possessing a blue litmus solution indicator by a glass tube. The addition of a small amount of water to the flask creates a lower pressure in the flask, a fountain of red solution is created due to the sucking of water from the trough to the flask. This shows that HCl is highly soluble in water. Thus (c) is correct option.

2. Hydrogen chloride gas being highly soluble in water is dried by:
 - (a) Anhydrous calcium chloride
 - (b) Phosphorus pentoxide
 - (c) Quick lime
 - (d) Concentrated sulphuric acid

Ans :

SQL 2011

Hydrogen chloride gas is dried by passing it through concentrated sulfuric acid because sulfuric acid has a high affinity for water and doesn't react with hydrogen chloride. Sulfuric acid is hygroscopic, meaning it absorbs water. Thus (d) is correct option.

3. The name of aqueous solution of HCl is

(a) aqua-regia	(b) muriatic acid
(c) oil of vitriol	(d) aqua fortis

Ans :

MAIN 2018

Hydrochloric acid, also known as muriatic acid or spirits of salt, is an aqueous solution of hydrogen chloride (HCl).

Thus (b) is correct option.

4. Bi-sulphates are formed at a temperature 200°C.
 - (a) less than
 - (b) more than
 - (c) equal to
 - (d) more than or equal to

Ans :

COMP 2020

At lower temperatures, sulphuric acid partially dissociates into a bisulphate ion (HSO_4^-).

At higher temperature ($>200^\circ\text{C}$), the acid undergoes complete dissociation, releasing SO_4^{2-} .

Thus (a) is correct option.

5. Soluble complex of silver salt with NH_4OH .
 - (a) Silver Hydroxide
 - (b) Diamine Silver (I) chloride
 - (c) Chloride Silver Chloride
 - (d) No reaction

Ans :

SQL 2019

When ammonium hydroxide (NH_4OH) reacts with silver chloride (AgCl), a soluble complex called diammine silver (I) chloride is formed.

Thus (b) is correct option.

6. Name a substance which oxidises conc. hydrochloric acid to chlorine.
 - (a) Sulphuric Acid (H_2SO_4)
 - (b) Calcium Oxide (CaO)
 - (c) Manganese Dioxide MnO_2
 - (d) Nitric acid (HNO_3)

Ans :

MAIN 2013

Manganese (IV) oxide, lead (IV) oxide and red lead (Pb_3O_4) react with concentrated hydrochloric acid to liberate chlorine.

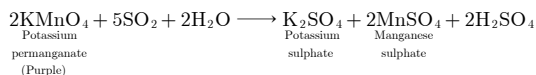
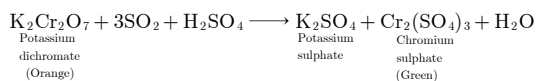
Thus (c) is correct option.

7. Aqua regia is mixture of
 - (a) dil. hydrochloric acid and dil. nitric acid
 - (b) conc. HCl (1 part) and conc. nitric acid (3 parts)
 - (c) dil. hydrochloric acid and conc. nitric acid
 - (d) conc. hydrochloric acid (3 parts) and conc. nitric acid (1 part)

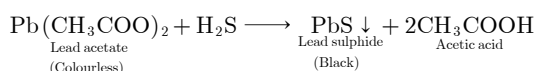
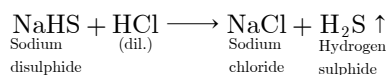
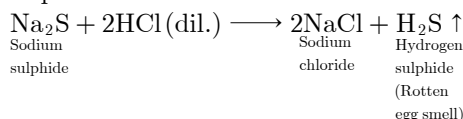
Ans :

SQL 2016

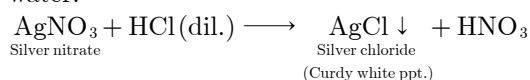
Aqua regia, which translates to "royal water" in Latin, is a mixture of concentrated hydrochloric



- (g) Reaction with metallic sulphides and bisulphides: Dilute hydrochloric acid reacts with metallic sulphides and metallic bisulphides to liberate a colourless gas having rotten egg smell which turns lead acetate solution from colourless to shining black, showing that the gas evolved is hydrogen sulphide.

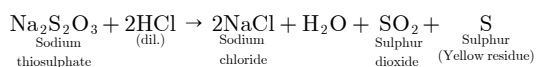


Lead chloride is a white precipitate which is soluble in hot water but insoluble in cold water.



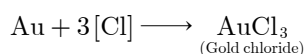
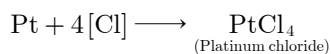
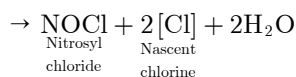
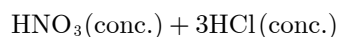
Silver chloride is a curdy white precipitate which is soluble in excess of ammonium hydroxide.

- (h) Reaction with thiosulphates: Dilute hydrochloric acid on reaction with sodium thiosulphate produces sulphur dioxide and the solution formed has a yellow turbidity.



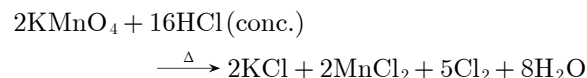
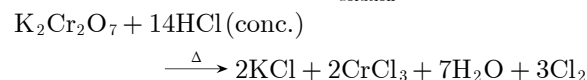
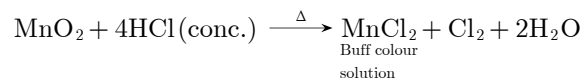
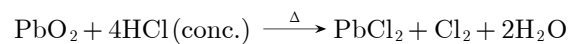
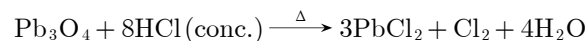
3. AQUA REGIA

Aqua regia is three parts of concentrated hydrochloric acid and one part of concentrated nitric acid. It is used for dissolving noble metals like gold and platinum.



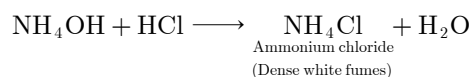
1. Concentrated hydrochloric acid is oxidised to chlorine by oxidising agents like red lead (Pb_3O_4),

lead(IV) oxide (PbO_2), manganese(IV) oxide (MnO_2), potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and potassium permanganate (KMnO_4).

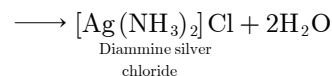
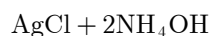
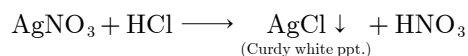


2. Tests for hydrogen chloride gas:

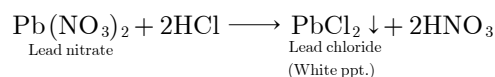
- (a) It turns moist blue litmus paper red.
 (b) It gives dense white fumes with ammonium hydroxide.



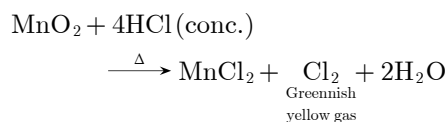
- (c) It gives curdy white precipitate with silver nitrate solution, which is soluble in excess of ammonium hydroxide.



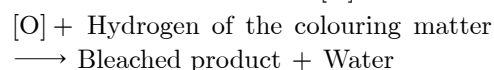
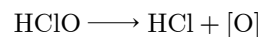
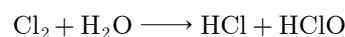
- (d) It gives a white precipitate with lead nitrate solution, which is soluble in hot water but insoluble in cold water.



- (e) On reaction with oxidising agents like manganese (IV) oxide, concentrated hydrochloric acid produces a greenish yellow coloured gas having pungent suffocating smell which turns:



- (i) Moist blue litmus paper to red and finally bleaches it to white, i.e. decolourises



- (ii) Moist starch iodide paper blue-black.



16. Which method is used to collect hydrogen chloride gas?

(a) Downward displacement of water
(b) Upward displacement of water
(c) Upward displacement of air
(d) Downward displacement of air

Ans :

SQP 2015

Hydrogen chloride (HCl) gas is collected by upward displacement of air because it is heavier than air and not water.

Thus (c) is correct option.

17. A white compound which is insoluble in nitric acid but soluble in ammonium hydroxide.

(a) Calcium Chloride (CaCl_2)
(b) Manganese oxide (MnO_2)
(c) Magnesium Chloride (MgCl_2)
(d) Silver Chloride AgCl

Ans :

SQP 2015

The white compound that is insoluble in dilute nitric acid but soluble in ammonium hydroxide is silver chloride (AgCl)

Thus (d) is correct option.

18. An experiment to prove high solubility of ammonia.

(a) Fischer Experiment
(b) Fountain Experiment
(c) Chromic acid Test
(d) Fehling Test

Ans :

MAIN 2020

The ammonia fountain experiment is a classic demonstration that shows the high solubility of ammonia in water

Thus (b) is correct option.

19. A black substance which on treatment with HCl liberate greenish yellow gas.

(a) Hydrogen Sulfide (H_2S)
(b) Sulfur dioxide (SO_2)
(c) Carbon dioxide (CO_2)
(d) Manganese dioxide (MnO_2)

Ans :

COMP 2011

The color of manganese dioxide is a black color amorphous compound. When manganese dioxide when heated with concentrated hydrochloric acid and a greenish-yellow color gas is formed. This gas is chlorine gas.

Thus (d) is correct option.

20. Which of the following is not used to detect hydrochloric acid

(a) MnO_2 (b) H_2SO_4
(c) AgNO_3 (d) NH_3

Ans :

SQP 2016

Thus (b) is correct option.

21. Mixture of one part of HNO_3 and three parts of HCl.

(a) Tincture of Iodine (b) Aqua Regia
(c) Citric acid (d) Bromine water

Ans :

MAIN 2011

Aqua regia is a mixture of three parts of hydrochloric acid and one part of nitric acid. It is also called as royal water and is used for dissolving gold and platinum.

Thus (b) is correct option.

22. Hydrogen chloride gas fumes in moist air due to its high in water.

(a) solubility (b) basicity
(c) reactivity (d) acidity

Ans :

COMP 2017

Hydrogen chloride (HCl) gas fumes in moist air due to its high solubility in water. When HCl gas mixes with water vapor in the air, it forms a mist of hydrochloric acid droplets that appear as white fumes. This property is often used to differentiate HCl gas from hydrogen sulfide gas (H_2S).

Thus (a) is correct option.

23. Any drying agent with which HCl reacts is

(a) AgCl (b) CaO
(c) MnO_2 (d) CaOCl_2

Ans :

MAIN 2019

Conc.

H_2SO_4 is a very strong drying agent and it is used in purification of hydrogen chloride.

Thus (b) is correct option.

24. A salt which is soluble in hot water, but insoluble in cold water.

(a) PbCl_2 (b) $\text{Pb}(\text{NO}_3)_2$
(c) HClO (d) KCl

Ans :

SQP 2023

Lead chloride is insoluble in cold water and soluble in hot water. Lead ion has a borderline acidic nature in the context of a hard-soft acid-base theory.

Thus (a) is correct option.

Ans : COMP 2000
Fountain experiment.

- 41.** A polar covalent compound which on dissolving in water produces ions.

Ans : SQP 2005
Hydrogen chloride gas.

- 42.** Solvent for Silver chloride.

Ans : MAIN 2010
Ammonium hydroxide.

- 43.** Name the arrangement used for the prevention of back suction of water during the dissolution of Hydrogen chloride gas in water.

Ans : COMP 2015
Inverted funnel arrangement.

- 44.** Name two aqueous solutions which give white precipitate with dil. Hydrochloric acid?

Ans : MAIN 2019
Lead nitrate solution and Silver nitrate solution.

- 45.** Name the compound which can be oxidised to chlorine.

Ans : MAIN 2006
Hydrochloric acid.

- 46.** Name one lead compound that can be used to oxidise hydrogen chloride to chlorine.

Ans : MAIN 2019
Lead (IV) oxide

DIRECTION : Fill in the blank with the choices given in bracket :

- 47.** When sodium chloride is heated with concentrated sulphuric acid below 200°C , one of the products formed is _____. (sodium hydrogen sulphate/sodium sulphate/ chlorine)

Ans : SQP 2019
Sodium hydrogen sulphate

- 48.** Quicklime is not used to dry HCl gas because _____ (CaO is alkaline, CaO is acidic, CaO is neutral)

Ans : MAIN 2014
CaO is alkaline

- 49.** Quick lime is not used to dry HCl gas because it is _____ (alkaline, acidic, neutral)

Ans : COMP 2014
alkaline

- 50.** On reaction with manganese (IV) oxide, conc. hydrochloric acid produces a _____ (reddish/brown/greenish, yellow) coloured gas.

Ans : SQP 2014
greenish/yellow

- 51.** Aqua regia is a mixture of _____ ($1/2$) part(s) of concentrated nitric acid and _____ ($2/3$) parts of conc. hydrochloric acid.

Ans : COMP 2014
1, 3

- 52.** Aqueous solution of hydrogen chloride is _____ (basic/acidic).

Ans : SQP 2014
acidic

- 53.** Density of Hydrogen chloride gas is _____ (greater/smaller) than that of air.

Ans : MAIN 2014
greater

- 54.** During the formation of hydrogen chloride, a hard mass which sticks to the glass vessel is _____ (sodium sulphate/sodium borate).

Ans : COMP 2014
sodium sulphate

- 55.** Hydrogen chloride gas is not dried using _____ (conc. H_2SO_4 , CaO)

Ans : SQP 2018
CaO

- 56.** Hydrogen chloride gas on heating above 500°C gives hydrogen and chlorine. The reaction is an example of _____ (thermal decomposition, thermal dissociation).

Ans : MAIN 2019
thermal dissociation.

- 57.** Iron reacts with hydrogen chloride gas forming _____ (iron (II) chloride, iron (III) chloride) and hydrogen. The reaction is an example of _____ (double decomposition,

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

MAIN 2007

Metals above hydrogen in the activity series react with acids like hydrochloric acid to produce hydrogen gas.

Thus (a) is correct option.

- 32. Assertion :** Hydrogen chloride gas does not conduct electricity.

Reason : Hydrogen chloride gas is a covalent compound.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

COMP 2022

As a covalent compound, hydrogen chloride does not conduct electricity because it does not have free ions.

Thus (a) is correct option.

- 33. Assertion :** Hydrochloric acid turns blue litmus paper red.

Reason : Hydrochloric acid is a strong acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

MAIN 2009

Hydrochloric acid, being a strong acid, dissociates fully in water and turns blue litmus paper red.

Thus (a) is correct option.

- 34. Assertion :** Hydrogen chloride gas is collected by upward displacement of air.

Reason : Hydrogen chloride gas is heavier than air.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

SQP 2012

Hydrogen chloride gas is heavier than air, so it is collected by upward displacement of air.

Thus (a) is correct option.

35. Assertion : Hydrochloric acid reacts with sodium carbonate to produce carbon dioxide.

Reason : Hydrochloric acid reacts with metal carbonates to produce carbon dioxide, water and a salt.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
 (c) Assertion is true but reason is false.
 (d) Assertion is false but reason is true.

Ans :

SQP 2015

The reaction between hydrochloric acid and sodium carbonate produces carbon dioxide, water and sodium chloride.

Thus (a) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following:

- 36.** Two compounds of Lead which combine with conc. HCl to liberate Chlorine.

Ans :

COMP 2021

Lead dioxide and Red lead (Pb_3O_4)

- 37.** Solvent for noble metal.

Ans :

SQP 2022

Aqua regia.

- 38.** The gas obtained when rock salt reacts with conc. Sulphuric acid.

Ans :

MAIN 2012

Hydrogen chloride gas.

- 39.** Drying agent for Hydrogen chloride gas.

Ans :

SQP 2017

Concentrated sulphuric acid.

- 40.** The experiment which demonstrates extreme solubility of Hydrogen chloride gas.

ASSERTION AND REASON

25. Assertion : Dry hydrogen chloride gas is collected by the upward displacement of air.

Reason : Hydrogen chloride gas is lighter than air.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2025

Any gas with a molecular weight less than 29 will be lighter than air.

Thus (c) is correct option.

26. Assertion : Hydrogen chloride gas is heavier than air.

Reason : Hydrogen chloride gas is a polar covalent compound.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

MAIN 2018

Hydrogen chloride gas is heavier than air due to its molecular weight, not because it is a polar covalent compound.

Thus (b) is correct option.

27. Assertion : Hydrogen chloride gas is highly soluble in water.

Reason : Hydrogen chloride gas is a non-polar molecule.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2010

Hydrogen chloride gas is highly soluble in water because it is a polar molecule, not non-polar.

Thus (c) is correct option.

28. Assertion : Dry hydrogen chloride gas has no effect on litmus paper.

Reason : Hydrogen chloride gas is a strong acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

MAIN 2002

Dry hydrogen chloride gas does not dissociate into ions and thus has no acidic properties, so it does not affect litmus paper.

Thus (c) is correct option.

29. Assertion : Hydrogen chloride gas extinguishes a burning splinter.

Reason : Hydrogen chloride gas is neither combustible nor a supporter of combustion.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

COMP 2008

Hydrogen chloride gas extinguishes a burning splinter because it is neither combustible nor a supporter of combustion.

Thus (a) is correct option.

30. Assertion : Hydrogen chloride gas reacts with ammonia to form dense white fumes.

Reason : Ammonia is a strong base and reacts with hydrogen chloride to form ammonium chloride.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of Assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

Ans :

SQP 2006

The reaction between ammonia (a strong base) and hydrogen chloride (a strong acid) forms ammonium chloride, which appears as dense white fumes.

Thus (a) is correct option.

31. Assertion : Hydrogen chloride gas reacts with metals above hydrogen in the activity series to produce hydrogen gas.

Reason : Metals above hydrogen in the activity series displace hydrogen from acids.

synthesis, simple displacement).

Ans :

COMP 2021

iron (II) chloride , simple displacement.

58. Hydrogen chloride and water are examples of _____ (polar covalent compounds, non-polar covalent compounds) and a solution of hydrogen chloride in water _____. (contains, does not contain) free ions.

Ans :

SQP 2023

polar covalent compounds, contains.

59. Addition of _____ (sodium nitrate, zinc nitrate, silver nitrate) to hydrochloric acid, gives an insoluble precipitate of the respective chloride. The precipitate is _____ (soluble, insoluble) in ammonium hydroxide and _____ (soluble, insoluble) in dilute nitric acid.

Ans :

MAIN 2016

silver nitrate, soluble, insoluble.

60. Addition of _____ (iron (III) sulphide, iron(II) sulphide, iron pyrites) to dilute hydrochloric acid results in liberation of hydrogen sulphide gas.

Ans :

COMP 2018

iron (II) sulphide.

61. Aqua regia is a mixture of _____ (one, two, three) part/s of concentrated nitric acid and _____ (one, two, three) part/s of concentrated hydrochloric acid by _____ (weight, volume). In aqua regia, nitric acid _____ (oxidises, reduces) hydrochloric acid to chlorine.

Ans :

SQP 2015

one, three, weight, oxidises.

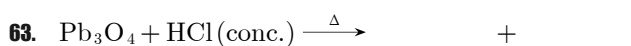
62. Hydrochloric acid can be converted into chlorine by heating with _____ (calcium oxide, lead (II) oxide, lead (IV) oxide) which acts as a/an _____ (oxidising, reducing) agent.

Ans :

COMP 2019

Lead (IV) oxide, oxidising.

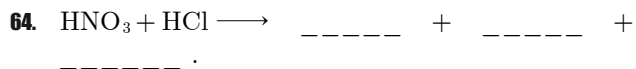
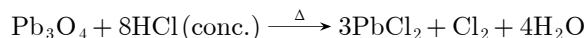
DIRECTION : Complete and balance the following equations :



+ _____ .

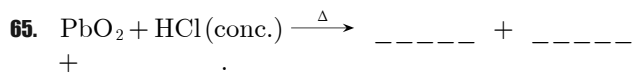
Ans :

SQP 2020



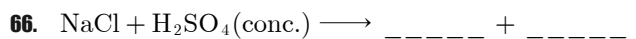
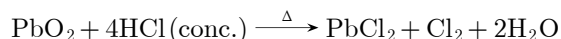
Ans :

MAIN 2023



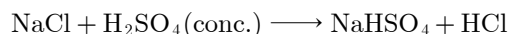
Ans :

COMP 2011



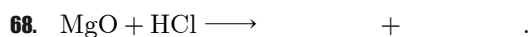
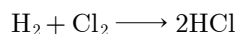
Ans :

SQP 2017



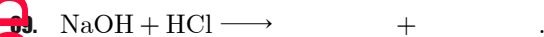
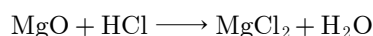
Ans :

MAIN 2012



Ans :

COMP 2019



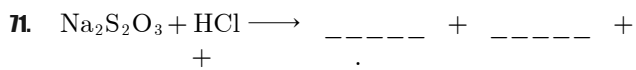
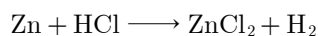
Ans :

MAIN 2023



Ans :

SQP 2016



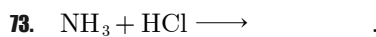
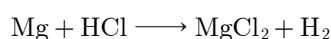
Ans :

COMP 2000



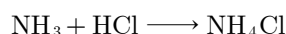
Ans :

SQP 2005



Ans :

MAIN 2007



in excess ammonium hydroxide.

Ans :

COMP 2015

- (i) Hydrochloric acid
- (ii) Hydrochloric acid

135. State one appropriate observation for each of the following :

- (i) Copper sulphide is treated with dilute hydrochloric acid.
- (ii) A few drops of dilute hydrochloric acid are added to silver nitrate solution, followed by addition of ammonium hydroxide solution.

Ans :

SQP 2013

- (i) A gas having rotten egg smell (H_2S) is released which turns lead acetate paper black.
- (ii) A curdy white precipitate (of AgCl) is formed which is insoluble in HNO_3 but soluble in NH_4OH .

136. Write a fully balanced equation for each of the following cases :

- (i) Red lead is warmed with concentrated hydrochloric acid.
- (ii) Magnesium metal is treated with dilute hydrochloric acid.

Ans :

COMP 2009

- (i) $\text{Pb}_3\text{O}_4 + 8\text{HCl} \longrightarrow 3\text{PbCl}_2 + 4\text{H}_2\text{O} + \text{Cl}_2\uparrow$
- (ii) $\text{Mg} + 2\text{HCl} \longrightarrow \text{MgCl}_2 + \text{H}_2\uparrow$

137. Distinguish between the following pairs of compounds using a reagent as a chemical test : Magnesium chloride and Magnesium nitrate solution.

Ans :

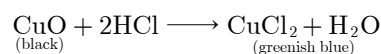
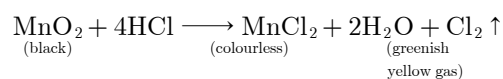
SQP 2020

Magnesium chloride	Magnesium nitrate
Add silver nitrate solution to magnesium chloride.	Add silver nitrate solution to magnesium nitrate.
$\text{MgCl}_2 + 2\text{AgNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + 2\text{AgCl}\downarrow$	$\text{Mg}(\text{NO}_3)_2 + \text{AgNO}_3 \rightarrow \text{No reaction}$
Curdy white precipitates of silver chloride will be formed.	No precipitates are formed.

138. Distinguish between the following pair of compounds using the reagent given in the bracket. Manganese dioxide and copper (II) oxide. (using concentrated HCl).

Ans :

MAIN 2019



139. Identify the gas evolved and give the chemical test for it in each of the following cases:

- (i) Dilute hydrochloric acid reacts with sodium sulphite.
- (ii) Dilute hydrochloric acid reacts with iron (II) sulphide.

Ans :

COMP 2016

- (i) SO_2 — a colourless gas having burning sulphur smell which turns acidified $\text{K}_2\text{Cr}_2\text{O}_7$ from orange to green.
- (ii) H_2S — a colourless gas having rotten egg smell which turns lead acetate solution shining black or silver-black.

140. Give a chemical test to distinguish between the following pairs of compounds:

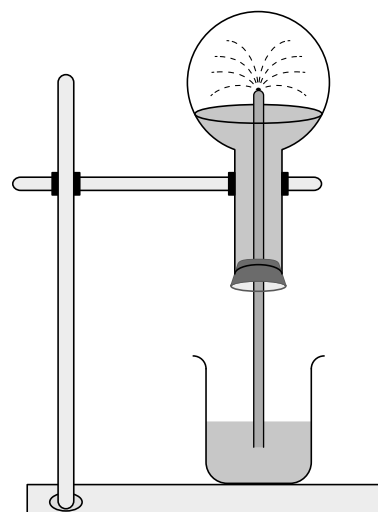
Hydrogen chloride gas and hydrogen sulphide gas.

Ans :

SQP 2013

A rod dipped in NH_4OH is brought near gas jars containing HCl gas and H_2S gas respectively.
 HCl gas – dense white fumes of NH_4Cl are seen.
 H_2S gas – no reaction.

141. The diagram below shows a simple arrangement of the fountain experiment.



- (i) Name the two gases you have studied which can be used in this experiment.
- (ii) What is the common property demonstrated by this experiment?

Ans :

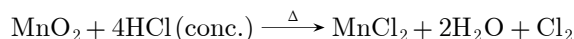
COMP 2021



96. Write balanced equation for the reaction of manganese(IV) oxide and concentrated hydrochloric acid.

Ans :

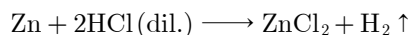
MAIN 2018



97. Write balanced chemical equation for the reaction of zinc and dilute hydrochloric acid.

Ans :

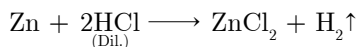
COMP 2019



98. Write balanced equation for the reaction of zinc and dilute hydrochloric acid.

Ans :

COMP 2006



99. Action of dilute hydrochloric acid on sodium sulphide.

Ans :

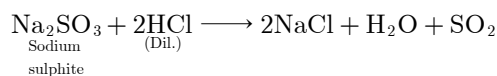
SQP 2014



100. Write a balanced chemical equation for the action of dilute hydrochloric acid on sodium sulphite.

Ans :

COMP 2001



DIRECTION : Identify the following substances which are underlined :

101. An alkaline gas which produces dense white fumes when reacted with hydrogen chloride gas.

Ans :

COMP 2013

Ammonia

102. A gas which does not conduct electricity in the liquid state but conducts electricity when dissolved in water.

Ans :

SQP 2018

Hydrogen chloride

DIRECTION : Identify the gas evolved in the following reactions when :

103. Potassium sulphite is treated with dilute hydrochloric acid.

Ans :

MAIN 2013

Sulphur dioxide

104. Concentrated hydrochloric acid is made to react with manganese dioxide.

Ans :

COMP 2013

Chlorine

DIRECTION : State own appropriate observation for the following :

105. Copper sulphide is treated with dilute hydrochloric acid.

Ans :

MAIN 2013

Colourless gas having rotten egg smell evolves which turns lead acetate solution black.

106. Action of dilute Hydrochloric acid on iron (II) sulphide.

Ans :

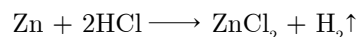
SQP 2017

Rotten egg smell due to formation of hydrogen sulphide.

107. A small piece of zinc is added to dilute hydrochloric acid.

Ans :

MAIN 2019



Zinc metal dissolves forming solution with the liberation of hydrogen gas which burns with blue flame and gets extinguished with pop sound.

108. When dilute hydrochloric acid is added to sodium carbonate crystals.

Ans :

MAIN 2014

Brisk effervescence takes place and a gas that turns lime water milky (CO_2) is evolved.

DIRECTION : Give reason for the following:

109. Hydrogen chloride gas fumes in moist air.

Ans :

MAIN 2020

Hydrogen chloride gas when exposed to air, gives white fumes due to the formation of hydrochloric acid on reacting with atmospheric water vapour.

110. Hydrogen chloride gas cannot be dried over quick lime.

Ans :

COMP 2012

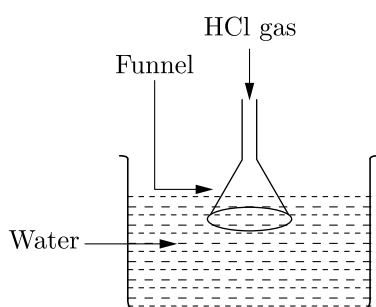
163. In the laboratory preparation of hydrochloric acid, HCl gas is dissolved in water.

- Draw a diagram to show the arrangement used for the absorption of HCl in water.
- Why is such an arrangement necessary? Give two reasons.
- Write the chemical equations for the laboratory preparation of HCl gas when the reactants are:
 - Below 200 °C
 - Above 200 °C

Ans :

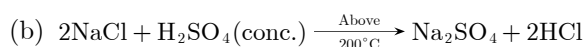
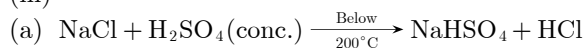
COMP 2011

(i)

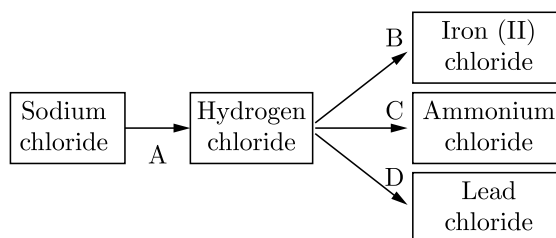


- (ii) It prevents back suction of water into the reaction flask and provides greater surface area for the absorption of the gas.

(iii)

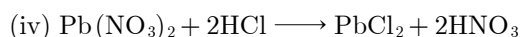
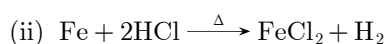
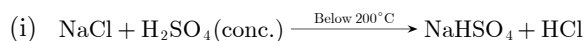


164. Refer to the flow chart below and give balanced equations with conditions, if any, for the following conversions A to D.



Ans :

SQP 2012



165. (a) When moist chlorine reacts with hydrogen sulphide two products are formed :

(i) A gas which fumes in moist air

(ii) A yellow solid.

(b) What type of reaction is taking place when chlorine acts as a bleaching agent ?

Ans :

MAIN 2017

(a) (i) Hydrochloric acid gas

(ii) Sulphur

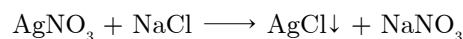
(b) Oxidation.

166. The following questions are pertaining to the Explain, why silver nitrate crystals are dissolved in distilled water and not in tap water in order to prepare a solution of silver nitrate as a laboratory reagent.

Ans :

COMP 2019

Tap water always contains some amount of dissolved sodium chloride. Thus, when the solution of silver nitrate is prepared in tap water, it reacts to form curdy white precipitate of silver chloride.



To prevent the above reaction, the solution of silver nitrate is prepared in distilled water.

167. (a) Name the drying agent :

(i) used in drying hydrogen chloride gas.

(ii) which cannot be used to dry hydrogen chloride gas.

(b) Name the chemical in which gold can be dissolved.

Ans :

MAIN 2017

(a) (i) Concentrated sulphuric acid.

(ii) Phosphorus pentoxide, P_2O_5 and quick lime, CaO .

(b) Aqua regia : It is a mixture of three parts of conc. HCl and one part of conc. Nitric acid.

168. To a solution of hydrogen chloride, the following substances are added separately in small portions. Copy and complete the table given below.

S. No.	Substance added	Gas evolved	Odour
1.	Sodium sulphite	_____	_____
2.	Calcium carbonate	_____	_____
3.	Magnesium ribbon	_____	_____

Ans :

SQP 2019

- 123.** What is the property of concentrated sulphuric acid which allows it to be used in the preparation of hydrogen chloride and nitric acid ?

Ans : SQP 2008

Non-volatile acid

- 124.** What property of hydrogen chloride is demonstrated when it is collected by downward delivery ?

Ans : COMP 2003

It is heavier than air.

- 125.** Why is hydrogen chloride not collected over water?

Ans : MAIN 2008

Because it is highly soluble in water.

- 126.** What is aqua regia ?

Ans : COMP 2019

Aqua regia is a mixture of three parts of conc. HCl and one part of conc. HNO_3 .

- 127.** State the uses of aqua regia.

Ans : SQP 2011

It is used for refining of the noble metals like gold and platinum.

- 128.** What is the function of HCl in the preparation of aqua regia ?

Ans : COMP 2017

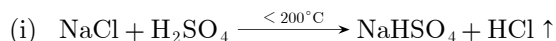
In the preparation of aqua regia conc. HCl acts as a reducing agent.

- 130.** Write the equation for :

(i) The preparation of hydrogen chloride from sodium chloride and sulphuric acid. State whether the sulphuric acid should be concentrated or dilute.

(ii) The reaction of hydrogen chloride with ammonia.

Ans : MAIN 2018



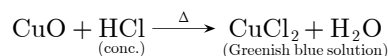
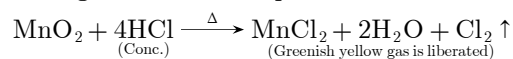
- 131.** State one chemical test to distinguish between the following pairs :

Manganese dioxide and Copper (II) oxide

Ans : COMP 2012

Manganese dioxide and Copper (II) oxide:

To both the compounds add conc. HCl and heat, the following observation helps :



(No gas is liberated but the solution turns bluish)

- 132.** You enter a laboratory after a class has completed the fountain experiment. How will you be able to tell whether the gas used in the experiment was hydrogen chloride or ammonia ?

Ans : SQP 2007

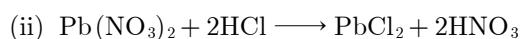
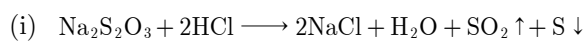
We can use neutral litmus solution to detect the type of solution. 5 mL solution formed after the gas has dissolved is taken and to it neutral litmus is added. If it turns blue the solution is of ammonia. If it turns red the solution is of hydrogen chloride.

- 133.** Write the equations for the following reactions :

(i) Dilute hydrochloric acid and sodium thiosulphate.

(ii) Dilute hydrochloric acid and lead nitrate solution.

Ans : MAIN 2008



- 134.** Identify the acid which matches the following description (i) to (ii) :

(i) The acid which is used in the preparation of a non-volatile acid.

(ii) The acid on mixing with silver nitrate solution produces a white precipitate which is soluble

TWO MARKS QUESTIONS

- 129.** State your observation in each of the following cases:

(i) When dilute hydrochloric acid is added to sodium carbonate crystals.

(ii) When moist starch iodide paper is introduced into chlorine gas.

Ans : SQP 2014

(i) Colourless and odourless gas evolves which turns lime water milky.

(ii) It turns blue black.

Hydrogen chloride gas cannot be dried over quick lime as it reacts with it to form calcium chloride.

DIRECTION : Answer the following :

- 111.** Select from the list the gas that matches the description given in following case :
[ammonia, ethane, hydrogen chloride, hydrogen sulphide, ethyne]
This gas produces dense white fumes with ammonia gas.

Ans : MAIN 2015
Hydrogen chloride

- 112.** Some word/words are missing in the following statement. You are required to rewrite the statement in the correct form using the appropriate word/words :
Aqua regia contains one part by volume of nitric acid and three parts by volume of hydrochloric acid.

Ans : COMP 2012
Aqua regia contains one part by volume of conc. nitric acid and three parts by volume of conc. hydrochloric acid.

- 113.** *A, B, C* and *D* summarise the properties of sulphuric acid depending on whether it is dilute or concentrated.
A = Typical acid property
B = Non volatile acid
C = Oxidizing agent
D = Dehydrating agent
Choose the property (*A, B, C* or *D*) depending on which is relevant to the following :
Preparation of Hydrogen chloride gas.

Ans : SQP 2016
B

- 114.** Identify the salt *Q* from the observation given below:
When dilute HCl is added to a salt *Q*, a brisk effervescence is produced and the gas turns lime water milky. When NH_4OH solution is added to the above mixture (after adding dilute HCl), it produces a white precipitate which is soluble in excess NH_4OH solution.

Ans : COMP 2017
 ZnCO_3

- 115.** Why HCl is considered as a polar covalent compound ?

Ans : SQP 2019
HCl is a polar covalent compound due to the difference in electronegativities of H and Cl. Thus on dissolving in water it dissociates into H_3O^+ and Cl^- .

- 116.** What property of hydrogen chloride is demonstrated when it is collected by downward delivery (upward displacement)?

Ans : SQP 2023
Hydrogen chloride gas is heavier than air.

- 117.** Why is hydrogen chloride not collected over water?

Ans : MAIN 2011
Hydrogen chloride is not collected over water as it is highly or extremely soluble in water.

- 118.** Name the gas evolved (formula not acceptable) by the action of concentrated sulphuric acid on sodium chloride.

Ans : COMP 2012
Hydrogen chloride gas.

- 119.** What do you observe when hydrochloric acid is added to silver nitrate solution?

Ans : SQP 2014
A curdy white precipitate appears which is soluble in excess of ammonium hydroxide.

- 120.** Correct the following statement.
Hydrochloric acid is prepared in the laboratory by passing hydrogen chloride directly through water.

Ans : SQP 2011
Hydrochloric acid is prepared in the laboratory by passing hydrogen chloride through water using inverted funnel arrangement.

- 121.** State what is observed when hydrochloric acid is added to silver nitrate solution.

Ans : SQP 2006
A white precipitate of silver chloride is obtained.

- 122.** Explain why dil. HCl cannot be concentrated by distillation.

Ans : COMP 2017
This is because HCl forms a constant boiling mixture with water containing 22.2% by mass of HCl.

Ans :

COMP 2010

- (i) Ammonia and Hydrogen chloride gas.
 (ii) Both the gases are highly or extremely soluble in water.

- 142.** Certain blank spaces are left in the following table and these are labelled as A and B. Identify each of them.

Lab prepa-ration of	Reactants used	Products formed	Drying agent	Method of collection
HCl gas	NaCl + H ₂ SO ₄	A _____	conc. H ₂ SO ₄	B _____

Ans :

MAIN 2019

- A → Below 200°C (NaHSO₄)
 Above 200°C (Na₂SO₄)
 B → Upward displacement of air

- 143.** By the addition of only one solution, how would you distinguish between dilute hydrochloric acid and dilute nitric acid?

Ans :

SQP 2010

Silver nitrate solution.

HCl will give white precipitate which is soluble in excess of NH₄OH.HNO₃ — No visible reaction.

- 144.** Write the equations for the reaction of hydrochloric acid with each of the following :

- (i) Lead nitrate solution.
 (ii) Manganese (IV) oxide.

Ans :

MAIN 2012

- (i) $\text{Pb}(\text{NO}_3)_2 + 2\text{HCl} \longrightarrow \text{PbCl}_2\downarrow + 2\text{HNO}_3$
 (ii) $\text{MnO}_2 + 4\text{HCl} \longrightarrow \text{MnCl}_2 + \text{Cl}_2\downarrow + 2\text{H}_2\text{O}$
 (Conc.)

- 145.** Calcium oxide and phosphorous pentoxide are good drying agents but they are not employed to dry hydrogen chloride gas. Give reasons for each.

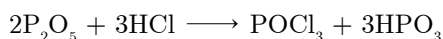
Ans :

COMP 2015

Calcium oxide cannot be used to dry hydrogen chloride gas because it reacts with it.



Phosphorus pentoxide cannot be used to dry hydrogen chloride gas because it reacts with it.



- 146.** What is the purpose of using a funnel while preparing hydrochloric acid from hydrogen chloride gas ?

Ans :

MAIN 2017

The funnel arrangement is used to :

- (i) prevent or decrease back-suction of water and
 (ii) produce a large surface area for the absorption of hydrogen chloride gas.

- 147.** Write balanced equations for the following reactions:

- (i) Copper oxide and dilute hydrochloric acid
 (ii) Manganese (IV) oxide and concentrated hydrochloric acid.

Ans :

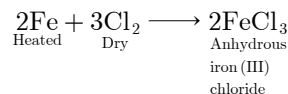
SQP 2019

- (i) $\text{CuO} + 2\text{HCl} \longrightarrow \text{CuCl}_2 + \text{H}_2\text{O}$
 (Dil.)
 (ii) $\text{MnO}_2(s) + 4\text{HCl} \longrightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$
 (Conc.)

- 148.** Outline the steps required to convert hydrogen chloride to anhydrous iron(III) chloride. Write the equations for the reactions which take place.

Ans :

MAIN 2023

Prepare chlorine by reacting conc. HCl with any oxidising agent (MnO₂, PbO₂, Pb₃O₄, etc.)Pass chlorine through conc. H₂SO₄ to dry it. Pass dry chlorine over heated iron

- 149.** Give balanced equations for the following reactions :

- (i) Concentrated hydrochloric acid and potassium permanganate solution.
 (ii) Silver nitrate solution and sodium chloride solution.

Ans :

COMP 2000

- (i) $2\text{KMnO}_4 + 16\text{HCl} \longrightarrow 2\text{KCl} + 2\text{MnCl}_2 + 8\text{H}_2\text{O} + 5\text{Cl}_2$
 (Conc.)
 (ii) $\text{AgNO}_3 + \text{NaCl} \longrightarrow \text{AgCl} + \text{NaNO}_3$
 Curdy white ppt.

- 150.** State which of the two a solution of HCl in water and a solution of HCl in toluene is an electrolyte. Give reasons for your answer.

Ans :

SQP 2005

Solution of HCl in water is an electrolyte. It is because HCl being polar covalent compound ionises in polar covalent water to form H₃O⁺ ions and Cl⁻ ions, which make it conducting and hence an electrolyte.

Solution of HCl in toluene is non-electrolyte. It is because HCl, a polar covalent compound does not ionise in toluene which is a covalent compound. As no ions are formed, therefore, solution is non-electrolyte.

151. Explain the following :

- Dry hydrogen chloride gas does not affect a dry strip of blue litmus paper but it turns red in the presence of a drop of water.
- Hydrogen chloride gas is not collected over water.

Ans :

MAIN 2010

- This is because dry HCl gas is a covalent compound and there are no hydronium (H_3O^+) ions present. But in the presence of a drop of water, H_3O^+ ions are produced.



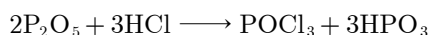
- This is because it is highly soluble in water.

152. Why hydrogen chloride gas is not dried by using phosphorous pentaoxide and calcium oxide?

Ans :

COMP 2015

Hydrogen chloride gas is not dried by using phosphorous pentaoxide and calcium oxide because both the drying agents undergo chemical reaction with the gas.



153. Describe tests (other than electrolysis) to prove that hydrochloric acid contains :

- Hydrogen gas
- Chlorine gas

Ans :

MAIN 2017

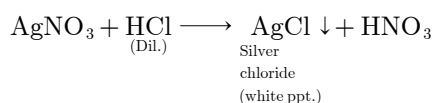
- To show the presence of hydrogen in hydrochloric acid : Add few magnesium pieces to a dilute solution of HCl. A gas will be liberated which will burn with a pop sound and blue flame proving that it is hydrogen.
- To show the presence of chlorine in hydrochloric acid : Add MnO_2 to HCl and boil the mixture. A greenish yellow gas is released which turns potassium iodide paper blue proving itself to be chlorine.

154. Give one chemical test you will do to distinguish between dil. HCl and dil. HNO_3 .

Ans :

COMP 2019

On adding silver nitrate solution to dil. HCl, a curdy white precipitate of silver chloride is formed. On adding silver nitrate solution to dil. HNO_3 , no precipitation or reaction occurs.



155. Write the equations for the following reactions.

- Dilute hydrochloric acid and sodium thiosulphate.
- Dilute hydrochloric acid and lead nitrate solution.

Ans :

MAIN 2011

- $\text{Na}_2\text{S}_2\text{O}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_2 \uparrow + \text{S} \downarrow$
Yellow residue
- $\text{Pb}(\text{NO}_3)_2 + 2\text{HCl} \rightarrow \text{PbCl}_2 \downarrow + 2\text{HNO}_3$
(White ppt.)

THREE MARKS QUESTIONS

156. State the colour changes observed when dilute hydrochloric acid is added to the following indicators.

- Neutral litmus solution
- Alkaline phenolphthalein solution
- Methyl orange solution

Ans :

COMP 2019

- It turns red.
- It gets de-colourised.
- It turns red or pink.

157. Write the observations and balanced equation. The following questions are pertaining to the laboratory preparation of hydrogen chloride gas.

- Write the equation for its preparation mentioning the conditions required.
- Name the drying agent used and justify your choice.
- State a safety precaution you would take during the preparation of hydrochloric acid.

Ans :

SQP 2015

- $\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow[\text{conc.}]{\text{Below } 200^\circ\text{C}} \text{NaHSO}_4 + \text{HCl}$
 $2\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow[\text{conc.}]{\text{Above } 200^\circ\text{C}} \text{Na}_2\text{SO}_4 + 2\text{HCl}$
- Concentrated sulphuric acid, as other drying agents like CaO and P_2O_5 undergo chemical reaction with HCl gas.
- Hydrogen chloride gas must be dissolved in water with the help of funnel arrangement.

158. State your observation when:

- Dilute Hydrochloric acid is added to Lead nitrate solution and the mixture is heated.
- Dilute Hydrochloric acid is added to Copper carbonate.
- Dilute Hydrochloric acid is added to Sodium

thiosulphate.

Ans :

COMP 2016

- White precipitate appears which dissolves on heating.
- Colourless and odourless gas is evolved which turns lime water milky.
- A colourless gas having burning sulphur smell which turns acidified $K_2Cr_2O_7$ from orange to green and yellow particles are seen.

159. Laboratory preparation of hydrogen chloride gas :

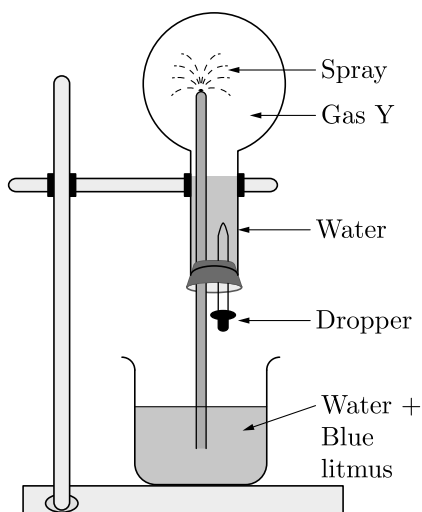
- Write the equation for its preparation mentioning the condition required.
- Name the drying agent used and justify your choice.
- State a safety precaution you would take during the preparation of hydrochloric acid.

Ans :

SQP 2015

- $NaCl + H_2SO_4 \xrightarrow{\text{below } 200^\circ C} NaHSO_4 + HCl$
- The gas is purified and dried by passing through conc. H_2SO_4 which absorbs moisture. We cannot use basic drying agents like calcium oxide (CaO) and phosphorus pentoxide (P_2O_5) because they react with it.
- Use inverted funnel arrangement for its preparation.
If inverted funnel arrangement is not used back suction can take place leading to cracking of all apparatus.

160. Study the figure given below and answer the questions that follow :



- Identify the gas Y.
- What property of gas Y does this experiment demonstrate ?

- Name another gas which has the same property and can be demonstrated through this experiment.

Ans :

MAIN 2014

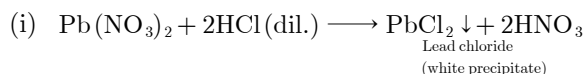
- Hydrogen chloride.
- High solubility of hydrogen chloride.
- Ammonia.

161. State your observations when :

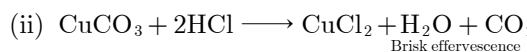
- Dilute Hydrochloric acid is added to Lead nitrate solution and the mixture is heated.
- Dilute Hydrochloric acid is added to Copper carbonate.
- Dilute Hydrochloric acid is added to Sodium thiosulphate.

Ans :

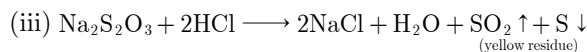
COMP 2016



When dilute hydrochloric acid is added to lead nitrate white precipitates of lead chloride are formed.



When dilute hydrochloric acid is added to copper carbonate brisk effervescence due to the liberation of carbon dioxide is observed.



When dilute hydrochloric acid is added to sodium thiosulphate yellow residue (due to formation of sulphur) is formed and a gas with choking odour is formed.

162. Manganese (IV) oxide, lead (IV) oxide and red lead (Pb_3O_4) react with concentrated hydrochloric acid liberating chlorine.

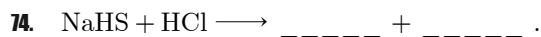
- What is the common property shown by these metals oxides ?
- Write the equation for the reaction of hydrochloric acid with Pb_3O_4 .
- What kind of compound can be added to the bleaching powder to obtain chlorine?

Ans :

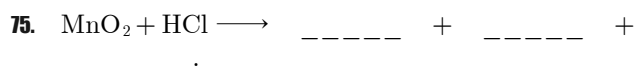
MAIN 2002

- They act as oxidising agents and oxidise hydrochloric acid.
- $Pb_3O_4 + 8HCl \xrightarrow{(Conc.)} 3PbCl_2 + 4H_2O + Cl_2 \uparrow$
- Acid i.e., hydrochloric acid is added.

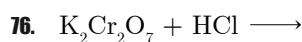
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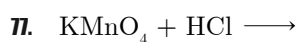
Ans : SQP 2010



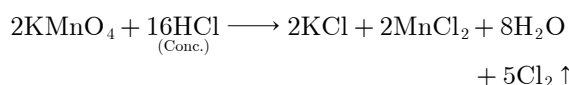
Ans : COMP 2013



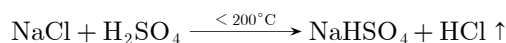
Ans : MAIN 2005



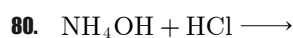
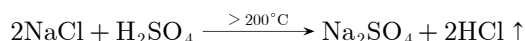
Ans : COMP 2017



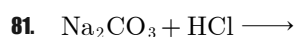
Ans : SQP 2010



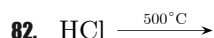
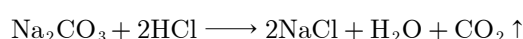
Ans : MAIN 2002



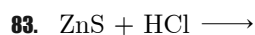
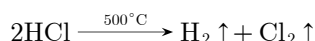
Ans : COMP 2018



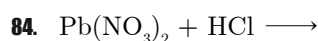
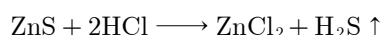
Ans : MAIN 2015



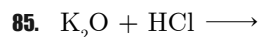
Ans : SQP 2008



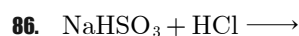
Ans : SQP 2006



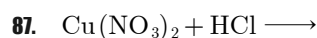
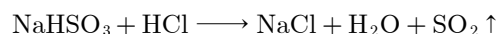
Ans : MAIN 2004



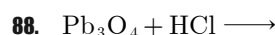
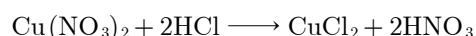
Ans : MAIN 2019



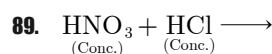
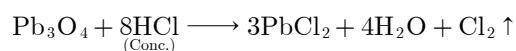
Ans : COMP 2012



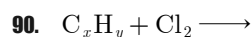
Ans : SQP 2003



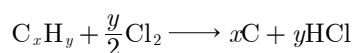
Ans : MAIN 2014



Ans : MAIN 2014

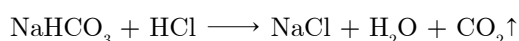


Ans : COMP 2001



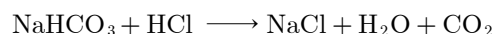
91. Action of Hydrochloric acid on sodium bicarbonate.

Ans : SQP 2016



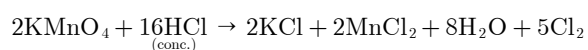
92. Action of Hydrochloric acid on sodium bicarbonate.

Ans : MAIN 2015



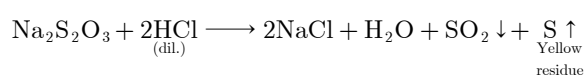
93. Concentrated hydrochloric acid and potassium permanganate solution.

Ans : SQP 2012



94. Sodium thiosulphate is reacted with dilute hydrochloric acid.

Ans : MAIN 2011



95. Action of dilute hydrochloric acid on sodium sulphide.

S. No.	Substance added	Gas evolved	Odour
1.	Sodium sulphite	Sulphur dioxide	Suffocating gas which causes coughing
2.	Calcium carbonate	Carbon dioxide	Faint acidic smell
3.	Magnesium ribbon	Hydrogen gas	Odourless

FOUR MARKS QUESTIONS

169. Hydrogen chloride gas is prepared in the laboratory using concentrated sulphuric acid and sodium chloride. Answer the questions that follow based on this reaction :

- Give the balanced chemical equation for the reaction with suitable condition(s) if any.
- Why is concentrated sulphuric acid used instead of concentrated nitric acid ?
- How is the gas collected ?
- Name the drying agent not used for drying the gas.

Ans :

COMP 2020

- $\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow{\text{Below } 200^\circ\text{C}} \text{NaHSO}_4 + \text{HCl}\uparrow$
- Conc. nitric acid is not used during the preparation of HCl because it is volatile and may volatilize out along with hydrogen chloride.
- Hydrogen chloride is collected by upward displacement of air.
- It is dried by passing through concentrated sulphuric acid.

- 170.**
- What must be added to sodium chloride to obtain hydrogen chloride ? Write the equation for the reaction.
 - What would you see when hydrogen chloride mixes with ammonia ?
 - Hydrogen chloride dissolves in water forming an acidic solution.
 - Name the experiment which demonstrates that hydrogen chloride is highly soluble in water.
 - Give three distinct tests (apart from using an indicator) you would carry out with this solution to illustrate the typical properties of an acid.

- Write the equation for the reaction of hydrochloric acid with each of the following:
 - Lead nitrate solution
 - Manganese dioxide.

Ans :

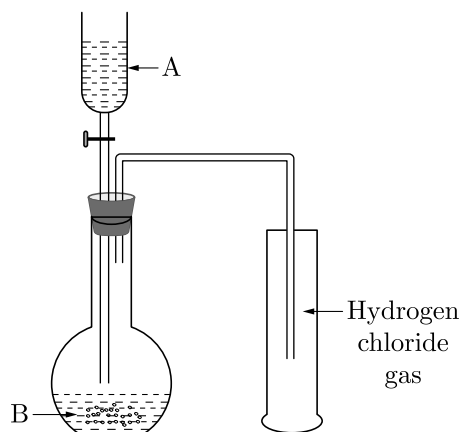
SQP 2013

- Concentrated sulphuric acid

$$\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow[\text{(Conc.)}]{< 200^\circ\text{C}} \text{NaHSO}_4 + \text{HCl}$$
- Dense white fumes of ammonium chloride are produced.
- Fountain experiment.
 - It produces CO_2 gas with sodium carbonate.
 - It produces SO_2 gas with sodium sulphite.
 - It produces hydrogen sulphide gas with iron sulphide.
- $$\text{Pb}(\text{NO}_3)_2 + 2\text{HCl} \longrightarrow \text{PbCl}_2\downarrow + 2\text{HNO}_3$$

(White ppt.)
 - $$\text{MnO}_2 + 4\text{HCl} \xrightarrow[\text{(Conc.)}]{\text{Heat}} \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2\uparrow$$

171. The diagram below shows an apparatus for the laboratory preparation of hydrogen chloride.

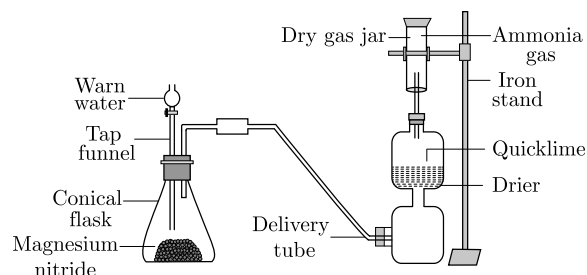


- Identify A and B.
- Write the equation for the reaction.
- How would you check whether or not the gas jar is filled with hydrogen chloride?
- What does the method of collection tell you about the density of hydrogen chloride?

Ans :

MAIN 2010

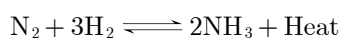
- A is conc. sulphuric acid and B is NaCl.
- $$\text{NaCl} + \text{H}_2\text{SO}_4(\text{conc.}) \xrightarrow[\text{200}^\circ\text{C}]{\text{Below}} \text{NaHSO}_4 + \text{HCl}$$
- Bring a glass rod dipped in NH_4OH in contact with the mouth of gas jar, if dense white fumes appear immediately then the gas jar is filled with HCl.
- HCl gas is heavier than air.



Laboratory preparation of Ammonia gas from Magnesium nitride.

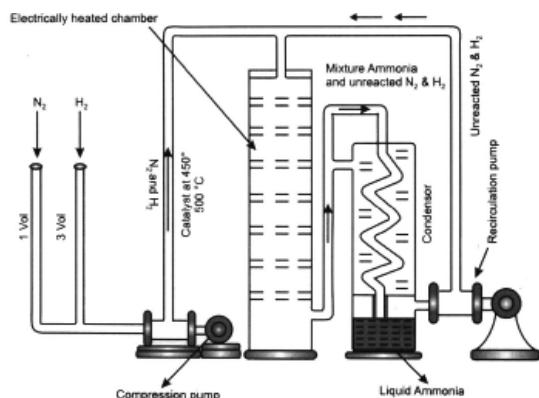
(d) Manufacture of Ammonia-Haber's-Process

- (i) Ammonia is manufactured by Haber's process. The ratio by volume of Nitrogen and Hydrogen is 1 : 3.
- (ii) Nitrogen is obtained by the fractional distillation of qualified air. Hydrogen is obtained by Bosch process.
- (iii) Ammonia is separated from unrelated Nitrogen and Hydrogen by
 1. Liquefaction: Ammonia can be easily qualified in comparison to Nitrogen and Hydrogen.
 2. By absorbing Ammonia in water. As Ammonia is highly soluble in water where as Nitrogen and Hydrogen are insoluble in water.
- (iv) The speed of the reaction can be enhanced by taking finely divided iron as the catalyst. The efficiency of a catalyst is increased by using a promoter which is either Molybdenum or Aluminium oxide. The reaction is reversible and exothermic.



The favourable conditions for the reaction are

Catalyst	Finely divided iron
Promoter	Molybdenum
Temperature	450-500° C
Atmospheric pressure	200-1000 atmosphere.

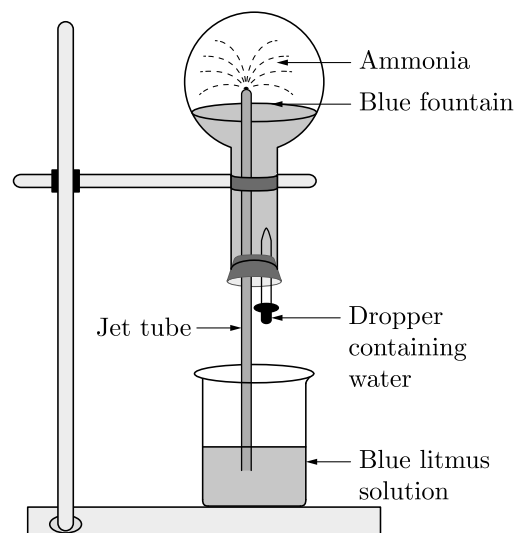


Haber's process of manufacture of Ammonia.

2.2 Physical Properties of Ammonia

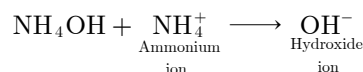
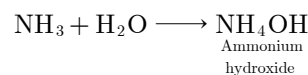
The physical properties of Ammonia are as follows:

- (i) It is a colourless gas having pungent irritating odour.
- (ii) It is lighter than air.
- (iii) It is highly or extremely soluble in water. The extreme solubility of Ammonia is demonstrated by Fountain's experiment.
- (iv) It is a non poisonous gas which can bring tears to eyes if inhaled.



Fountain experiment to demonstrate extreme solubility of NH_3 gas

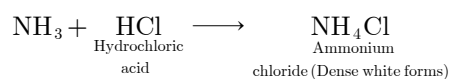
- (v) Ammonia is dissolved in water with the help of funnel arrangement so as to prevent back suction of water as the gas is highly soluble in water. Ammonia when dissolved in water produces Ammonium hydroxide which is alkaline in nature.



2.3 Chemical Properties of Ammonia

The chemical properties of Ammonia are as follows:

- (a) Basic nature:
 - (i) It on dissolving in water produces hydroxyl ions as the only negatively charged particles.
- (ii) Ammonia reacts with acids to form salts.

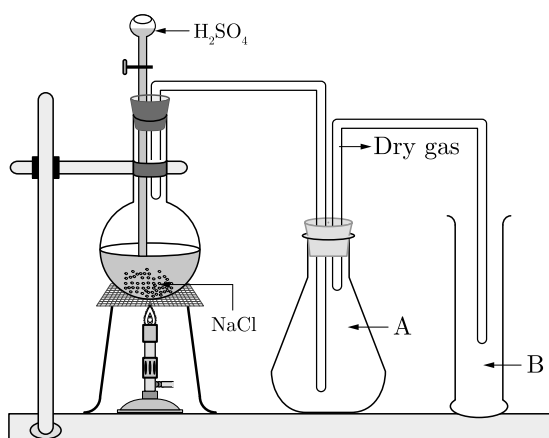


Ans :

MAIN 2012

- (i) It is collected by the upward displacement of air as it is heavier than air and is highly soluble in water.
- (ii) It is not collected over water as it is highly or extremely soluble in water.
- (iii) As the direct absorption leads to the back suction of water.
- (iv) Dry HCl gas does not change the colour of blue litmus as hydrogen ions are not formed in the dry state.

176. With respect to the laboratory preparation of hydrochloric acid answer the following questions.

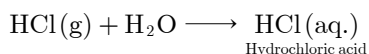


- (i) Name the substance A and give its use.
- (ii) Which method is used to collect hydrogen chloride gas ?
- (iii) Give the reaction which takes place in round bottom flask.
- (iv) Why is the temperature of the reaction mixture kept below 200°C ?
- (v) How can hydrochloric acid be prepared from substance B ?

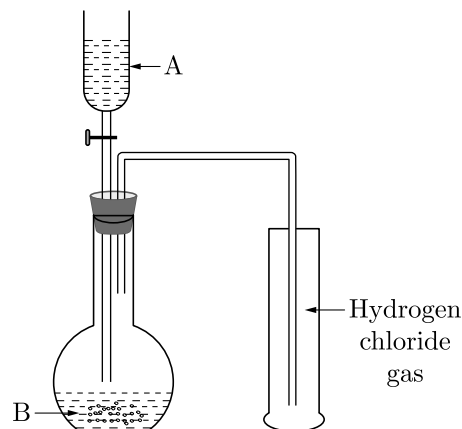
Ans :

COMP 2017

- (i) Substance A is sulphuric acid and it acts as a drying agent.
- (ii) Upward displacement of air.
- (iii) $\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow{< 200^\circ\text{C}} \text{NaHSO}_4 + \text{HCl}$
- (iv) To avoid the formation of sodium sulphate as it sticks to the glass surface and lot of fuel is wasted.
- (v) By passing substance B in water.
B is hydrogen chloride. When we pass hydrogen chloride in water hydrochloric acid is formed.



177. (a) State your observation for the following cases:
Glass rod dipped in ammonium hydroxide is brought near the mouth of the concentrated hydrochloric acid bottle.
- (b) The diagram shows an apparatus for the laboratory preparation of hydrogen chloride.

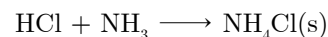


- (i) Identify A and B.
- (ii) Write the equation for the reaction.
- (iii) How would you check whether or not the gas jar is filled with hydrogen chloride ?
- (iv) What does the method of collection tell you about the density of hydrogen chloride ?

Ans :

MAIN 2010

- (a) Dense white fumes of ammonium chloride are observed.
- (b) (i) A → Sulphuric acid
B → Sodium chloride
- (ii) $\text{NaCl} + \text{H}_2\text{SO}_4 \xrightarrow[200^\circ\text{C}]{\text{Below}} \text{NaHSO}_4 + \text{HCl}$
Sodium bisulphate Hydrogen chloride gas
- (iii) In order to know that the jar is filled with the gas, bring a glass rod dipped in ammonium hydroxide solution near its mouth. If dense white fumes of ammonium chloride are produced, it indicates that the gas jar is full of HCl gas.



- (iv) The method used to collect HCl is "Upward displacement of air". This clearly indicates that HCl gas is heavier than air.

178. What will you observe when:

- (i) Hydrogen chloride gas is passed through Silver nitrate solution?
- (ii) Hydrogen chloride gas comes in contact with Ammonia solution?

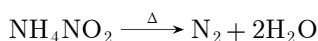
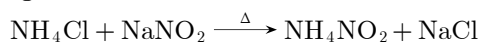
CHAPTER 9

AMMONIA

SUMMARY

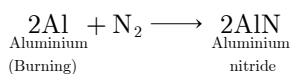
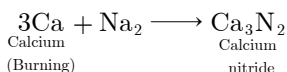
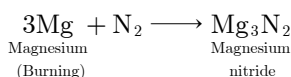
1. NITROGEN

In laboratory, Nitrogen is prepared by heating the solution of Ammonium chloride and Sodium nitrite. In solid state, they are not heated because Ammonium chloride in solid state sublimes on heating.

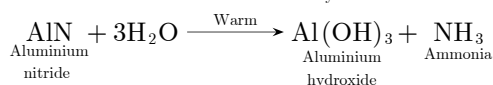
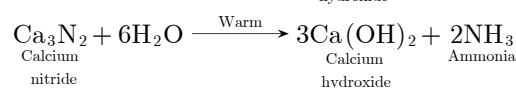
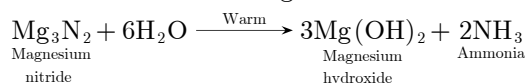


Nitrogen cannot be obtained by heating only Ammonium nitrite as it is highly unstable and readily decomposes even at room temperature.

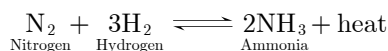
1. Nitrogen obtained is collected over water as it is practically insoluble in Water.
2. Nitrogen obtained from air is more denser as compared to the Nitrogen obtained from chemicals because Nitrogen obtained from air contains traces of inert gases.
3. Nitrogen is a colourless, odourless, tasteless gas which is practically insoluble in water. It is non-poisonous in nature however animals die in the atmosphere of Nitrogen due to want of Oxygen.
4. Chemically, Nitrogen is non-reactive at ordinary temperature because of the presence of a triple covalent bond in its molecule.
5. Nitrogen is neutral towards litmus.
6. Nitrogen is neither combustible nor a supporter of combustion.
7. Burning metals like Calcium, Magnesium and Aluminium continue to burn in the jar of Nitrogen.



These metallic nitrides are warmed with water to produce their respective hydroxides with the liberation of Ammonia gas.

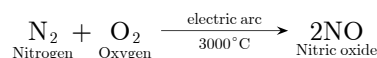


8. Ammonia is synthesized from its elements, i.e. Nitrogen and Hydrogen by Haber's process.

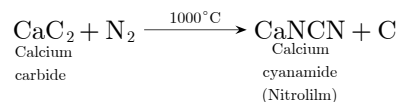


Catalyst	Finely divided iron
Promoter	Molybdenum
Temperature	450-500° C
Atmospheric pressure	200-1000 atmospheres.

9. Nitrogen combines with Oxygen at 3000°C or during thunder and lightning to form Nitric oxide.



10. Nitrogen reacts with Calcium carbide at 1000° C to form Nitrolim which is an important fertilizer.



2. AMMONIA

Ammonia was prepared by Joseph Priestley in 1744. He prepared ammonia gas by heating ammonium chloride with slaked lime and collected the gas over mercury. Ammonia was known as alkaline air due to its basic nature. Claude Louis Berthelot in 1785 and Davy in 1800 established the elementary nature of ammonia, i.e. ammonia is a compound of nitrogen and hydrogen. The molecular formula of Ammonia is NH_3 . The relative molecular mass is 17. Ammonia is a polar

The aqueous solution turns blue litmus red and conducts electricity. But when it dissolves in toluene it produces no ions. Hence, it has no effect on litmus and does not conduct electricity.

CASE BASED QUESTION

182. A high school lab is synthesizing hydrogen chloride gas by reacting sodium chloride with concentrated sulfuric acid. The gas is collected using upward displacement of air. The students also plan to test the gas's solubility in water with a fountain experiment.

- What issues could arise if the reaction mixture temperature exceeds 200°C and how can they be avoided?
- Why is hydrogen chloride gas collected by upward displacement of air and not over water?
- How can the presence of hydrogen chloride gas be confirmed in the jar?
- Why does the blue litmus solution turn red in the fountain experiment?

Ans :

- Exceeding 200°C can form sticky sodium sulfate, which is hard to clean and may crack the glass.
Keep the temperature below 200°C to avoid this.
- Hydrogen chloride is highly soluble in water, so collecting it over water would dissolve the gas, making proper collection impossible.
- Bringing a glass rod dipped in ammonium hydroxide near the jar will produce dense white fumes if hydrogen chloride is present.
- The blue litmus turns red because hydrogen chloride dissolves in water to form hydrochloric acid, which is acidic.

183. In a lab experiment, students synthesize hydrogen chloride gas by reacting sodium chloride with concentrated sulfuric acid. The gas is collected using upward displacement of air. The temperature during the reaction briefly rises above 200°C . The students also conduct a fountain experiment to test the solubility of the gas in water.

- Why is the gas collected by upward displacement of air instead of over water?

- How can you confirm the presence of hydrogen chloride gas in the jar?
- Why does the blue litmus solution turn red in the fountain experiment?

Ans :

- Hydrogen chloride is highly soluble in water, which would dissolve the gas, preventing collection.
- Use a glass rod dipped in ammonium hydroxide; dense white fumes confirm the gas.
- Hydrogen chloride dissolves in water to form acidic hydrochloric acid, turning the litmus red.

184. During a classroom demonstration, students observe the preparation of hydrogen chloride gas by reacting sodium chloride with concentrated sulfuric acid. The gas is collected in a dry gas jar. They also witness an experiment where hydrogen chloride is bubbled through water; and the resulting solution is tested with indicators.

- Why is sodium chloride preferred over other chlorides for preparing hydrogen chloride gas?
- What safety precaution should be taken while collecting hydrogen chloride gas?
- What happens when hydrogen chloride gas is bubbled through water?
- Why is concentrated sulfuric acid used to dry hydrogen chloride gas instead of other drying agents?

Ans :

- Sodium chloride is preferred because it is inexpensive and readily available, making it practical for laboratory use.
- Ensure that the gas jar is dry, as hydrogen chloride is highly soluble in water, which could affect the collection process.
- The gas dissolves to form hydrochloric acid, which can be confirmed by turning blue litmus paper red.
- Concentrated sulfuric acid is used because it does not react with hydrogen chloride, ensuring the gas remains pure.

185. In a high school chemistry lab, students are tasked with generating hydrogen chloride gas by reacting sodium chloride with concentrated sulfuric acid. The gas is then used in several follow-up experiments, including testing its reaction with ammonia and observing its behavior when exposed to a flame.

- (iii) Hydrogen chloride gas is passed through Lead nitrate solution and the product thus formed is heated?
- (iv) Manganese dioxide is treated with concentrated Hydrochloric acid?

Ans :

COMP 2014

- (i) A white precipitate is formed which is soluble in excess of Ammonium hydroxide.
- (ii) Dense white fumes are observed.
- (iii) A white precipitate is formed which gets dissolved on heating.
- (iv) Light brown coloured solution is formed with the evolution of greenish, yellow coloured gas.

179. The following questions are related to the laboratory preparation of hydrochloride acid.

- (i) Name the reactants used.
- (ii) Give suitable reason for choosing these reactants.
- (iii) Write balanced chemical equation for the reaction taking place below 200°C.
- (iv) Why the temperature of the reaction must be maintained below 200°C ?

Ans :

COMP 2023

- (i) Sodium chloride and concentrated sulphuric acid.
- (ii) Sodium chloride is preferred as it is easily and cheaply available and concentrated sulphuric acid is preferred as it is least volatile acid.
- (iii) $\text{NaCl} + \text{H}_2\text{SO}_4(\text{conc.}) \xrightarrow[\text{200}^\circ\text{C}]{\text{Below}} \text{NaHSO}_4 + \text{HCl}$
- (iv) The temperature of the reaction is maintained below 200°C because:
- (a) On heating lot of fuel is wasted.
- (b) A sticky mass of sodium sulphate is formed which destroys the glass apparatus.

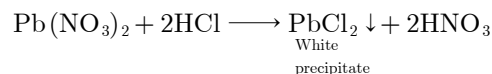
- 180.** (i) From the following gases : NH_3 , Cl_2 , HCl , SO_2 , select the gas that matches the description given below and answer the questions that follow : When gas *C* is mixed with gas *B*, dense white fumes are seen and there is no other product (gas *B* turns moist red litmus paper blue) (a) What is the name of gas *C* ? (b) What is the name of the product of the reaction between gas *B* and gas *C* ?
- (ii) What happens (state your observations) when dil. HCl is added to lead nitrate solution.
- (iii) Manganese (IV) oxide, lead (IV) oxide and red lead (Pb_3O_4) react with conc. HCl liberating chlorine. (a) What is the common property being shown by these metal oxides? (b) Write

the equation for the reaction of conc. HCl with metal oxides named above.

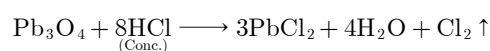
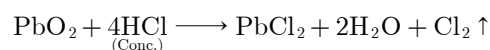
Ans :

MAIN 2013

- (i) (a) Hydrogen chloride
(b) Ammonium chloride.
- (ii) A white precipitate of lead chloride is obtained.



- (iii) (a) Oxidising agents
(b) $\text{MnO}_2 + 4\text{HCl}(\text{Conc.}) \longrightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2 \uparrow$



181. Explain why ?

- (i) Anhydrous HCl is a poor conductor while aq. HCl is an excellent conductor.
- (ii) Only a very dilute solution of hydrogen chloride in water can be concentrated by boiling the solution while a very concentrated solution would become less concentrated when boiled.
- (iii) When the stopper of a bottle full of hydrogen chloride gas is opened there are fumes in the air.
- (iv) A solution of hydrogen chloride in water turns blue litmus red and conducts electricity, while a solution of the same gas in toluene (a) has no effect on litmus and (b) does not conduct electricity.

Ans :

SQP 2019

- (i) This is because anhydrous HCl is a covalent compound and there are no ions present but in aq. HCl , ions are present.



Hence, the aq. HCl conducts electric current.

- (ii) This is because in the first case the vapours evolved consist mostly vapours of water but when concentrated HCl is boiled, its vapours consist of mostly the molecules of HCl .
- (iii) This is due to the formation of hydrochloric acid on reacting with atmospheric water vapour as it is highly soluble in water. These droplets of liquid hydrochloric acid, appear like fumes.
- (iv) When hydrogen chloride is dissolved in water, hydrochloric acid is formed. The covalent compound ionises in water.



water.

- (ii) Hydrochloric acid is added to neutralize alkaline substances, bringing the pH level down to a desired neutral or slightly acidic level.
- (iii) Workers should wear protective gear, including gloves and goggles and work in well-ventilated areas to avoid inhalation of fumes. Proper storage in acid-resistant containers is also essential.
- (iv) Hydrochloric acid is a strong, monoprotic acid that is highly effective at dissolving substances and is relatively cost-effective, making it a preferred choice for many industrial applications.

189. A university chemistry lab uses hydrochloric acid in various experiments. Recently, there was an incident where a student accidentally spilled concentrated hydrochloric acid on the lab bench. The lab team needs to review and reinforce safety protocols to prevent future accidents and ensure the safe handling of this strong acid.

- (i) What immediate actions should be taken if hydrochloric acid is accidentally spilled in the lab?
- (ii) Why is it important to use fume hoods when working with concentrated hydrochloric acid?
- (iii) What protective gear should be worn when handling hydrochloric acid to prevent injury?
- (iv) How should hydrochloric acid be stored in the lab to minimize risk?

Ans :

- (i) The spill should be neutralized immediately with a base, such as sodium bicarbonate and then cleaned up using appropriate protective equipment. The area should be well-ventilated to disperse fumes.
- (ii) Fume hoods are essential because they vent harmful fumes outside the lab, reducing the risk of inhaling toxic hydrogen chloride gas, which can cause respiratory irritation.
- (iii) Lab personnel should wear acid-resistant gloves, safety goggles, a lab coat and, if necessary, a face shield to protect against splashes and fumes.
- (iv) Hydrochloric acid should be stored in a cool, well-ventilated area, away from incompatible substances like bases and in corrosion-resistant containers with clear labeling to prevent accidental misuse.

190. A food processing company uses hydrochloric acid in its production line to adjust the pH of certain products and clean equipment. The company must ensure that the acid is used in compliance with food safety regulations to avoid contamination.

- (i) Why is hydrochloric acid used in food processing, particularly in pH adjustment?
- (ii) What precautions must be taken to ensure hydrochloric acid does not contaminate food products?

Ans :

- (i) Hydrochloric acid is used to adjust the pH of food products to ensure safety, stability and desired taste, as well as to prevent the growth of harmful microorganisms.
- (ii) The acid must be diluted appropriately, handled in clean environments and thoroughly rinsed from equipment to avoid any residual contamination in the final food products.

191. A pharmaceutical company uses hydrochloric acid in the synthesis of active pharmaceutical ingredients (APIs). The company must ensure that the acid is used precisely to achieve the desired chemical reactions without compromising product quality.

- (i) How does hydrochloric acid contribute to the synthesis of active pharmaceutical ingredients (APIs)?
- (ii) What measures should be taken to ensure that hydrochloric acid is used safely in pharmaceutical manufacturing?

Ans :

- (i) Hydrochloric acid is used as a reagent to facilitate specific chemical reactions, such as the hydrolysis or neutralization of compounds, which are essential in the production of APIs.
- (ii) Strict protocols must be followed, including precise measurement, proper ventilation and thorough documentation, to ensure that the acid is used safely and does not compromise the quality or safety of the final pharmaceutical products.

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- (i) Why is hydrogen chloride gas collected in a gas jar and not over water?
- (ii) What observation would you make when hydrogen chloride gas comes into contact with ammonia gas?
- (iii) How does hydrogen chloride gas behave when exposed to a burning splinter?
- (iv) Why must the temperature be controlled during the preparation of hydrogen chloride gas?

Ans :

- (i) Hydrogen chloride gas is highly soluble in water, which would dissolve the gas, making proper collection impossible.
- (ii) Dense white fumes of ammonium chloride will form immediately upon contact.
- (iii) The splinter is extinguished because hydrogen chloride is neither combustible nor a supporter of combustion.
- (iv) If the temperature exceeds 200°C , sodium sulfate forms, which can damage the glass apparatus and hinder gas collection.

186. In a classroom experiment, students set up an electrolysis apparatus to decompose water into hydrogen and oxygen gases using a dilute sulfuric acid solution as the electrolyte. They observe the gases collected at the electrodes and measure the volume produced over time.

- (i) Why is sulfuric acid added to water during the electrolysis process?
- (ii) What is the ratio of hydrogen to oxygen gas collected during the electrolysis of water and why?
- (iii) Why is hydrogen gas collected at the cathode during electrolysis?
- (iv) What safety precautions should be taken when collecting the gases during the experiment?

Ans :

- (i) Sulfuric acid increases the conductivity of water, allowing the electrolysis process to proceed efficiently by providing ions that carry the current
- (ii) The ratio is 2:1 because water (H_2O) decomposes into two parts hydrogen (H_2) and one part oxygen (O_2).
- (iii) Hydrogen ions gain electrons at the cathode (reduction) to form hydrogen gas, which is collected at this electrode.
- (iv) Ensure the apparatus is properly sealed to prevent gas leakage and keep the collected hydrogen and oxygen away from open flames,

as hydrogen is highly flammable.

187. In a chemistry lab, students are exploring the properties of hydrochloric acid by conducting a series of experiments. They test its reaction with various substances, including litmus paper, metal oxides and metals, to observe the typical behaviors of a strong acid.

- (i) What color change occurs when blue litmus paper is dipped into hydrochloric acid and what does this indicate?
- (ii) How does hydrochloric acid react with zinc oxide and what are the products formed?
- (iii) What gas is produced when hydrochloric acid reacts with magnesium and how can it be identified?
- (iv) Why does hydrochloric acid not show any acidic behavior when it is dry?

Ans :

- (i) The blue litmus paper turns red, indicating that hydrochloric acid is a strong acid.
- (ii) Hydrochloric acid reacts with zinc oxide to form zinc chloride and water. This demonstrates the acid's ability to neutralize metal oxides.
- (iii) Hydrogen gas is produced, which can be identified by a popping sound when a lit splint is brought near the gas.
- (iv) Dry hydrochloric acid does not ionize, so it does not show acidic properties. Its acidic behavior only appears when it is dissolved in water.

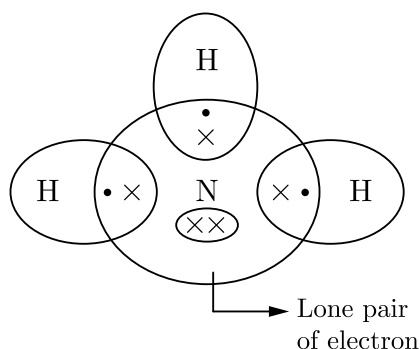
188. A chemical manufacturing company uses hydrochloric acid in various industrial processes. The company needs to ensure that the acid is used safely and effectively in metal cleaning, pH control and as a reagent in different chemical reactions.

- (i) Why is hydrochloric acid commonly used for cleaning metal surfaces in industrial settings?
- (ii) How does hydrochloric acid help in controlling pH levels in industrial wastewater treatment?
- (iii) What safety precautions should be taken when handling hydrochloric acid in large-scale industrial processes?
- (iv) Why is hydrochloric acid preferred over other acids for certain industrial reactions?

Ans :

- (i) Hydrochloric acid reacts with metal oxides and carbonates, removing rust and scale from metal surfaces by forming soluble salts and

covalent compound.



Electron dot diagram of Ammonia:

In combined state Ammonia is found in the form of Ammonium salts like Ammonium chloride, Ammonium sulphate etc.

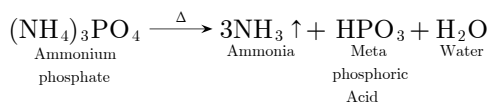
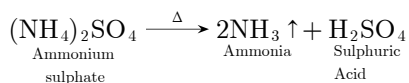
The smell of Ammonia in toilets is due to the bacterial decomposition of urea present in urine.



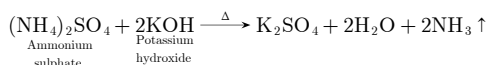
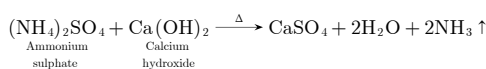
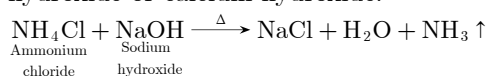
2.1 Preparation of Ammonia

(a) Generally, Ammonia is prepared by the following methods:

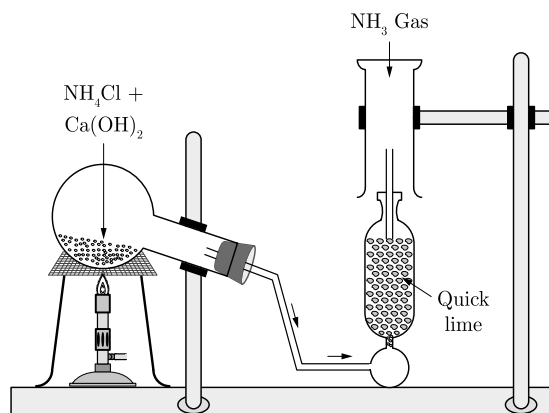
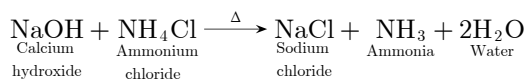
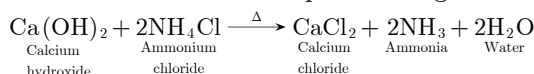
(i) By heating ammonium salts of non-volatile acids:



(ii) By warming ammonium salts with caustic alkali like sodium hydroxide, potassium hydroxide or calcium hydroxide.



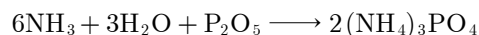
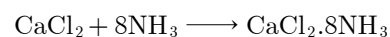
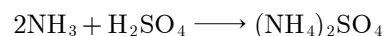
(b) In laboratory Ammonia is prepared by heating ammonium salts (Except ammonium nitrate) with caustic alkalies like sodium hydroxide, potassium hydroxide or calcium hydroxide in the ratio 2 : 3 of their respective weights.



Laboratory preparation of ammonia from ammonium chloride.

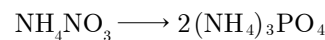
(i) The reactants are finely ground and then taken in a round bottom flask. The round bottom flask is fitted in a slanting position bending in the downward direction.

(ii) Ammonia is dried by passing over Quick lime, i.e. Calcium oxide. It is not dried by passing through conventional drying agents like conc. Sulphuric acid, anhydrous Calcium chloride, Phosphorus pentoxide because these drying agents undergo chemical reaction with ammonia.

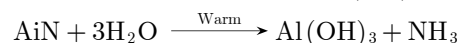
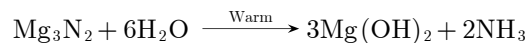


(iii) Ammonia is collected by downward displacement of air as the gas is lighter than air and highly soluble in water.

(iv) Ammonium nitrate is not used for the preparation of Ammonia as it is explosive and gives Nitrous oxide and water.



(c) Action of warm water on metallic nitrides Magnesium nitride, Calcium nitride and Aluminium nitride on warming with water produces their respective metallic hydroxide with the liberation of Ammonia.



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172. Write balanced equations for the reaction of dilute hydrochloric acid with each of the following :

- Iron
- Sodium hydrogen carbonate
- Iron (II) sulphide
- Sodium sulphite
- Sodium thiosulphate solution.

Ans :

COMP 2007

- $\text{Fe} + 2\text{HCl} \longrightarrow \text{FeCl}_2 + \text{H}_2 \uparrow$
Iron (II) chloride
- $\text{NaHCO}_3 + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \uparrow$
Sodium chloride
- $\text{FeS} + 2\text{HCl} \longrightarrow \text{FeCl}_2 + \text{H}_2\text{S} \uparrow$
Iron (II) chloride Hydrogen sulphide
- $\text{Na}_2\text{SO}_3 + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_2 \uparrow$
Sodium chloride
- $\text{Na}_2\text{S}_2\text{O}_3 + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_2 \uparrow + \text{S} \downarrow$
Sodium chloride Sulphur

173. From the gases-ammonia, hydrogen chloride, hydrogen sulphide, sulphur dioxide – Select the following :

- The gas which gives a white precipitate when reacted with silver nitrate solution acidified with dilute nitric acid.
- Write a balanced equation for the reaction of red lead (trilead tetraoxide) when warmed with concentrated hydrochloric acid.
- A solution of hydrogen chloride in water is prepared. The following substances are added to separate portions of the solution.

Substances Added	Gas evolved	Odour
Calcium carbonate	—	—
Magnesium ribbon	—	—
Manganese (IV) oxide with heating	—	—
Sodium sulphide	—	—

Complete the table by writing the gas evolved in each case and its odour.

Ans :

MAIN 2004

- Hydrogen chloride
- $\text{Pb}_3\text{O}_4 + 8\text{HCl} \longrightarrow 3\text{PbCl}_2 + 4\text{H}_2\text{O} + \text{Cl}_2 \uparrow$
(Conc.)
-

Substances Added	Gas evolved	Odour
Calcium carbonate	Carbon dioxide	Odourless
Magnesium ribbon	Hydrogen	Odourless

Manganese (IV) oxide with heating	Chlorine	Pungent irritating
Sodium sulphide	Hydrogen Sulphide	Rotten eggs

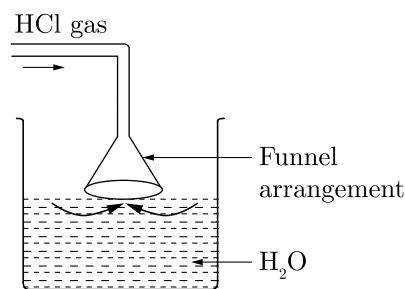
174. In the laboratory preparation of hydrochloric acid, HCl gas is dissolved in water.

- Draw a diagram to show the arrangement used for the absorption of HCl in water.
- Why is such an arrangement necessary? Give two reasons.
- Write the chemical equations for the laboratory preparation of HCl gas when the reactants are :
 - below 200°C
 - above 200°C .

Ans :

SQP 2011

(i)



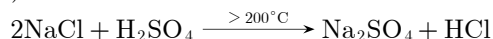
Funnel arrangement used for absorption of HCl in water

- Two reasons for the use of funnel arrangement are :
 - Prevents back suction of water into the flask.
 - Provides a large surface area for the absorption of the gas.

(iii) (a) Below 200°C

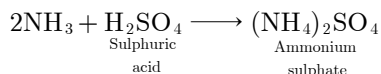
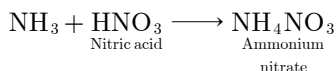


(b) Above 200°C



175. Give reasons for the following :

- Hydrogen chloride gas is collected by the upward displacement of air.
- Hydrogen chloride gas is not collected over water.
- For the preparation of hydrochloric acid, hydrogen chloride is not directly absorbed in water.
- Dry HCl gas does not change the colour of blue litmus.



(iii) As Ammonia on dissolving in Water produces hydroxyl ions as the only negatively charged particle thus the aqueous solution of ammonia called Ammonium hydroxide which is alkaline in nature and it shows characteristic colour change with indicators.

Red litmus solution — Blue

Phenolphthalein — turns pink

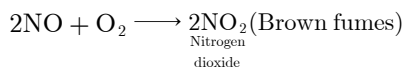
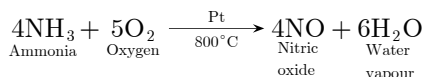
Methyl orange — yellow

(b) Combustibility:

(i) Ammonia is neither combustible nor it is a supporter of combustion. However if jet of Ammonia is ignited in atmosphere of oxygen it burns with green flame.



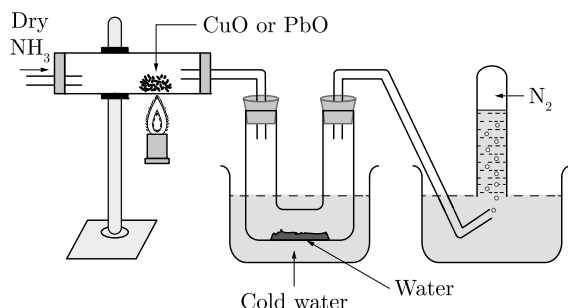
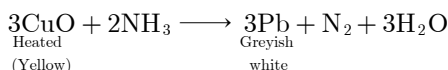
(ii) Catalytic oxidation of Ammonia:



Pt = Platinum — catalyst.

(c) Reducing nature of Ammonia:

(i) Ammonia reduces heated metallic oxides to corresponding metals, water vapour and nitrogen (Figure).



Showing reducing nature of NH_3

Observations :

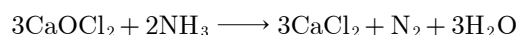
1. In case of Copper oxide, black Copper oxide on heating changes to pinkish red or reddish brown metal whereas in the case of Lead oxide, yellow Lead oxide changes to greyish

white metallic lead.

2. In both the cases, colourless liquid water gets condensed in the U-tube. Water converts anhydrous Copper sulphate from white to blue and anhydrous Cobalt chloride from blue to pink.

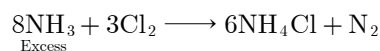
3. In both the cases, colourless and odourless gas is collected over water. This gas is nitrogen which does not relight the glowing splinter. The above experiment proves that Ammonia is made of Nitrogen and Hydrogen and thus, it can be referred to as the hydride of Nitrogen.

(i) When passed over Bleaching powder.

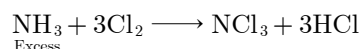


(ii) Reduction of Chlorine : When Ammonia is in excess.

Greenish yellow Chlorine disappears to give dense white fumes of Ammonium chloride.



When Chlorine is in excess

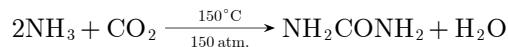


These reactions show that

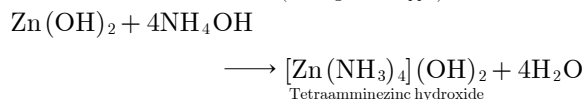
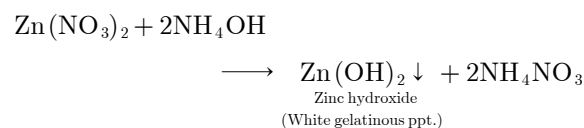
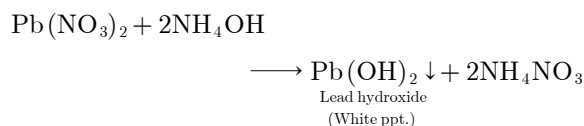
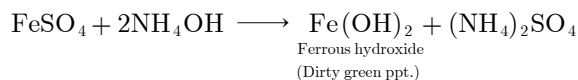
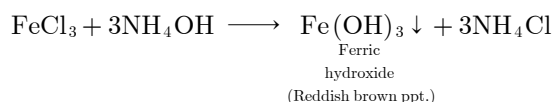
(i) Ammonia is a reducing agent

(ii) Chlorine has strong affinity for Hydrogen.

4. Ammonia reacts with Carbon dioxide to form Urea which is a very important nitrogenous fertilizer containing 46.66% of Nitrogen.



5. Aqueous solution of Ammonia precipitates metallic hydroxides from their soluble salts.



Ans :

COMP 2002

Ammonia turns red litmus paper blue because it is a weak base, not a weak acid.

Thus (c) is correct option.

47. Assertion : Ammonia is not collected over water.

Reason : Ammonia is highly soluble in water.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2016

Ammonia's high solubility in water prevents it from being collected over water, which is why it's collected by downward displacement of air.

Thus (a) is correct option.

48. Assertion : The Haber process is used for the large-scale production of ammonia.

Reason : The Haber process combines nitrogen and hydrogen at high temperature and pressure in the presence of a catalyst.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2010

The Haber process synthesizes ammonia from nitrogen and hydrogen at high temperature and pressure using a catalyst.

Thus (a) is correct option.

49. Assertion : Ammonia is used in the manufacture of nitrogenous fertilizers.

Reason : Ammonia is a source of nitrogen, an essential nutrient for plant growth.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2009

Ammonia is a key component in fertilizers because it provides nitrogen, which is crucial for plant growth.

Thus (a) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following :

50. An acidic gas which reacts with a basic gas liberating neutral gas.

Ans :

SQP 2011

Hydrogen chloride gas

51. A metallic chloride soluble in ammonium hydroxide.

Ans :

MAIN 2017

Silver chloride, AgCl

52. The gas obtained when ammonia burns in an atmosphere of oxygen without any catalyst.

Ans :

COMP 2019

Nitrogen

53. A nitride of a divalent metal which reacts with warm water liberating ammonia.

Ans :

SQP 2020

Magnesium nitride, Mg_3N_2

54. An amphoteric oxide reduced by the basic gas.

Ans :

MAIN 2000

Lead (II) oxide, PbO

55. The solution which turns brown when it comes in contact with Ammonia.

Ans :

COMP 2006

Nessler's reagent.

56. Drying agent for Ammonia.

Ans :

SQP 2009

Calcium oxide or Quick lime.

57. Experiment which demonstrates the extreme solubility of Ammonia.

Ans :

COMP 2010

Fountain experiment.

58. Gas obtained when Magnesium nitride is warmed with water.

Ans :

SQP 2000

Ammonia.

will evaporate unless the vapour pressure is decreased. Cooling decreases the vapour pressure so that the liquid remains in the same state. Hence, the bottle is cooled before opening. Thus (a) is correct option.

5. The ratio of ammonia and air taken in Oswald's process is
 (a) 10 : 1 (b) 1 : 10
 (c) 1 : 3 (d) 3 : 1

Ans : COMP 2018

The ratio of ammonia to air in the Ostwald process is 1:10 at 800°C. The ammonia is obtained from the Haber's process and the oxygen is obtained from air. Thus (b) is correct option.

6. Which compound liberates ammonia on reaction with water?
 (a) Nitrite (b) Nitrate
 (c) Nitride (d) None of these

Ans : SQP 2011

Magnesium nitride reacts with water to liberate ammonia. Thus (c) is correct option.

7. Dry ammonia is because it is a covalent molecule.
 (a) acidic (b) neutral
 (c) basic (d) amphoteric

Ans : COMP 2017

Dry ammonia is a covalent molecule, so it is neutral even in liquefied form. Its aqueous solution is a weak base as the basicity is due to lone pair of electrons on its nitrogen atom. Ammonia is a typical weak base. Thus (b) is correct option.

8. Ammonia is soluble in water because it is :
 (a) a base
 (b) an acid
 (c) a polar molecule
 (d) a simple covalent compound.

Ans : COMP 2011

The high solubility of ammonia is due to the presence of lone pairs at the nitrogen. It is attracted to hydrogen in the water molecule hydrogen bonds. The presence of hydrogen bonding between two molecules means that the molecules are polar. Thus (c) is correct option.

9. The colour of precipitate obtained when ammonium hydroxide is added to ferric chloride is
 (a) brown (b) reddish-green
 (c) red (d) reddish-brown

Ans : MAIN 2019

When ammonium hydroxide is added to ferric chloride, a reddish brown precipitate of ferric hydroxide ($\text{Fe}(\text{OH})_3$) is formed. Thus (d) is correct option.

10. Ammonia gas is dried by using
 (a) Wood Alcohol (CH_2OH)
 (b) Washing soda (Na_2CO_3)
 (c) Slaked lime (CaOH_2)
 (d) Quicklime (CaO)

Ans : COMP 2020

Ammonia gas is dried by passing it through quicklime, also known as calcium oxide (CaO). Thus (d) is correct option.

11. Chemical which is used as drying agent for ammonia.
 (a) Sodium chloride
 (b) Magnesium pentaoxide
 (c) Calcium oxide
 (d) Calcium hydroxide

Ans : SQP 2021

Calcium oxide (CaO), also known as quicklime, is a common drying agent for ammonia gas. It's used in laboratory preparations to remove water vapor from ammonia gas. The calcium oxide absorbs the water content and produces pure ammonia gas. Thus (c) is correct option.

12. Ammonia gas is collected by downward displacement of
 (a) Water (b) Hydrogen
 (c) Air (d) Hydrogen Sulfide

Ans : MAIN 2023

Ammonia gas is collected in an inverted gas jar by the downward displacement of air because ammonia is lighter than air. Thus (c) is correct option.

13. reacts with water to produce ammonia.
 (a) Mg_3N_2 (b) NH_4OH
 (c) AgNO_3 (d) MgCl_2

Ans : COMP 2023

Thus (a) is correct option.

31. Lead hydroxide precipitates are in water
 (a) insoluble (b) soluble
 (c) partially soluble (d) partially insoluble

Ans :

SQP 2011

Lead hydroxide, $\text{Pb}(\text{OH})_2$, is an insoluble base that is slightly soluble in water. When metallic lead is exposed to oxygen and water, it converts to lead hydroxide. The solubility of lead hydroxide is 0.0155 grams per 100 milliliters of water.

Thus (a) is correct option.

32. The specific gravity of ammonia is
 (a) 0.59 (b) 0.49
 (c) 0.48 (d) 0.68

Ans :

COMP 2019

The specific gravity of ammonia can vary depending on the state of ammonia and the solution it's has a specific gravity of 0.89 g/L at 0°C and 1 atm.

Thus (a) is correct option.

33. Promoter used in Haber's process
 (a) Lead (b) Finely divided iron
 (c) Calcium oxide (d) Molybdenum

Ans :

SQP 2006

Molybdenum is the promoter used in the Haber process, which is the primary industrial process for producing ammonia. Molybdenum improves the performance and rate of chemical reactions and in the Haber process, it increases the efficiency of the catalyst iron, which in turn increases the yield of ammonia.

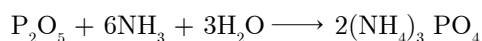
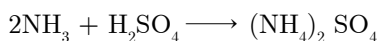
Thus (d) is correct option.

34. Which of the following-statements is incorrect about ammonia?
 (a) It can be dried by P_2O_5 , H_2SO_4 and CaCl_2 .
 (b) It gives black precipitate with calomel
 (c) It is oxidised by oxygen at 700°C in the presence of platinum.
 (d) It gives white fumes with HCl

Ans :

MAIN 2000

Ammonia gas is basic and conc. H_2SO_4 is an acid thus it will react to form white fumes of $(\text{NH}_4)_2\text{SO}_4$. P_2O_5 and CaCl_2 also react with ammonia, hence cannot be used for drying it.



Thus (a) is correct option.

35. Ammonium nitrate is used _____.
 (a) in lining vessels
 (b) as a smelling salt
 (c) in textile industry
 (d) in preparing explosives

Ans :

COMP 2007

Ammonium Nitrate is used as an ingredient for manufacture of explosives, anaesthetic gases, fertilizers, cold packs, etc.

Thus (d) is correct option.

36. With excess of chlorine, NH_3 forms :
 (a) NH_4Cl (b) NCl_3
 (c) N_2 (d) NOCl

Ans :

MAIN 2009

When ammonia reacts with excess chlorine, it produces nitrogen trichloride and hydrogen chloride gas.

Thus (b) is correct option.

37. Ammonium compounds are used as fertilisers because of the vital element
 (a) Oxygen (b) Sulfur
 (c) Hydrogen (d) Nitrogen

Ans :

SQP 2010

Ammonium compounds are used as fertilisers because of the vital element nitrogen. Nitrogen is essential for plant growth as it is involved in critical processes like protein synthesis and photosynthesis.

Thus (d) is correct option.

38. Name the oxidising agent used in Ostwald's process.
 (a) O_2 (b) NO_2
 (c) CO (d) NO

Ans :

COMP 2015

Oxygen is used as the oxidizing agent in the Ostwald process for making nitric acid.

Thus (a) is correct option.

39. Ammonia is condensed in cooling pipes which are immersed in refrigerated solution.
 (a) Fehling (b) Brine
 (c) Benedict (d) Tollen's Reagent

Ans :

MAIN 2013

Ammonia is condensed in cooling pipes which are immersed in refrigerated Tollen's Reagent solution.

Thus (d) is correct option.

stored in closed containers under pressure. When the pressure is released, the liquid evaporates rapidly, generally forming an invisible vapour or gas. This is why ammonia is used in refrigeration. Thus (c) is correct option.

23. Saturated solution of ammonia in water.

- (a) Liquid ammonia
- (b) Liquor ammonia fortis
- (c) Liquid quicklime
- (d) Nessler's reagent

Ans :

SQP 2019

Liquor ammonia fortis is a saturated solution of ammonia in water. It is called 880 ammonia. It has a relative density of 0.880.

Thus (b) is correct option.

24. was the first organic compound to be synthesised in laboratory.

- (a) Ammonia $[\text{NH}_3]$
- (b) Urea $(\text{NH}_2\text{CONH}_2)$
- (c) Methane (CH_4)
- (d) Acetic Acid (CH_3COOH)

Ans :

COMP 2021

Ammonia was the first organic compound to be synthesised in laboratory.

Thus (b) is correct option.

25. Nitrogen gas can be obtained by heating :

- (a) Ammonium nitrate
- (b) Ammonium chloride
- (c) Magnesium nitride
- (d) Ammonium nitrite

Ans :

SQP 2023

Nitrogen gas can be obtained by heating ammonium nitrite.

Thus (d) is correct option.

26. Unreacted gases are circulated back to compression pump through

- (a) Desiccator
- (b) Boiler
- (c) Compressor
- (d) Condenser

Ans :

MAIN 2000

Unreacted gases are circulated back to compression pump through condenser.

Thus (d) is correct option.

27. is the dilute solution of liquor ammonia.

- (a) Blue Vitriol
- (b) Mohr's Salt
- (c) Bench Reagent
- (d) Vinegar

Ans :

SQP 2005

Bench Reagent is the dilute solution of liquor ammonia. Liquid ammonia is used as a refrigerant because its heat of vaporisation is 5700 calories per gram molecule. Liquid ammonia is liquified ammonia and is available in cylinders.

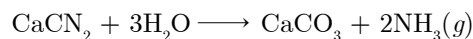
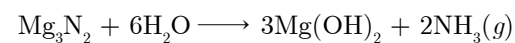
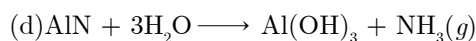
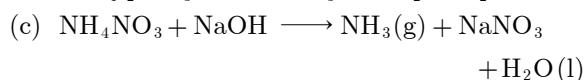
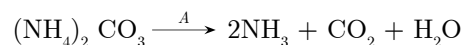
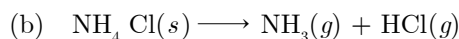
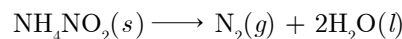
Thus (c) is correct option.

28. NH_3 cannot be obtained by

- (a) reaction of AlN or Mg_3N_2 or CaCN_2 with H_2O
- (b) heating of NH_4Cl or $(\text{NH}_4)_2\text{CO}_3$
- (c) heating of NH_4NO_3 with NaOH
- (d) heating of NH_4NO_3 or NH_4NO_2

Ans :

MAIN 2006



Thus (d) is correct option.

29. is used as an analytical reagent to identify metal ions in qualitative analysis.

- (a) Ammonium Sulphate
- (b) Ammonium Chloride
- (c) Ammonium Carbonate
- (d) Ammonium Hydroxide

Ans :

COMP 2009

Ammonium Hydroxide is used as an analytical reagent to identify metal ions in qualitative analysis.

Thus (d) is correct option.

30. Liquid NH_3 is employed in refrigerator because:

- (a) it has high heat of evaporation.
- (b) it is stable hydride.
- (c) it has a high dipole moment.
- (d) it is more basic.

Ans :

MAIN 2017

Liquid ammonia is used as a refrigerant in refrigerators because it absorbs heat when it vaporizes and it can easily undergo liquefaction at room temperature under pressure.

Thus (a) is correct option.

- 76.** Copy and complete the following table relating to important industrial processes. Output refers to the product of the process not the intermediate steps.

Name of process	Inputs	Catalyst	Equation for catalysed reaction	Output
Haber's Process	Hydrogen + _____	_____	_____	_____

Ans :

COMP 2018

Name of process	Inputs	Catalyst	Equation for catalysed reaction	Output
Haber's Process	Hydrogen + Nitrogen	Iron	$N_2 + 3H_2 \rightarrow 2NH_3$	Ammonia

- 77.** From the list given below, select the word(s) required to correctly complete the blanks (i) to (v) in the following passage:

Note: Words chosen from the list are to be used only once. Write only the answers. Do not copy the passage.

[reddish brown, ammonium, nitrogen dioxide, hydroxyl, dirty green, ammonia, acidic, alkaline]
 Nitrogen and hydrogen combine in the presence of a catalyst to give (i) _____ gas. When the above mentioned gas is passed through water it forms a solution which will be (ii) _____ in nature and the solution contains (iii) _____ ions and (iv) _____ ions. The above solution when added to iron(II) sulphate solution, gives a (v) _____ coloured precipitate of iron(II) hydroxide.

Ans :

COMP 2010

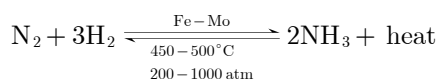
- (i) ammonia
 (ii) alkaline
 (iii) ammonium
 (iv) hydroxyl
 (v) dirty green

DIRECTION : Write balanced chemical equations for the following:

- 78.** Ammonia is prepared from its elements.

Ans :

COMP 2001



- 79.** Rod dipped in concentrated Hydrochloric acid is brought in contact with Ammonia.

Ans :

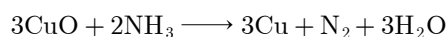
MAIN 2009



- 80.** Reduction of hot Copper(II) oxide to copper using ammonia gas.

Ans :

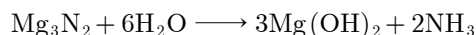
COMP 2013



- 81.** Action of warm water on magnesium nitride.

Ans :

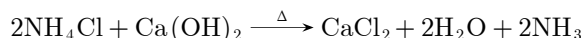
SQP 2014



- 82.** Lab preparation of ammonia using an ammonium salt.

Ans :

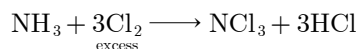
MAIN 2015



- 83.** Reaction of ammonia with excess chlorine.

Ans :

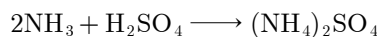
COMP 2015



- 84.** Reaction of ammonia with sulphuric acid.

Ans :

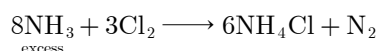
MAIN 2015



- 85.** When excess of ammonia is treated with chlorine.

Ans :

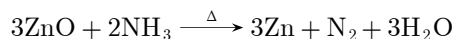
SQP 2016



- 86.** An equation to illustrate the reducing nature of ammonia.

Ans :

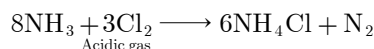
COMP 2016



- 87.** Ammonia to nitrogen using an acidic gas.

Ans :

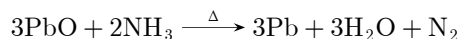
COMP 2007



- 88.** Lead oxide to lead.

Ans :

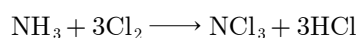
MAIN 2017



- 89.** Ammonia to nitrogen trichloride.

Ans :

MAIN 2011



ASSERTION AND REASON

- 40. Assertion :** Ammonia is a polar covalent compound.

Reason : Ammonia has a trigonal pyramidal structure due to the lone pair of electrons on nitrogen.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2010

The polarity of ammonia arises from its trigonal pyramidal structure, which is due to the lone pair of electrons on nitrogen.

Thus (a) is correct option.

- 41. Assertion :** Ammonia can be prepared in the laboratory by heating ammonium salts with caustic alkali.

Reason : Ammonium salts on heating with caustic alkali liberate ammonia gas.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2005

Ammonia is liberated when ammonium salts react with caustic alkali, which is a standard method for preparing ammonia in the laboratory.

Thus (a) is correct option.

- 42. Assertion :** Ammonia is collected by downward displacement of air.

Reason : Ammonia is lighter than air and highly soluble in water.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2008

Ammonia is lighter than air and highly soluble in water, making downward displacement of air the suitable method for collection.

Thus (a) is correct option.

- 43. Assertion :** Ammonium hydroxide is alkaline in nature.

Reason : Ammonium hydroxide dissociates in water to produce hydroxyl ions.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2018

Ammonium hydroxide dissociates in water to form hydroxyl ions, which makes the solution alkaline. Thus (a) is correct option.

- 44. Assertion :** Ammonia can act as a reducing agent.

Reason : Ammonia reduces metal oxides to metals when heated.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2007

Ammonia can reduce metal oxides to metals, demonstrating its reducing properties.

Thus (a) is correct option.

- 45. Assertion :** Ammonia is used as a refrigerant.

Reason : Ammonia has a high latent heat of vaporization.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2020

Ammonia's high latent heat of vaporization makes it an effective refrigerant.

Thus (a) is correct option.

- 46. Assertion :** Ammonia gas turns moist red litmus paper blue.

Reason : Ammonia is a weak acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

14. Ammonia is manufactured by the Haber's process using iron catalyst. Which of the following statements is incorrect?

- (a) Nitrogen is reduced by hydrogen.
 (b) It is not possible to obtain a 100% yield of ammonia.
 (c) The iron catalyst is used to increase the speed of the reaction.
 (d) A higher temperature will increase the yield of ammonia.

Ans :

MAIN 2014

Thus (d) is correct option.

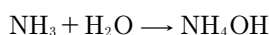
15. Ammonium compounds are in water.

- (a) Partially soluble (b) Insoluble
 (c) Soluble (d) Partially insoluble

Ans :

SQP 2017

Ammonium compounds are soluble in water



Thus (c) is correct option.

16. Ammonia turns yellow turmeric solution

- (a) Orange (b) brown
 (c) red (d) blue

Ans :

MAIN 2019

When sprayed with ammonia, turmeric powder turns red-orange. Turmeric is a natural indicator that turns yellow in acidic solutions and deep pinkish-red in basic solutions. When exposed to bases, turmeric paste turns brown

Thus (b) is correct option.

17. The ratio by volume of Nitrogen and Hydrogen in Haber's process is

- (a) 1 : 3 (b) 4 : 2
 (c) 3 : 1 (d) 2 : 4

Ans :

COMP 2010

The ratio of hydrogen to nitrogen by volume in the Haber process is 3 : 1. The Haber process is used to produce ammonia from nitrogen and hydrogen gas. The process involves combining the gases at high pressure and temperature in the presence of a catalyst.

Thus (a) is correct option.

18. Nessler's reagent has the formula and it imparts brown coloration with ammonia.

- (a) $\text{Ag}(\text{NH}_3)_2\text{OH}$ (b) K_2HgI_4
 (c) CH_3MgCl (d) NH_2CONH_2

Ans :

MAIN 2009

Nessler's reagent is an alkaline solution of potassium tetraiodomercurate(II) ($\text{K}_2[\text{HgI}_4]$) and potassium hydroxide (KOH). When it reacts with ammonia, it produces a brown precipitate or coloration.

Thus (b) is correct option.

19. When ammonia is prepared from ammonium chloride, the sublimable component is

- (a) Sodium Chloride (NaCl)
 (b) Ammonia (NH_3)
 (c) Ammonium Chloride (NH_4Cl)
 (d) Sodium Hydride (NaH)

Ans :

COMP 2011

When ammonium chloride is heated, it undergoes sublimation, a physical change that causes it to change directly from a solid to a gas without becoming a liquid first. The gas produced contains ammonia and hydrogen chloride molecules.

Thus (a) is correct option.

20. Name the gas produced when ammonium sulphate is heated with sodium hydroxide solution.

- (a) Hydrogen chloride gas
 (b) Chlorine
 (c) Sulphuric acid
 (d) Ammonia

Ans :

MAIN 2016

Warming ammonium sulfate with sodium hydroxide solution produces ammonia gas.

Thus (d) is correct option.

21. is used for reviving a fainted person.

- (a) Ammonium Carbonate
 (b) Ammonium Hydroxide
 (c) Ammonium Sulphate
 (d) Ammonium Chloride

Ans :

SQP 2017

Ammonium Carbonate is used for reviving a fainted person.

Thus (a) is correct option.

22. Liquid ammonia is used for refrigeration because it

- (a) has a high dipole moment
 (b) is basic
 (c) has a high heat of vaporisation
 (d) is a stable compound

Ans :

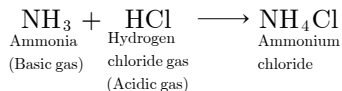
COMP 2015

Ammonia is a clear liquid that boils at a temperature of -28°F . In refrigeration, the liquid is

59. A white salt produced by an acid gas and a basic gas.

Ans : SQP 2005

Ammonium chloride,



60. Metal which directly combines with Nitrogen on heating.

Ans : MAIN 2017

Magnesium, Calcium, Aluminium.

61. Catalyst used during Haber's process.

Ans : COMP 2000

Finely divided iron.

62. The fertilizer formed when Carbon dioxide is reacted with Ammonia.

Ans : SQP 2001

Urea.

63. The industrial process by which Ammonia is manufactured.

Ans : MAIN 2005

Haber's process.

DIRECTION : Fill in the blank with the choices given in bracket:

64. Ammonia reacts with excess chlorine to form _____. (nitrogen/nitrogen tri-chloride/ammonium chloride)

Ans : MAIN 2019

Nitrogen tri-chloride

65. Ammonia gas is collected by _____ (an upward displacement of air, a downward displacement of water, a downward displacement of air)

Ans : SQP 2014

A downward displacement of air.

66. When ammonium chloride is heated, it undergoes _____ (thermal decomposition/thermal dissociation).

Ans : SQP 1999

Thermal dissociation

67. Ammonium chloride is a soluble salt prepared by _____ (precipitation, neutralisation).

Ans : COMP 1999

Neutralisation

68. Heating ammonium chloride with sodium hydroxide produces _____ (ammonia, nitrogen).

Ans : MAIN 1999

Ammonia.

69. Ammonia gas is collected by _____ (an upward displacement of air, a downward displacement of water, a downward displacement of air).

Ans : COMP 2000

Downward displacement of air

70. Nitrogen is prepared by heating the solution of _____ (potassium chloride/ammonium chloride) and sodium nitrite.

Ans : MAIN 2002

Ammonium chloride

71. The reaction involved in Haber's process is _____ (reversible/irreversible) and _____ (endothermic/exothermic).

Ans : COMP 2004

reversible, exothermic

72. Ammonia is burnt in atmosphere of oxygen with _____ (green/bluish white) colour.

Ans : MAIN 2005

green

73. Ammonium salts react with _____ (acids/alkalis) to liberate ammonia.

Ans : SQP 2007

alkalis

74. Nitrogen reacts with calcium carbide to form _____ (Nitrolim/Urea).

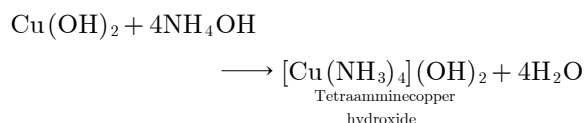
Ans : COMP 2009

Nitrolim

75. _____ (Nitrates/Nitrides) on reaction with water give ammonia.

Ans : MAIN 2010

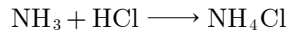
Nitrides



	Metallic salt solution	Colour of the ppt (in small quantity)	Nature of ppt (soluble/ Insoluble) in excess
(i)	Iron (III) chloride	Reddish brown	Insoluble
(ii)	Iron (II) sulphate	Dirty green	Insoluble
(iii)	Lead nitrate	White	Insoluble
(iv)	Zinc nitrate	White	Soluble
(v)	Copper sulphate	Pale blue or Bluish white	Soluble

2.4 Tests for Ammonia

- (a) Ammonia gives dense white fumes with concentrated Hydrochloric acid.



- (b) Ammonia turns Nessler's reagent brown.
 (c) When Ammonia is passed through Copper sulphate solution first a little then a bluish white precipitate is formed which dissolves in excess of Ammonia to give deep blue solution or inky blue solution or Prussian blue solution.
 (d) As Ammonia is basic in nature therefore it turns moist red litmus blue, phenolphthalein from colourless to pink.

2.5 Use of Ammonia

Ammonia is extensively used in the manufacture of nitrogenous fertilizers, Nitric acid, Sodium carbonate and other explosives. Generally, it is used as a refrigerant and as a cleansing agent (removes grease).

3. CHLOROFLUOROCARBON

A hydrocarbon (usually alkane) with all the hydrogen atoms are replaced with either chlorine atoms or fluorine atoms. They cannot be all chlorine atoms or all fluorine atoms but must be some mixture of CFC's are commonly called freon.

The work on alternatives of CFC in refrigerant in the late 1970s after the first warnings to

the damage of stratospheric ozone layer. The alternative is hydro-chlorofluorocarbons which are less stable in lower atmosphere and thus, they break down before reaching the ozone layer.

MULTIPLE CHOICE QUESTION

1. Ammonia can be obtained by adding water to :
 (a) Ammonium chloride
 (b) Ammonium nitrite
 (c) Magnesium nitride
 (d) Magnesium nitrate

Ans :

COMP 2003

Ammonia can be obtained by adding water to Magnesium nitrate.

Thus (c) is correct option.

2. The catalyst used in the contact process is
 (a) vanadium pent-oxide
 (b) iron
 (c) copper
 (d) manganese dioxide

Ans :

MAIN 2018

The catalyst used in the contact process for producing sulfuric acid is vanadium pentoxide (V_2O_5).

Thus (a) is correct option.

3. Nitrogen gas can be obtained by heating
 (a) ammonium nitrate
 (b) ammonium nitrite
 (c) magnesium nitride
 (d) ammonium chloride

Ans :

SQP 2013

Nitrogen gas can be obtained by heating ammonium nitrite.

Thus (b) is correct option.

4. It is recommended that ammonia bottles should be opened after cooling in ice for sometime. This is because
 (a) it has high vapour pressure.
 (b) it brings tears.
 (c) it is explosive liquid.
 (d) none of these

Ans :

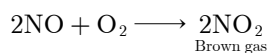
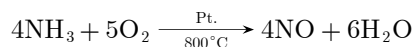
MAIN 2014

The vapour pressure of ammonia at room temperature is very high and hence the ammonia

90. Ammonia to brown gas.

Ans :

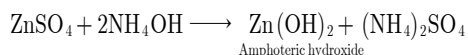
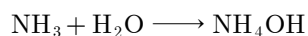
SQP 2009



91. Ammonia solution to an amphoteric hydroxide.

Ans :

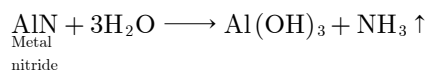
COMP 2014



92. A nitride of a trivalent metal to ammonia.

Ans :

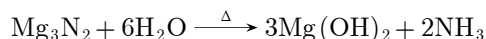
MAIN 2017



93. Magnesium nitride is treated with warm water.

Ans :

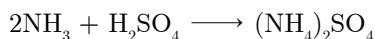
SQP 2020



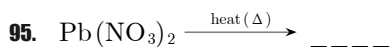
94. Write the correct balanced equation for the reaction between ammonia and sulphuric acid.

Ans :

MAIN 1993

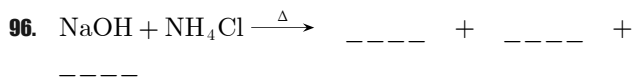
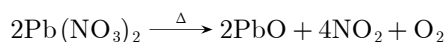


DIRECTION : Complete and balance the following equations.



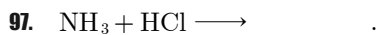
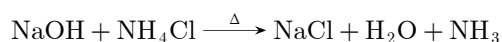
Ans :

MAIN 2018



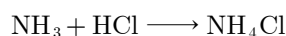
Ans :

SQP 2019



Ans :

COMP 2020



Ans :

MAIN 2023



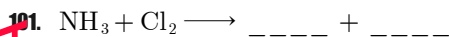
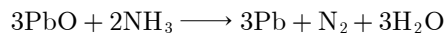
Ans :

SQP 2021



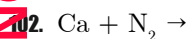
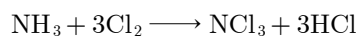
Ans :

COMP 2023



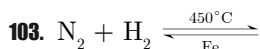
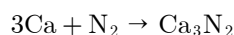
Ans :

SQP 2022



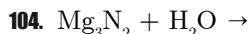
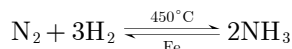
Ans :

COMP 2011



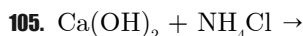
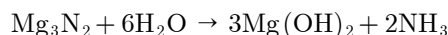
Ans :

SQP 2000



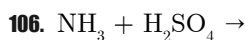
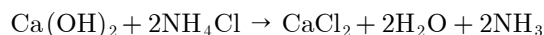
Ans :

MAIN 2014



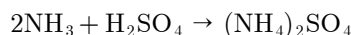
Ans :

SQP 2015



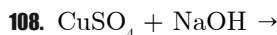
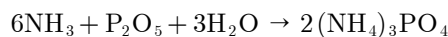
Ans :

COMP 2017



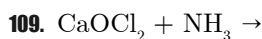
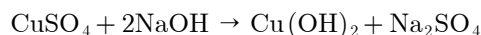
Ans :

SQP 2011



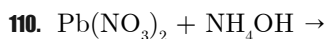
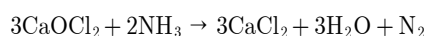
Ans :

MAIN 2010



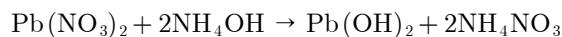
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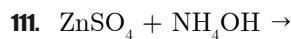
COMP 2017



Ans :

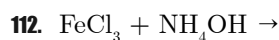
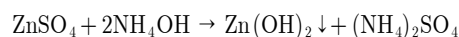
MAIN 2019





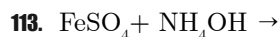
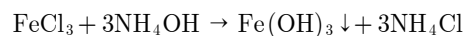
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SQP 2010



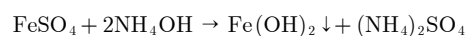
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MAIN 2011



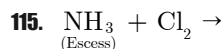
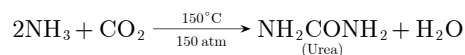
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COMP 2015



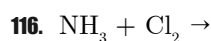
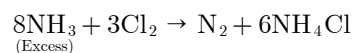
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MAIN 2017



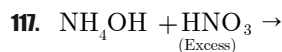
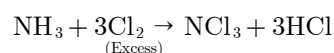
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SQP 2019



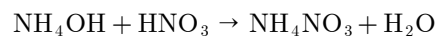
Ans :

MAIN 2018



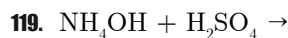
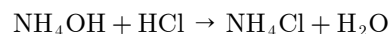
Ans :

COMP 2014



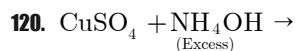
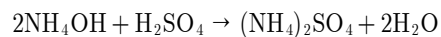
Ans :

MAIN 2012



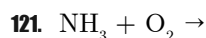
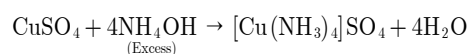
Ans :

COMP 2011



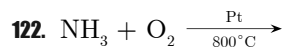
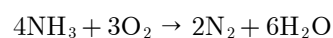
Ans :

MAIN 2000



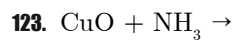
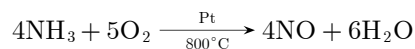
Ans :

SQP 2001



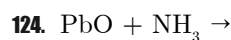
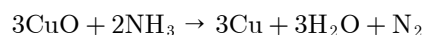
Ans :

MAIN 2005



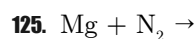
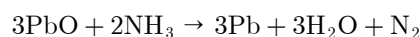
Ans :

COMP 2009



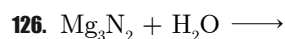
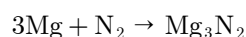
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SQP 2010



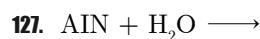
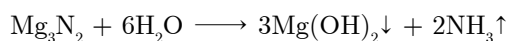
Ans :

COMP 2019



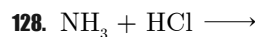
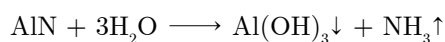
Ans :

MAIN 2018



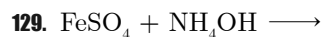
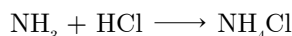
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SQP 2000



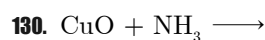
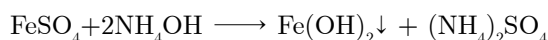
Ans :

COMP 2012



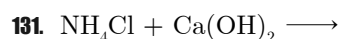
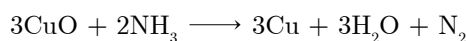
Ans :

MAIN 2000



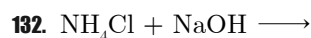
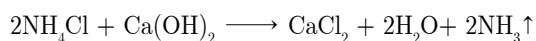
Ans :

SQP 2005



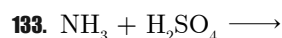
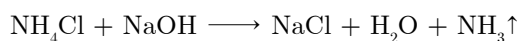
Ans :

COMP 2016



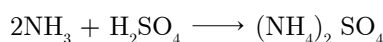
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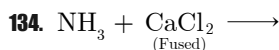
MAIN 2006



Ans :

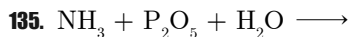
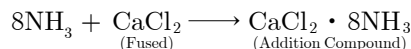
SQP 2010





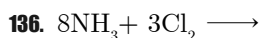
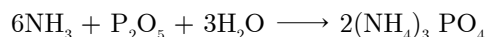
Ans :

MAIN 2016



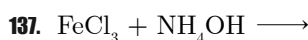
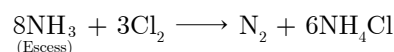
Ans :

COMP 2012



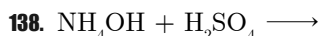
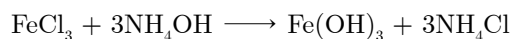
Ans :

SQP 2002



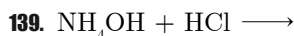
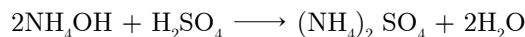
Ans :

MAIN 2010



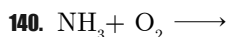
Ans :

COMP 2007



Ans :

SQP 2005



Ans :

COMP 2015



DIRECTION : State one relevant observation for of the following :

141. When ammonia gas is burnt in an atmosphere of excess oxygen.

Ans :

COMP 2015



Ammonia burns with a yellow flame.

142. Excess of chlorine gas is reacted with ammonia gas.

Ans :

MAIN 2013

A yellow explosive liquid (nitrogen tri-chloride) is formed.

143. Ammonia gas is burnt in an atmosphere of oxygen in the absence of a catalyst.

Ans :

SQP 2010

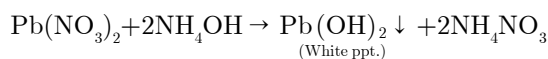
Greenish yellow flame is observed.

144. When excess of ammonia is passed through an aqueous solution of lead nitrate

Ans :

COMP 2006

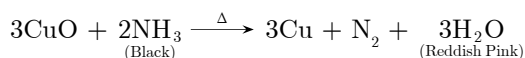
When ammonia is passed through an aqueous solution of lead nitrate, a white precipitate is produced which is insoluble even in an excess of ammonia.



145. Ammonia gas is passed over heated copper (II) oxide.

Ans :

SQP 2019



The black colour copper oxide will change to reddish pink copper.

DIRECTION : Identify the following substance:

146. An alkaline gas (A) which gives dense white fumes with hydrogen chloride.

Ans :

SQP 2019

Ammonia

147. Identify the substance Q based on the information given: The white crystalline solid 'Q' is soluble in water. It liberates a pungent smelling gas when heated with sodium hydroxide solution.

Ans :

MAIN 2020

Ammonium chloride

DIRECTION : Name the gas in the following :

148. The gas produced when excess ammonia reacts with chlorine.

Ans :

MAIN 2012

Nitrogen

149. The catalyst used to oxidise ammonia.

Ans :

COMP 2019

Platinum

150. The gas that can be oxidised to sulphur.

Ans :

SQP 2009

Hydrogen sulphide (H_2S)

- 151.** An alkaline gas A which gives dense white fumes with hydrogen chloride.

Ans : COMP 2008
Ammonia

- 152.** Name (formula is not acceptable) the gas produced in the following reaction :
Warming ammonium sulphate with sodium hydroxide solution.

Ans : COMP 2001
Ammonia

DIRECTION : Name the gas evolved when the following mixtures are heated:

- 153.** Calcium hydroxide and Ammonium Chloride.

Ans : COMP 2016
Ammonia

- 154.** Sodium Nitrite and Ammonium Chloride.

Ans : SQP 2016
Nitrogen

- 155.** This gas is used as a reducing agent in reducing copper oxide to copper.

Ans : MAIN 2015
Ammonia

- 156.** This gas produces dense white fumes with ammonia gas.

Ans : SQP 2015
Hydrogen chloride

- 157.** A gas which dissolves in water to give alkaline solution.

Ans : COMP 2015
Ammonia

- 158.** An oxidising agent which does not contain any oxygen.

Ans : MAIN 2015
Chlorine gas

DIRECTION : Answer the following :

- 159.** Name the reaction taking place when ammonia is prepared in the laboratory. How is ammonia dried ?

Ans : COMP 2019
 $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3\uparrow$
Ammonia so prepared is dried by passing it over quicklime (CaO).

- 160.** What is laboratory bench reagent ?

Ans : MAIN 2010
It is dilute solution of liquor ammonia.

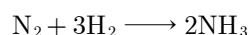
- 161.** During laboratory preparation how is ammonia dried and collected?

Ans : COMP 2021
Ammonia is dried by passing through Quick lime, i.e. Calcium oxide and collected by the downward displacement of air.

- 162.** Copy and complete the following table relating to important industrial process:

Name of process	Temperature	Catalyst	Equation for the catalysed reaction
Haber's Process			

Ans : MAIN 2013
Temperature: 450-500° C.
Catalyst: Finely divided iron



- 163.** What CFC's commonly called as ?

Ans : SQP 2018
Freon

- 164.** State what do you observe when neutral litmus solution is added to an alkaline solution.

Ans : SQP 2001
It turns blue.

- 165.** What are the products formed when ammonia is oxidised with copper oxide? Also give the balanced equation.

Ans : MAIN 2001
Cu, N₂ and H₂O
 $2\text{NH}_3 + 3\text{CuO} \longrightarrow 3\text{Cu} + 3\text{H}_2\text{O} + \text{N}_2\uparrow$

- 166.** How is ammonia collected ?

Ans : SQP 2003
By the downward displacement of air.

167. Why is ammonia not collected over water ?

Ans : MAIN 2003

Because ammonia is highly soluble in water.

168. Which compound is normally used as a drying agent for ammonia ?

Ans : COMP 2003

Quicklime

169. State what you observe when a piece of moist red litmus paper is placed in a gas jar of ammonia.

Ans : SQP 2019

It turns blue.

170. Ammonium salts decompose on heating. What other property do ammonium salts have in common ?

Ans : MAIN 2012

They react with alkalis to produce ammonia.

171. Is ammonia more dense or less dense than air ?

Ans : COMP 2015

Less dense

172. What property of ammonia is demonstrated by the Fountain Experiment ?

Ans : SQP 2017

High solubility in water.

brought near the mouth of the concentrated hydrochloric acid bottle.

Ans : SQP 2010

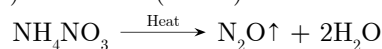
- (i) Green flame,
- (ii) Dense white fumes

175. State the products of following reactions :

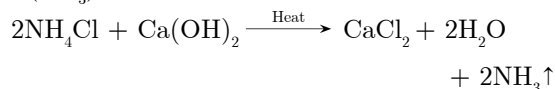
- (i) Ammonium nitrate is heated.
- (ii) A well ground mixture of ammonium chloride and slaked lime is heated.

Ans : MAIN 2011

- (i) The products formed when ammonium nitrate (NH_4NO_3) is heated are nitrous oxide (N_2O) and water (steam).



- (ii) The products formed when a well ground mixture of ammonium chloride (NH_4Cl) and slaked lime [$\text{Ca}(\text{OH})_2$] is heated are calcium chloride (CaCl_2), water (H_2O) and ammonia (NH_3).



176. Distinguish between the following pairs of compounds using the test given within brackets:

- (i) Iron (II) sulphate and iron (III) sulphate (using ammonium hydroxide)
- (ii) A lead salt and a zinc salt (using excess ammonium hydroxide)

Ans : COMP 2014

- (i) Iron (II) sulphate (FeSO_4) : Dirty green ppt which changes to reddish brown after sometime and the ppt remains insoluble in excess of NH_4OH .

Iron (III) sulphate: Reddish brown ppt appears which is insoluble in excess of NH_4OH .

- (ii) Lead salt : White ppt is formed which is insoluble in excess of NH_4OH .

Zinc salt : White ppt is formed which is soluble in excess of NH_4OH .

177. State two relevant observations, for each of the following:

- (i) Ammonium hydroxide solution is added to copper (II) nitrate solution in small quantities and then in excess.
- (ii) Ammonium hydroxide solution is added to zinc nitrate solution in minimum quantities and then in excess.

Ans : SQP 2000

TWO MARKS QUESTIONS

173. (i) Ranjana wants to prove that ammonia is a reducing agent. To demonstrate this, she passes ammonia gas over heated copper oxide. What will she observe?

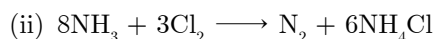
- (ii) Write a balanced chemical equation for the above reaction.

Ans : SQP 2025

- (i) Black copper oxide changes to reddish brown/pink copper
- (ii) $\text{CuO} + 2\text{NH}_3 \rightarrow \text{Cu} + 3\text{H}_2\text{O} + \text{N}_2$

174. State your observation for the following case:

- (i) Ammonia gas is burnt in an atmosphere of oxygen in the absence of a catalyst.
- (ii) Glass rod dipped in ammonium hydroxide is

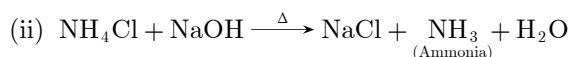
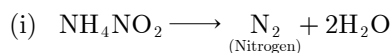


197. Name the gas that you can obtain in the laboratory from each of the following and write the equation for the reaction taking place in each case:

- (i) Ammonium nitrite
(ii) Ammonium chloride

Ans :

MAIN 2018



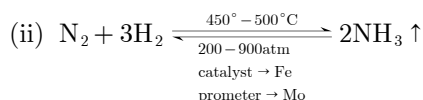
198. Copy and complete the following table which refers to the industrial method for the preparation of ammonia :

Name of the compound	Name of the process	Catalytic equations (with the catalyst)
Ammonia	(i) _____	(ii) _____

Ans :

COMP 2010

(i) Haber's process



199. How would you distinguish between Zn^{2+} and Pb^{2+} ions using ammonium hydroxide solution ?

Ans :

MAIN 2016

Zn^{2+} ions form gelatinous white precipitate of $\text{Zn}(\text{OH})_2$ with ammonium hydroxide solution which dissolves in an excess solution of ammonium hydroxide to form a complex ion, $[(\text{Zn}(\text{NH}_3)_4)]^{2+}$.
 Pb^{2+} ions form a chalky white precipitate of $\text{Pb}(\text{OH})_2$ with ammonium hydroxide solution which is insoluble in an excess of ammonium hydroxide.

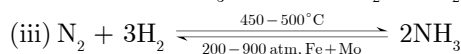
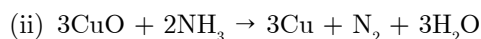
THREE MARKS QUESTIONS

- 200.** (i) Name the substance used for drying ammonia.
(ii) Write an equation to illustrate the reducing nature of ammonia.
(iii) With reference to Haber's process for the preparation for ammonia, write the equation and the condition required.

Ans :

COMP 2000

(i) Quicklime, CaO



201. Certain blank spaces are left in the following table and these are labelled as C, D and E. Identify each of them.

Lab preparation of	Reactants used	Products formed	Drying agent	Method of collection
NH_3 gas	C _____	$\text{Mg}(\text{OH})_2$ NH_3	D _____	E _____

Ans :

COMP 2017

C $\rightarrow$ Magnesium nitride (Mg_3N_2) and water

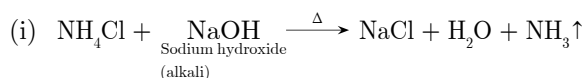
D $\rightarrow$ Calcium oxide

E $\rightarrow$ Downward displacement of air

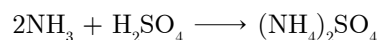
- 202.** (i) Write the balanced chemical equation to prepare ammonia gas in the laboratory by using an alkali.
(ii) State why concentrated sulphuric acid is not used for drying ammonia gas.
(iii) Why is ammonia gas not collected over water?

Ans :

MAIN 2018



(ii) Concentrated sulphuric acid is not used for drying ammonia gas because it reacts with ammonia.



(iii) Ammonia is highly soluble gas one volume of water can dissolve 702 volumes of ammonia at 20°C and at 1 atmospheric pressure. Hence it is not collected over water.

203. List the properties of ammonia that make it :

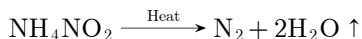
- (i) A good refrigerant
(ii) A cleaning agent
(iii) As a source of hydrogen.

Ans :

COMP 2023

- (i) Ammonia can be liquefied easily and has a high latent heat of vaporisation.
(ii) This is because ammonia solution emulsifies fats and grease.
(iii) Ammonia can be liquefied easily and transported easily and on decomposition it gives hydrogen whereas liquid hydrogen is dangerous to transport in cylinders.

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- 187.** Explain why dry or liquid ammonia is neutral to litmus.

Ans :

SQP 2017

Ammonia (NH_3) is a covalent compound, therefore, in the absence of ions, dry or liquid ammonia has no effect on litmus.

- 188.** What is Nessler's reagent ? What test does it give with ammonium salts ?

Ans :

MAIN 2018

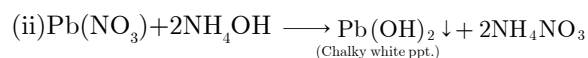
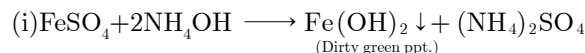
Nessler's reagent is an alkaline solution of potassium mercury-iodide [K_2HgI_4]. When ammonium compound is added to colourless Nessler's reagent, a brown colour is observed.

- 189.** Why ammonium hydroxide is used in qualitative analysis ? Give two equations to justify your answer.

Ans :

COMP 2019

Ammonium hydroxide is used in qualitative analysis because it precipitates hydroxides of metals when added to the aqueous solution of their salts. For example :



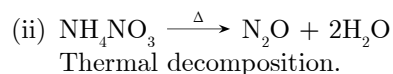
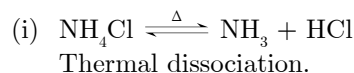
- 190.** Write the equation for the action of heat on

- (i) ammonium chloride and
- (ii) ammonium nitrate.

State whether each reaction is an example of thermal decomposition or thermal dissociation.

Ans :

SQP 2011



- 191.** (i) Though Ammonium nitrite readily gives Nitrogen on heating, a mixture of Ammonium chloride and Sodium nitrite in water is heated to prepare Nitrogen in the laboratory.
(ii) Ammonia cannot be collected over water.

Ans :

COMP 2014

- (i) Ammonium nitrite cannot be stored even

at room temperature, therefore Nitrogen is obtained by heating Ammonium chloride and Sodium nitrite.

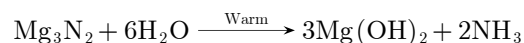
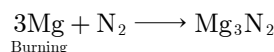
- (ii) Ammonia is highly or extremely soluble in water and therefore, it is not collected over water.

- 192.** Explain why Ammonia gas is evolved when Water is added to the product formed when Magnesium is burnt in the air.

Ans :

MAIN 2016

When Magnesium is burnt in air, it forms Magnesium nitride which, on warming with water produces Ammonia.



- 193.** Name the gas evolved when the following mixtures are heated:

- (i) Calcium hydroxide and Ammonium chloride.
- (ii) On decomposition of ammonium nitrite.

Ans :

SQP 2019

- (i) Ammonia
- (ii) Nitrogen

- 194.** You enter a laboratory after a class has completed the Fountain experiment. How will you be able to tell whether the gas used in the experiment was Hydrogen chloride or Ammonia?

Ans :

COMP 2012

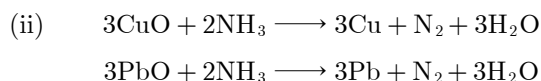
In case of Ammonia the solution in the flask was blue; whereas in Hydrogen chloride gas the solution entering the flask was red.

- 195.** (i) Name the substance used for drying Ammonia.
(ii) Write an equation to illustrate the reducing nature of Ammonia.

Ans :

MAIN 2015

- (i) Calcium oxide or quick lime.

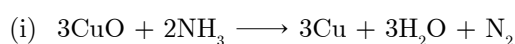


- 196.** Write a balanced equation for a reaction in which ammonia is oxidised by :

- (i) a metal oxide;
- (ii) a gas which is not oxygen.

Ans :

COMP 2017



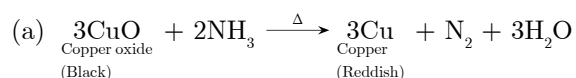
gas fitted with a rubber stopper with two holes, one for jet tube and other for dropper containing water. The jet tube is dipped in blue litmus solution taken in a trough. Squeeze the dropper so that few drops of water enter the flask. Ammonia gas present in the flask dissolves in water and due to its high solubility a partial vacuum is created in the flask as a result of it red litmus solution rushes up in the jet tube and emerges as a blue fountain.

- 209.** What do you observe when ammonia is passed through the following: (Also give equations)

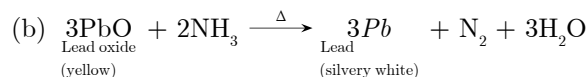
- (i) Copper oxide
- (ii) Lead oxide
- (iii) Excess chlorine

Ans :

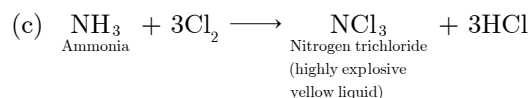
COMP 2005



Observation : Black copper oxide changes to red copper.



Observation : Yellow lead oxide changes to silvery white lead.



Observation : Gaseous mixture will give highly explosive yellow liquid.

- 210.** Distinguish between liquid ammonia and liquid ammonia fortis.

Ans :

MAIN 2009

The difference between liquid ammonia and liquid ammonia fortis are as follows:

	Liquid Ammonia		Liquid Ammonia fortis
1.	It is liquefied ammonia gas.	1.	It is a saturated solution of ammonia gas in water.
2.	It is a strong refrigerant.	2.	It is a weak refrigerant.
3.	It is volatile.	3.	It is less volatile.
4.	It consists of only molecules.	4.	It consists of molecules as well as ions.

5.	It is a non-conductor of electricity.	5.	It is a weak electrolyte.
6.	It is used in laundries.	6.	It is used as a laboratory reagent.

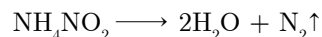
- 211.** Give reasons for the following :

- (i) Though ammonium nitrite readily gives nitrogen on heating, a mixture of ammonium chloride and sodium nitrite in water is heated to prepare nitrogen in laboratory.
- (ii) Ammonia cannot be collected over water.

Ans :

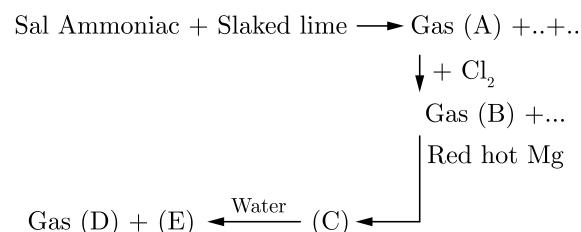
SQP 2012

- (i) Though ammonium nitrite readily gives nitrogen on heating but it is an unstable compound and continues decomposing by itself at ordinary temperature. Therefore, for the laboratory preparation of nitrogen it is usually replaced by a mixture of sodium nitrite and ammonium chloride which react by double decomposition to form ammonium nitrite. Ammonium nitrite so formed decomposes to give nitrogen.



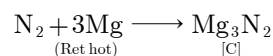
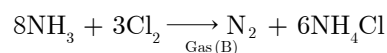
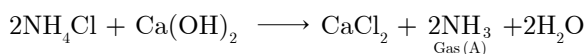
- (ii) Ammonia is highly soluble in water (1 cc of water dissolves about 702 cc of the gas at ordinary temperature) and hence it cannot be collected over water.

- 212.** Identify the substances A , B , C , D and E in the following reactions. Also give a balanced equation for each conversion.



Ans :

MAIN 2017



204. (i) Name the ion other than ammonium ion formed when ammonia dissolves in water.
 (ii) Write the equations for the following reactions which result in the formation of ammonia.
 (a) A mixture of ammonium chloride and slaked lime is heated.
 (b) Aluminium nitride and water.

Ans :

SQP 2017

- (i) Hydroxyl ion ($\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$)
 (ii) (a)
$$\underset{\text{Ammonium chloride}}{2\text{NH}_4\text{Cl}} + \underset{\text{Slaked lime}}{\text{Ca}(\text{OH})_2} \longrightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$$

 (b)
$$\text{AlN} + 3\text{H}_2\text{O} \longrightarrow \text{Al}(\text{OH})_3\downarrow + \text{NH}_3\uparrow$$

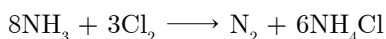
205. Give three reactions to show reducing property of ammonia.

Ans :

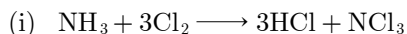
COMP 2011

Reduction of chlorine. On bringing chlorine and ammonia together, the yellowish-green colour of chlorine disappears and white fumes of ammonium chloride are formed.

- (a) When ammonia is in excess, the products are nitrogen and ammonium chloride.



- (b) When chlorine is in excess, then the products are hydrogen chloride and a yellow coloured highly explosive liquid, nitrogen trichloride.



These reactions show that ammonia is a strong reducing agent.

206. Complete the following table.

NH_3	Turns	Red litmus	
		Turmeric paper	
		Colourless	
		Phenolphthalein	
		Orange coloured	
		Methyl orange	
		Nessler's reagent	

Ans :

MAIN 2009

NH_3	Turns	Red litmus	Blue
		Turmeric paper	Brown
		Colourless	Pink
		Phenolphthalein	
		Orange coloured	Yellow
		Methyl orange	
		Nessler's reagent	Brown

207. Explain why nitrogen compounds are added to cultivated soils.

Ans :

COMP 2000

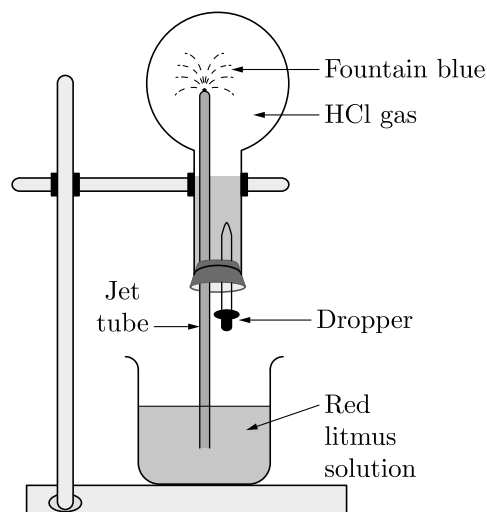
Plants need nitrogen for their healthy growth and development. Fertile soil generally has adequate quantity of nitrogen. However, the quantity of nitrogen in the soil decreases due to multiple cropping or leaching or due to irrigation. Therefore, fertile soil will become less fertile with the passage of time. It is to maintain the fertility of the soil that nitrogen compounds are added to the cultivated soil.

208. How will you demonstrate the solubility of ammonia in water ? Explain.

Ans :

SQP 2001

This can be demonstrated by the fountain experiment.



Fountain Experiment

Take a round bottomed flask filled with ammonia

- (i) Pale blue ppt appears which dissolves in excess of NH_4OH to give deep blue solution.
 (ii) White ppt appears which is soluble in excess of NH_4OH .

- 178.** (i) Of the two gases, ammonia and hydrogen chloride, which is more dense? Name the method of collection of this gas.
 (ii) Give one example of a reaction between the above two gases which produces a solid compound.

Ans : MAIN 2007

- (i) Hydrogen chloride is denser than ammonia. It is collected by upward displacement of air.
 (ii)
$$\underset{\substack{\text{Ammonia} \\ \text{(gas)}}}{\text{NH}_3} + \underset{\substack{\text{Hydrogen} \\ \text{chloride} \\ \text{(gas)}}}{\text{HCl}} \longrightarrow \underset{\substack{\text{Ammonium} \\ \text{chloride} \\ \text{(white solid)}}}{\text{NH}_4\text{Cl}}$$

- 179.** Identify the acid which matches the following description.
 (i) The acid which is prepared by catalytic oxidation of ammonia.
 (ii) The acid on mixing with silver nitrate solution produces a white precipitate which is soluble in excess ammonium hydroxide.

Ans : MAIN 2019

- (i) Nitric acid.
 (ii) Dilute hydrochloric acid.

- 180.** Write the equations for the following reactions which result in the formation of ammonia.

- (i) A mixture of ammonium chloride and slaked lime is heated.
 (ii) Aluminium nitride and water.

Ans : COMP 2005

- (i) $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{NH}_3\uparrow + 2\text{H}_2\text{O}$
 (ii) $\text{AlN} + 3\text{H}_2\text{O} \rightarrow \text{Al}(\text{OH})_3 + \text{NH}_3\uparrow$

- 181.** State your observations when ammonium hydroxide solution is added drop by drop and then in excess to each of the following solutions:

- (i) copper sulphate solution
 (ii) zinc sulphate solution.

Ans : MAIN 2016

- (i) Pale blue precipitate appears which dissolves in excess of NH_4OH to form deep blue solution.
 (ii) White precipitate appears which dissolves in excess of NH_4OH .

- 182.** Why is the catalyst chamber (in the formation of ammonia) provided with heat exchanger?

Ans : COMP 2017

The catalyst chamber is provided with heat exchangers so that the outgoing ammonia gas and the unreacted gases exchange their heat with the incoming nitrogen and hydrogen.

- 183.** Write down the equations for following reactions :

- (i) When ammonium chloride is warmed with sodium hydroxide solution.
 (ii) When ammonium chloride is warmed with concentrated sulphuric acid.

Ans : MAIN 2019

- (i) $\text{NH}_4\text{Cl} + \text{NaOH} \xrightarrow{\text{Heat}} \text{NaCl} + \text{H}_2\text{O} + \text{NH}_3\uparrow$
 (ii) $\text{NH}_4\text{Cl} + \underset{\text{(Conc.)}}{\text{H}_2\text{SO}_4} \longrightarrow (\text{NH}_4)_2\text{SO}_4 + 2\text{HCl}\uparrow$

- 184.** Under what conditions do nitrogen and hydrogen combine to form ammonia? State one large-scale use of ammonia.

Ans : COMP 2017

Nitrogen and oxygen combine to form ammonia under the following conditions :

- (1) High pressure
 (2) Low temperature
 (3) Presence of a catalyst

Large-scale use of ammonia : Manufacture of nitric acid by Oswald's process.

- 185.** Give five uses of ammonia.

Ans : MAIN 2019

Five uses of ammonia are as follows

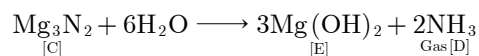
- (i) In laboratory.
 (ii) As a refrigerant.
 (iii) It is used in the manufacture of nitric acid.
 (iv) It is used in the manufacture of fertilisers.
 (v) It is used in the manufacture of dyes and drugs.

- 186.** What are the products formed when ammonium chloride is mixed with sodium nitrite and the mixture is heated. Also give chemical equations.

Ans : COMP 2020

The products formed when ammonium chloride (NH_4Cl) is mixed with sodium nitrite and the mixture is heated are sodium chloride, nitrogen gas and water (steam).





Thus :

- (a) Ammonia, NH_3
- (b) Nitrogen, N_2
- (c) Magnesium nitride, Mg_3N_2
- (d) Ammonia, NH_3
- (e) Magnesium hydroxide, $\text{Mg}(\text{OH})_2$

213. Give balanced equations for the reducing reactions of ammonia with :

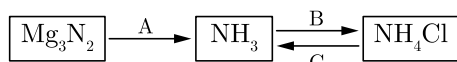
- (i) CuO
- (ii) PbO
- (iii) Chlorine : (a) excess NH_3 , (b) excess Cl_2 ,

Ans :

COMP 2018

- $$\begin{array}{l} \text{(i) } 3\text{CuO} + 2\text{NH}_3 \longrightarrow 3\text{Cu} + 3\text{H}_2\text{O} + \text{N}_2 \\ \text{(ii) } 3\text{PbO} + 2\text{NH}_3 \longrightarrow 3\text{Pb} + 3\text{H}_2\text{O} + \text{N}_2 \\ \text{(iii) (a) } \underset{\text{(excess)}}{8\text{NH}_3} + 3\text{Cl}_2 \longrightarrow 6\text{NH}_4\text{Cl} + \text{N}_2 \\ \quad \quad \quad \text{(b) } \text{H}_3 + \underset{\text{(excess)}}{3\text{Cl}_2} \longrightarrow \text{NCl}_3 + 3\text{HCl} \end{array}$$

214. Study the flow chart given and give balanced equations to represent the reactions A, B and C.



Ans :

MAIN 2022

- (a) $\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2 + 2\text{NH}_3$
 (b) $\text{NH}_3 + \text{HCl} \longrightarrow \text{NH}_4\text{Cl}$
 (c) $\text{NH}_4\text{Cl} + \text{NaOH} \xrightarrow{\Delta} \text{NaCl} + \text{H}_2\text{O} + \text{NH}_3\uparrow$

215. The following reactions are carried out:

- (i) Nitrogen + metal $\rightarrow$ compound X
(ii) X + water $\rightarrow$ ammonia + another compound
(iii) Ammonia + metal oxide $\rightarrow$ metal + water + N₂
One metal that can be used for reaction C (i) is magnesium.
- Write the formula of the compound X formed.
 - Write the correct balanced equation for reaction (ii) where X is the compound formed.
 - What property of ammonia is demonstrated by reaction (iii) ?

Ans :

COMP 1993

- (i) Mg_3N_2
- (ii) $\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2\downarrow + 2\text{NH}_3\uparrow$
- (iii) Reducing property.

216. Industrially, ammonia is obtained by direct combination between nitrogen and hydrogen.

- Write the correct balanced equation for the direct combination of nitrogen with hydrogen.
- Which of the metals : iron, platinum, copper catalyse this direct combination?
- What favours the formation of ammonia the use of high pressure or low pressure ?

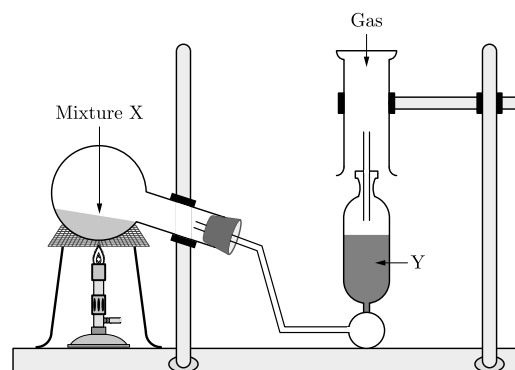
Ans :

MAIN 2012

- (i) $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
 (ii) Iron
 (iii) High pressure

FOUR MARKS QUESTIONS

217. The diagram shows an experimental set up for the laboratory preparation of a pungent smelling gas. The gas is alkaline in nature.



- Name the gas collected in the jar.
- Write the balanced equation for the above preparation.
- How is the gas being collected ?
- Name the drying agent used.
- How will you find that the jar is full of gas ?

Ans :

COMP 2011

- (i) Ammonia (NH_3)
- (ii) $\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3 \uparrow$
- (iii) Downward displacement of air
- (iv) Quicklime (CaO)
- (v) Bring a rod dipped in HCl near it. Dense white fumes of ammonium chloride will be formed.

218. What do you observe when:

- (i) Ammonia comes in contact with concentrated Hydrochloric acid.

Ans :

SQP 2010

Sulfuric acid (H_2SO_4) is used in the brown ring test, which is a chemical procedure for detecting nitrate ions in a solution.

Thus (a) is correct option.

11. The formula of chile salt petre is

- (a) KNO_3 (b) NaNO_3
(c) HNO_3 (d) None of these

Ans :

MAIN 2004

Thus (b) is correct option.

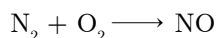
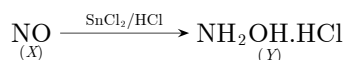
12. Lightning bolts in the atmosphere causes the formation of

- (a) NO (b) NH_3
(c) NH_4OH (d) NH_2OH

Ans :

COMP 2016

A natural source of nitrogen oxides occurs from a lightning stroke. The very high temperature in the vicinity of a lightning bolt causes the gases oxygen and nitrogen in the air to react to form nitric oxide.



Thus (a) is correct option.

13. Chile salt petre has the chemical formula :

- (a) $\text{Mg}(\text{NO}_3)_2$ (b) KNO_3
(c) NaNO_3 (d) HNO_3

Ans :

MAIN 2020

The chemical formula for Chile salt petre is NaNO_3 .

Thus (c) is correct option.

14. A solid which bursts into flames on addition of concentrated nitric acid is :

- (a) Turpentine oil
(b) Sawdust
(c) Alcohol
(d) Ferric sulphate

Ans :

COMP 2018

Sawdust is a solid that bursts into flames when concentrated nitric acid is added to it. This is because nitric acid is a strong oxidizing agent that breaks down to produce nascent oxygen, which is very reactive and oxidizes organic compounds into carbon dioxide and water.

Thus (b) is correct option.

15. Concentration of nitric acid obtained in Ostwald's process.

- (a) 10% (b) 5%
(c) 15% (d) 20%

Ans :

SQP 2021

Concentration of nitric acid obtained in Ostwald's process 5%.

Thus (b) is correct option.

16. A gas which dissolves in water to form the acid is known as

- (a) Acid Reflux (b) Acid anhydride
(c) Acidified Water (d) Acid Ketone

Ans :

SQP 2017

Thus (b) is correct option.

17. A solution used for dissolving noble metals.

- (a) Ammonia (b) Urea
(c) Nitrosyl Chloride (d) Aqua Regia

Ans :

MAIN 2011

Thus (d) is correct option.

18. A metal which react with very dilute nitric acid evolving hydrogen.

- (a) Mg (b) Au
(c) Zn (d) Li

Ans :

COMP 2006

Thus (a) is correct option.

19. Commercial and common name of tri nitroglycerine is

- (a) Aqua Regia (b) T.N.T.
(c) Dynamite (d) Nitrosyl Chlorid

Ans :

SQP 2013

Thus (b) is correct option.

20. Nitric acid combines with proteins to form.

- (a) Xanthoproteic acid
(b) Urea
(c) Nitrosyl Chloride
(d) Aqua Regia

Ans :

MAIN 2019

Thus (a) is correct option.

21. On photochemical decomposition of HNO_3 , the products formed are

- (a) NO_2 and O_2 (b) NO and O
(c) N_2O_4 and NO_2 (d) N_2O_5 and NO_2

Ans :

SQP 2022

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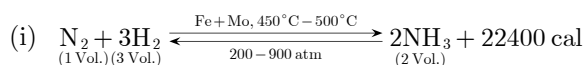
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223. In the preparation of ammonia in industry, the raw materials are nitrogen and hydrogen. These are mixed together in the correct proportions needed to form ammonia.

- (i) Write the balanced equation for the manufacture of ammonia.
- (ii) How much hydrogen would be there in 400 litres of gaseous mixture required for the manufacture of ammonia ?
- (iii) (a) If all nitrogen and hydrogen used were converted into ammonia, find the volume of ammonia formed.
(b) How would the volume of ammonia formed compare with the volume of original mixture ?
- (iv) The formation of ammonia from its elements is an exothermic reaction. What is meant by exothermic ?

Ans :

SQP 2013



- (ii) Total volume of the gaseous mixture (nitrogen and hydrogen) required for the manufacture of ammonia 400 litres.

Ratio (by volume) of nitrogen and hydrogen

$$= 1 : 3$$

Volume of hydrogen in the mixture

$$= \frac{3}{4} \times 400 \text{ litres}$$

$$= 300 \text{ litres}$$

- (iii) (1) Volume of ammonia formed

$$= \frac{400}{2} = 200 \text{ litres}$$

- (2) Ratio of volume of ammonia formed to the volume of the original mixture

$$= \frac{200 \text{ litres}}{400 \text{ litres}}$$

$$= \frac{1}{2} = 1:2$$

- (iv) The formation of ammonia from its elements is an exothermic reaction. Exothermic means heat is produced in the reaction.

224. Match the following:

	Column-I		Column-II
(i)	Promoter used in Haber's process	(a)	800° C
(ii)	Catalyst used in oxidation of ammonia	(b)	K ₂ HgI ₄

(iii)	Drying agent for ammonia	(c)	Molybdenum
(iv)	A solution which gives brown colouration with ammonium salts	(d)	Refrigent
(v)	Temperature in Haber's process	(e)	Platinum
(vi)	Liquid ammonia	(f)	Calcium oxide
(vii)	Temperature in oxidation of ammonia	(g)	450° C

Ans :

MAIN 2019

- (i)-(c); (ii)-(e); (iii)-(f); (iv)-(b); (v)-(g);
(vi)-(d); (vii)-(a)

225. Give reasons for the following :

- (i) Liquid ammonia is used as a refrigerant in ice plants.
- (ii) Aqueous solution of ammonia is used for removing grease stains from warm clothes.
- (iii) Aqueous solution of ammonia gives a pungent smell.
- (iv) Aqueous solution of ammonia conducts electricity.

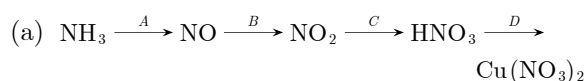
Ans :

COMP 2020

- (i) Liquid ammonia is used as a refrigerant because its latent heat of vaporisation is very high (5700 calories per gram). This heat is taken from the surrounding bodies which are consequently cooled down.
- (ii) Aqueous solution of ammonia acts as a solvent for grease and hence cleans it.
- (iii) When aqueous solution of ammonia (ammonium hydroxide) is kept exposed to air, ammonia gas is evolved due to which it gives a pungent smell.
- (iv) Aqueous solution of ammonia conducts electricity due to the presence of ions (NH_4^+ and OH^-) in it.



226. How are the following conversions carried out ?
Give equations only.



- (b)

hazardous. Additionally, they have observed that the reaction speed varies significantly, leading to inconsistent yields. They are looking for ways to stabilize their process.

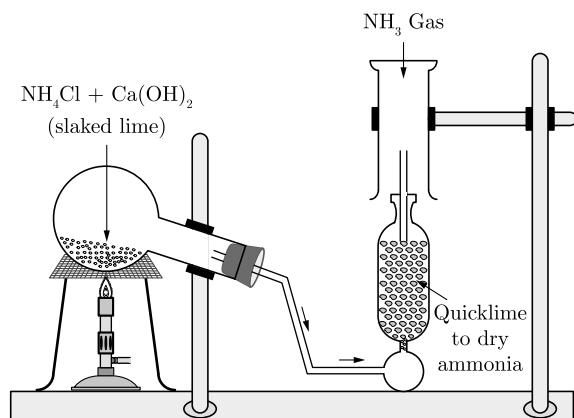
- (i) What could be causing the formation of nitrogen oxides during ammonia production?
- (ii) How can "GreenChem Corp." stabilize the reaction speed in ammonia production?
- (iii) Why is the formation of nitrogen oxides a concern in ammonia production?
- (iv) What adjustments can "GreenChem Corp." make to prevent nitrogen oxide formation?

Ans :

- (i) High temperatures or excess oxygen during the process.
- (ii) By maintaining consistent temperature and pressure conditions.
- (iii) Nitrogen oxides are harmful pollutants and can be dangerous if released into the environment.
- (iv) Lower the reaction temperature and ensure proper gas ratios.

- (iv) (a) Catalyst
(b) Promoter
(v) (a) By liquefaction.
(b) By dissolving in water.

- 229.** (i) What is the ratio of reactants taken in this process ? Why higher weight of ammonium chloride is taken ?
(ii) Why conc. sulphuric acid or anhydrous CaCl_2 is not used for drying ammonia ?

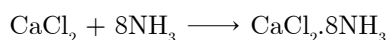
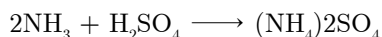


- (iii) Can you use ammonium nitrate in the above reaction ? If not, why ?
(iv) The reaction mixture is gently heated. Why high temperature is not, used ?
(v) Give two reasons why ammonia is collected by downward displacement of air.

Ans :

COMP 2000

- (i) 2 : 3. To avoid loss of ammonium chloride due to sublimation, higher ratio of alkali is used.
(ii) Because they react with ammonia.



- (iii) No, because it is explosive in nature and decomposes to give nitrous oxide and water vapour.
(iv) The reaction mixture should be gently heated otherwise ammonium chloride will sublime resulting in lower yield.
(v) (i) As it is highly soluble in water.
(ii) It is lighter than air.

CASE BASED QUESTION

- 230.** "AgriChem Industries" is focused on producing ammonia for fertilizers. Recently, they've noticed a significant drop in the solubility of ammonia

in water during the production process, leading to inefficiencies. Additionally, safety concerns have been raised due to the improper handling of drying agents. The management seeks solutions to optimize production and ensure safety.

- (i) What could be causing the decrease in ammonia solubility in water?
(ii) Why is the choice of drying agent crucial for ammonia production?
(iii) How can "AgriChem Industries" prevent safety issues related to drying agents?
(iv) What impact does temperature have on the solubility of ammonia in water?

Ans :

- (i) Incorrect temperature control during production.
(ii) Some drying agents react with ammonia, leading to contamination or loss.
(iii) Use quick lime, which does not chemically react with ammonia.
(iv) Higher temperatures reduce ammonia solubility.

- 231.** "SafeChem Ltd." is facing challenges with the storage of ammonia, where leaks have led to dangerous situations. The company is also concerned about the formation of unwanted by-products during ammonia synthesis. The management aims to enhance storage safety and improve the purity of their ammonia.

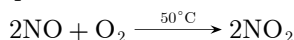
- (i) What material should "SafeChem Ltd." use for ammonia storage tanks to prevent leaks?
(ii) How can "SafeChem Ltd." minimize the formation of by-products during ammonia synthesis?
(iii) Why are leaks in ammonia storage particularly dangerous?
(iv) What steps can be taken to monitor and prevent ammonia leaks?

Ans :

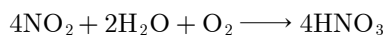
- (i) Stainless steel due to its resistance to ammonia.
(ii) Optimize reaction conditions and use pure reactants.
(iii) Ammonia is toxic and can cause respiratory issues or explosions if not handled properly.
(iv) Regular inspections and maintenance of storage tanks.

- 232.** "GreenChem Corp." has noticed that their ammonia production process occasionally results in the formation of nitrogen oxides, which are

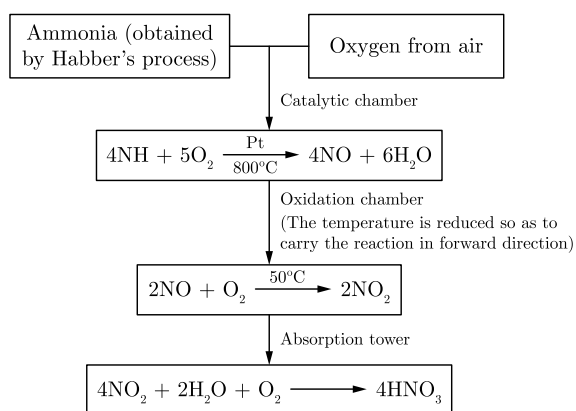
so that complete oxidation of Nitric oxide takes place.



- (c) Absorption Tower: The water slowly trickles down through the absorption tower, which is packed with quartz and nitrogen dioxide slowly rises up, get merged with water to form nitric acid. The quartz packing provides a greater surface area in which nitrogen dioxide comes in contact with water.



Flow Chart for the Manufacture of Nitric acid by Ostwald's process is given below :



1.3 Properties of Nitric Acid

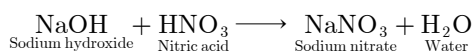
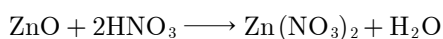
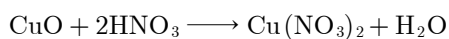
- Nitric acid is unstable and it decomposes even at room temperature.



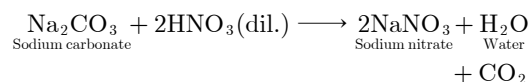
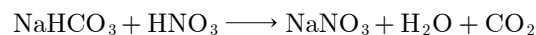
- Nitric acid is a typical monobasic acid. It gives all the properties of a dilute acid.
 - Dilute nitric acid shows characteristic colour change with indicators mentioned below:

	Indicators	Colour change
1.	Blue litmus	Red
2.	Phenolphthalein	Colourless
3.	Methyl orange	Red

- It reacts with metallic Oxides and metallic Hydroxides to form salt and water (neutralization).



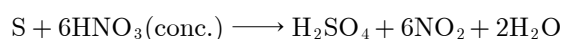
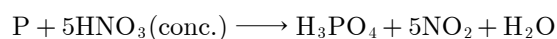
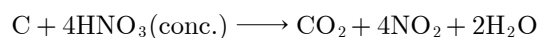
- It reacts with metallic Carbonates and metallic Bicarbonates to liberate Carbon dioxide.



Pure nitric acid is colourless, however the commercial sample of nitric acid is pale yellow in colour due to the presence of dissolved nitrogen dioxide.

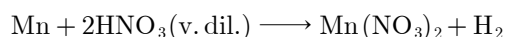
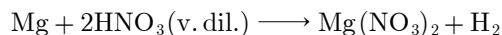
- Nitric acid is a strong oxidizing agent. It oxidises non-metals, metals and other compounds. Iron is rendered passive on reaction with concentrated Nitric acid.

Action with Non-Metals:

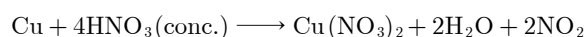
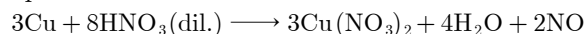


1.4 Action on Metals

As nitric acid is an oxidizing agent, therefore, it does not liberate hydrogen on reaction with metals. Only Magnesium and Manganese react with very dilute nitric acid to liberate hydrogen.

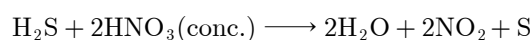


Nitric acid reacts with metals to produce metals nitrate and various oxides of nitrogen depending upon the concentration of nitric acid.



Copper dissolves in concentrated nitric acid to give blue coloured solution with the liberation of reddish brown gas having pungent smell which turns freshly prepared acidified ferrous sulphate solution brown black.

Compounds:



Nitric acid is used in the manufacture of dyes, paints, fertilizers, aqua-regia, etc.

1.5 Identification of Nitric Acid

This is tested in the same manner as test for NO_3^- ion and identification of NO_2 gas done in lab by using copper turnings and brown ring test.

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CHAPTER 10

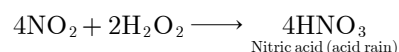
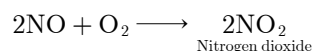
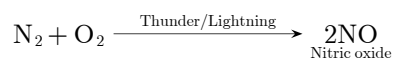
NITRIC ACID

SUMMARY

1. NITRIC ACID

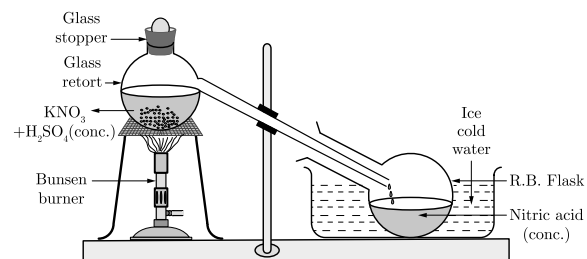
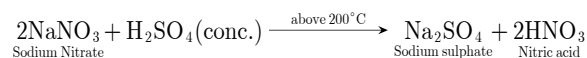
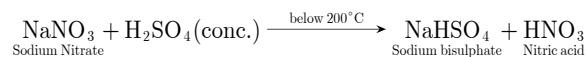
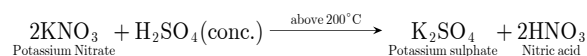
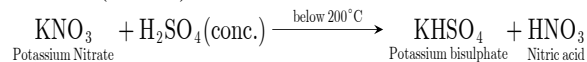
Nitric acid is commonly called as aqua fortis, i.e. strong water. Glauber first prepared Nitric acid by distilling mixture of nitre and concentrated Sulphuric acid.

Traces of Nitric acid come on to the earth in the form of Acid rain.



1.1 Preparation of Nitric Acid in Laboratory

In laboratory, Nitric acid is prepared by distilling either Sodium nitrate (NaNO_3) or Potassium nitrate (KNO_3) with concentrated Sulphuric acid.



The reaction mixture should not be heated beyond 200°C because Nitric acid decomposes at higher temperatures. Above 200°C sodium sulphate forms a hard crust which sticks to the

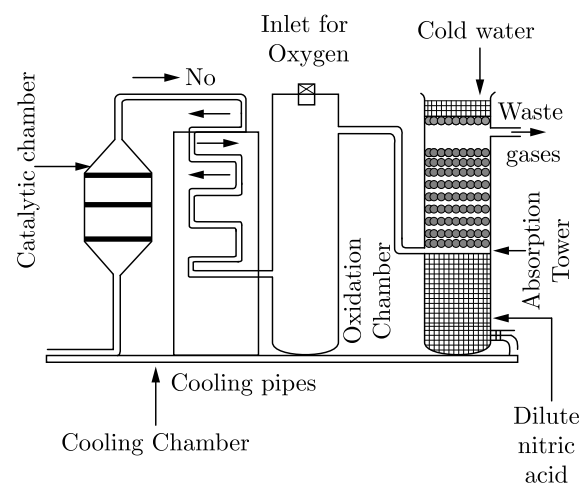
wall of apparatus and is very difficult to remove and apparatus gets damaged.



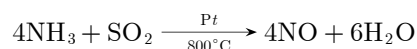
The apparatus used for the preparation of Nitric acid must be made of all glass as the vapours of Nitric acid are corrosive, therefore, it damages the rubber and cork. Vapours of nitric acid get condensed into pale yellow liquid by cooling the receiver with the cold water. In this way, the nitric acid gets collected. Pure Nitric acid is colourless however commercial sample of Nitric acid is pale yellow in colour due to the presence of dissolved Nitrogen dioxide.

1.2 Preparation of Nitric Acid by in Laboratory

Nitric acid is manufactured by Oswald's process as shown in the figure.



- (a) Catalytic oxidation of Ammonia: The gases entering the catalytic chamber must be absolutely pure, otherwise it would poison the catalyst. Only the initial heating of the catalyst is required as the reaction is exothermic.



- (b) Oxidation Chamber: Before entering the oxidation chamber, the gases must be cooled

- (ii) Ammonia is passed over heated Copper oxide.
- (iii) Ammonium dichromate is heated.
- (iv) Excess of chlorine gas is reacted with ammonia gas.
- (v) A few drops of dilute hydrochloric acid are added to silver nitrate solution, followed by addition of ammonium hydroxide solution.

Ans :

COMP 2015

- (i) Dense white fumes are observed.
- (ii) Black coloured Copper oxide changes to Pinkish red metal, a colourless liquid is obtained which turns anhydrous Copper sulphate blue and a colourless, odourless gas is evolved which is neither combustible nor it is a supporter of combustion and does not turn lime water milky.
- (iii) On heating Ammonium dichromate, exothermic reaction takes place and the green mass erupts in the form of volcano.
- (iv) Greenish yellow colour disappears.
- (v) White precipitate appears which is soluble in excess of NH_4OH .

219. The following questions are based on the preparation of ammonia gas in the laboratory:

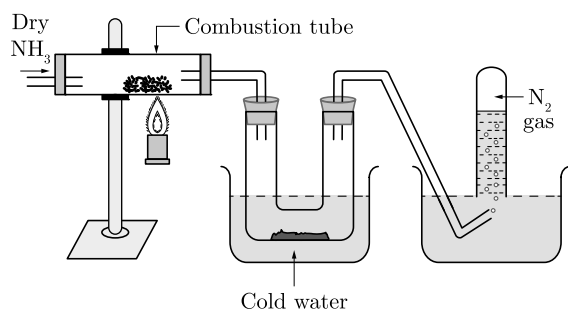
- (i) Explain why ammonium nitrate is not used in the preparation of ammonia.
- (ii) Name the compound normally used as a drying agent during the process.
- (iii) How is ammonia gas collected?
- (iv) Explain why it is not collected over water.

Ans :

SQP 2012

- (i) Ammonium nitrate is explosive.
- (ii) Quick lime.
- (iii) Downward displacement of air.
- (iv) Highly or extremely soluble in water.

- 220.** (i) Which property of ammonia is depicted in the given diagram ?
 (ii) What is taken in combustion tube ?



- (iii) Enlist your observations if the compound taken in combustion tube is (a) CuO , (b)

PbO . (Also give equations)

- (iv) Give the function of cold water.

Ans :

MAIN 2014

- (i) Reducing agent.
- (ii) Oxides are taken in the combustion tube.
- (iii) (a)
$$\underset{\text{Black}}{3\text{CuO}} + 2\text{NH}_3 \xrightarrow{\Delta} \underset{\text{Reddish}}{3\text{Cu}} + \text{N}_2 + 3\text{H}_2\text{O}$$
 (b)
$$\underset{\text{Yellow}}{3\text{PbO}} + 2\text{NH}_3 \xrightarrow{\Delta} \underset{\text{White}}{3\text{Pb}} + \text{N}_2 + 3\text{H}_2\text{O}$$
- (iv) Cold water condenses the water vapours formed during the reaction.

- 221.** (i) Name the method used for obtaining ammonia on a large-scale.
 (ii) What is the actual ratio of the reactants?
 (iii) Are the reactants necessarily taken in the same ratio ? Explain.
 (iv) The temperature used is 450°C . Explain why
 (a) A lower temperature is not used.
 (b) A higher temperature is not used.

Ans :

MAIN 2014

- (i) Haber's process.
- (ii) Nitrogen and hydrogen are taken in the ratio 1 : 3 by volume.
- (iii) No, if we take an excess of N_2 or H_2 the rate of formation of ammonia will be more.
- (iv) (a) At a temperature lower than 450°C , the reaction slows down and yield of ammonia will decrease.
 (b) At a temperature above 450°C , the ammonia formed would decompose to give nitrogen and hydrogen.

- 222.** (a) How would you obtain compound Magnesium nitride?
 (b) Which property of Ammonia is illustrated by reaction (a) (ii) above?
 (c) What is the name of important industrial process that starts with reaction (a) (iv) above? Name the catalyst used.
 (d) During laboratory preparation how is Ammonia dried and collected?

Ans :

SQP 2016

- (a) By introducing burning Magnesium in the jar of Nitrogen.
- (b) Reducing property.
- (c) Ostwald's process for the manufacture of Nitric acid. The catalyst used is Platinum.
- (d) Ammonia is dried by passing through Quick lime, i.e. Calcium oxide and collected by the downward displacement of air.

MULTIPLE CHOICE QUESTION

1. A nitrate which forms a precipitate with ammonium hydroxide and is also soluble in excess of it:

(a) ferrous nitrate (b) ferric nitrate
(c) lead nitrate (d) copper nitrate

Ans :

SQP 2025

A nitrate which forms a precipitate with ammonium hydroxide and is also soluble in excess of it.

Thus (d) is correct option.

2. The brown ring test is used for detection of

(a) CO_3^{2-} (b) NO_3^-
(c) SO_3^{2-} (d) Cl^-

Ans :

COMP 2011

Brown ring test is used for the detection of nitrate ions in a solution.

Thus (b) is correct option.

3. The compound responsible for the brown ring during the brown ring test of nitrate ion.

(a) Nitrosoiron(II) sulphate
(b) Iron(III) chloride
(c) Chromium sulphate
(d) Lead(II) chloride

Ans :

COMP 2010

When ferrous sulphate combines with nitrogen oxide, it forms a molecule called Nitroso ferrous sulphate, which is responsible for brown ring development.

Thus (a) is correct option.

4. Nitrogen gas can be obtained by heating:

(a) Ammonium nitrate.
(b) Ammonium nitrite.
(c) Magnesium nitride.
(d) Ammonium chloride.

Ans :

SQP 2013

Thus (b) is correct option.

5. Brown gas formed by oxidation of NO.

(a) Nitrogen dioxide NO_2
(b) Nitrate ion NO_3^-
(c) Nitrogen N_2
(d) None of the above

Ans :

SQP 2016

“Nitric oxide reacts with oxygen to form reddish

brown nitrogen dioxide gas”.

Thus (a) is correct option.

6. Aqua regia is a mixture of:

(a) Dilute hydrochloric acid and concentrated nitric acid
(b) Concentrated hydrochloric acid and dilute nitric acid
(c) Concentrated hydrochloric acid [1 part] and concentrated nitric acid [3 parts]
(d) Concentrated hydrochloric acid [3 parts] and concentrated nitric acid [1 part]

Ans :

MAIN 2010

Aqua regia is a mixture of hydrochloric acid and nitric acid present in the ratio 3:1, i.e. the volume of solution is 3 parts of hydrochloric acid and 1 part of nitric acid.

Thus (d) is correct option.

7. Yellow colour of nitric acid is due to dissolved.

(a) NO_2 (b) NH_3
(c) O_2 (d) NO_3

Ans :

SQP 2002

Thus (a) is correct option.

8. The Molecular weight of nitric acid.

(a) 53 a.m.u. (b) 50 a.m.u.
(c) 60 a.m.u. (d) 63 a.m.u.

Ans :

MAIN 2008

Molecular mass of HNO_3

$$= 1 + 14 + (16 \times 3) = 63 \text{ u}$$

Thus (d) is correct option.

9. Nitric acid was also known as :

(a) aqua fortis (b) aqua guard
(c) aqua hydroxide (d) aqua nitrate

Ans :

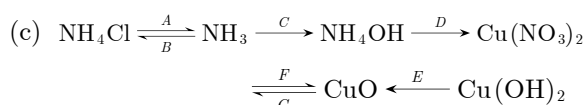
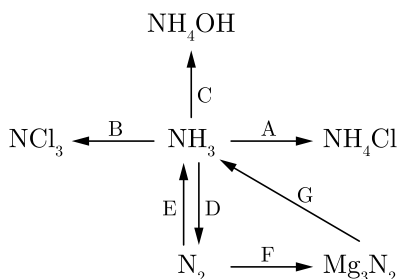
COMP 2012

Nitric acid (HNO_3), also known as aqua fortis (Latin for “strong water”) or spirit of niter, is a highly corrosive mineral acid. Nitric acid reacts with most metals, but the details depend on the concentration of the acid and the nature of the metal.

Thus (a) is correct option.

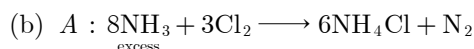
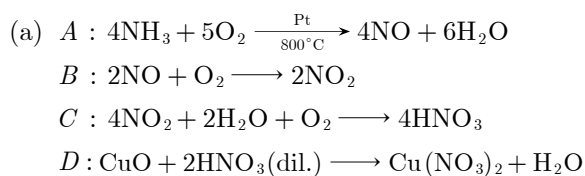
10. Which acid is used for brown ring test ?

(a) Sulphuric acid
(b) Carbonic acid
(c) Hydrochloric acid
(d) Sulphurous acid

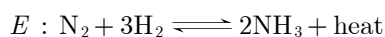
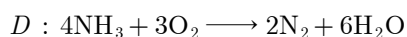
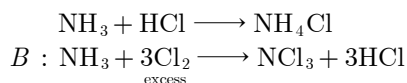


Ans :

SQP 2000



or

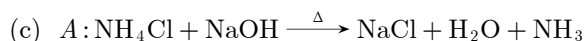
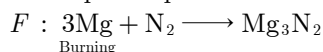


Catalyst – Iron

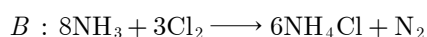
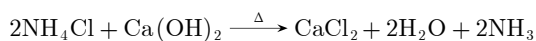
Promoter – Molybdenum

Temperature – 450-500°C

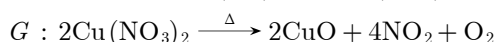
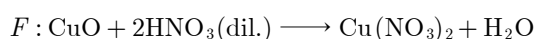
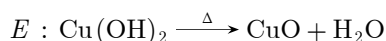
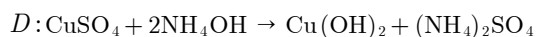
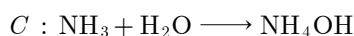
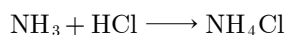
Atmospheric pressure – 200 -1000 atm



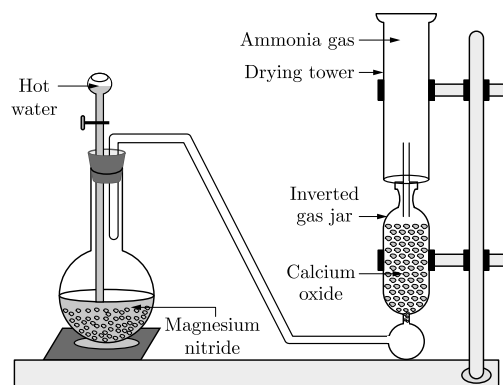
or



or



221. (i) Give the reaction which takes place between the reactants.
 (ii) What is the function of calcium oxide ?



- (iii) What is the function of inverted gas jar ?
 (iv) Can we use phosphorous pentaoxide to dry ammonia ? If not, why ?
 (v) Which method for collection of gas is shown in the diagram ?
 (vi) What happens to the product ?

Ans :

COMP 2007

- (i) $\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2 + 2\text{NH}_3$
 (ii) It acts as a drying agent.
 (iii) To collect ammonia.
 (iv) No, we cannot use P_2O_5 because it reacts with ammonia.

$$6\text{NH}_3 + \text{P}_2\text{O}_5 + 3\text{H}_2\text{O} \longrightarrow 2(\text{NH}_4)_3\text{PO}_4$$

 (v) Downward displacement of air.
 (vi) $\text{Mg}(\text{OH})_2$ will remain in the flask whereas NH_3 gas escapes through the delivery tube.

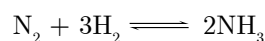
222. Ammonia is manufactured by Haber's process.

- (i) Under what conditions do the reactants combine to form ammonia ? Give a balanced equation for the reaction.
 (ii) In what ratio by volume, are the above gases used ?
 (iii) State one possible source of each reactant used in Haber's process.
 (iv) What is the function of :
 (a) finely divided iron,
 (b) molybdenum in the above process ?
 (v) Mention two possible ways by which ammonia produced is removed from unchanged gases.

Ans :

MAIN 2008

- (i) Temperature – 450 – 500°C
 Pressure – 200 – 900 atm.
 Catalyst – Finely divided iron
 Promoter – Molybdenum



- (ii) In the ratio 1 : 3 by volume
 (iii) N_2 is obtained from air.
 H_2 is obtained from water and water gas.



Thus (a) is correct option.

- 22.** Diammonium hydrogen phosphate, $(\text{NH}_4)_2\text{HPO}_4$, is a widely used fertiliser. Which of the following substance could be added to this compound to produce a mixture that provides the three principle elements needed for plant growth?
- Magnesium nitrate
 - Ammonium sulphate
 - Ammonium phosphate
 - Potassium chloride

Ans :

COMP 2023

Thus (d) is correct option.

- 23.** HNO_3 in pure state is colourless but it is often of yellow colour. It is due of
- unstable structure of HNO_3 which immediately changes to NO_2
 - conversion of HNO_3 into NO^+
 - interaction of atmospheric gases with HNO_3
 - photochemical decomposition in presence of sunlight.

Ans :

MAIN 2017

The pure state of HNO_3 is colourless, but is often of yellow colour due to photochemical decomposition into oxides of nitrogen and water. Thus (d) is correct option.

- 24.** Nitric acid in its pure state is colourless but laboratory nitric acid is slightly yellow or brown due to dissolved:
- Nitrogen dioxide
 - Nitrogen monoxide
 - Chlorine
 - None of these

Ans :

COMP 2005

Nitric acid in its pure state is colorless but in laboratory Nitric acid is slightly yellow or brown due to dissolved Nitrogen dioxide.

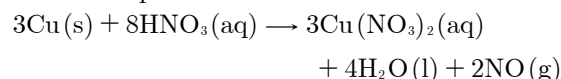
Thus (a) is correct option.

- 25.** The gas liberated when metals like copper reacts with cold and dilute nitric acid.
- Oxygen $[\text{O}_2]$
 - Nitric Oxide $[\text{NO}]$
 - Nitrogen (N_2)
 - Cupric Oxide (CuO)

Ans :

SQP 2000

When copper reacts with cold and dilute nitric acid, it liberates nitric oxide (NO) gas. The chemical equation for this reaction is



Thus (b) is correct option.

- 26.** A nitrate which evolves laughing gas on decomposition:
- Sodium nitrate
 - Calcium nitrate
 - Ammonium nitrate
 - Ferric nitrate

Ans :

SQP 2002

When Ammonium nitrate decomposes it gives Nitrous oxide and water vapors. Nitrous oxide is also known as laughing gas and continuous breathing of this gas diminishes the decision-making process.

Thus (c) is correct option.

- 27.** Material used to slow down the speed of gases in absorption tower.
- Platinum
 - Gold
 - Silver
 - Quartz

Ans :

MAIN 2023

Thus (d) is correct option.

- 28.** The nitrogen gas used in Haber's process is obtained by the
- decomposition of nitrate
 - fractional distillation of air
 - decomposition of nitrogen by bacteria
 - decomposition of nitrite

Ans :

COMP 2001

Thus (b) is correct option.

- 29.** A non metal which reacts with conc. nitric acid leaving no residue behind.
- Hydrazine (N_2H_4)
 - Ammonium $[\text{NH}_4\text{NO}_3]$
 - Ammonium Chloride (NH_4Cl)
 - Ammonia $[\text{NH}_3]$

Ans :

SQP 2008

Thus (b) is correct option.

- 30.** What poisons the catalytic chamber ?
- Nitrogen monoxide
 - Impurities
 - Platinum gauze
 - Excess air

Ans :

MAIN 2022

Thus (b) is correct option.

A nitrate which decrepitates and produces a yellow residue which fuses with the test tube :

- Silver nitrate
- Lead nitrate
- Zinc nitrate
- Mercuric nitrate

Ans :

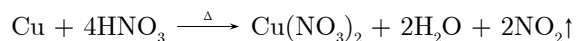
MAIN 2016

Thus (b) is correct option.

DIRECTION : Write balanced chemical equations for the following:

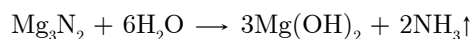
- 117.** Action of heat on a mixture of copper and concentrated nitric acid.

Ans : COMP 2014



- 118.** Action of warm water on magnesium nitride.

Ans : MAIN 2014



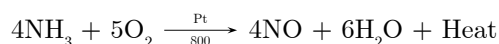
- 119.** Action of conc. Nitric acid on Sulphur.

Ans : SQP 2017



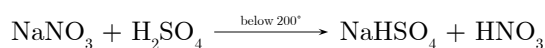
- 120.** Catalytic oxidation of Ammonia.

Ans : MAIN 2017



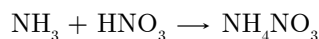
- 121.** Laboratory preparation of Nitric acid.

Ans : COMP 2017



- 122.** Reaction of Ammonia with Nitric acid.

Ans : COMP 2017



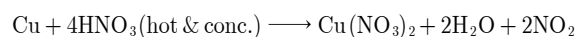
- 123.** Oxidation of carbon with concentrated nitric acid.

Ans : MAIN 2013



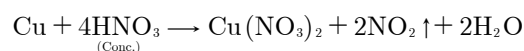
- 124.** Action of hot and concentrated Nitric acid on copper.

Ans : COMP 2014, 2016



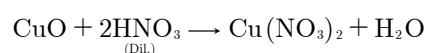
- 125.** Copper and concentrated nitric acid.

Ans : MAIN 2012



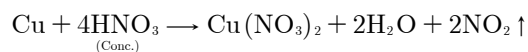
- 126.** Copper oxide and dilute nitric acid.

Ans : COMP 2023



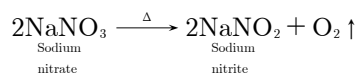
- 127.** Action of concentrated nitric acid on copper.

Ans : MAIN 2003



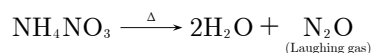
- 128.** Action of heat on sodium nitrate.

Ans : COMP 2006



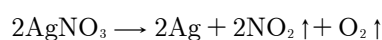
- 129.** Action of heat on ammonium nitrate.

Ans : MAIN 2017



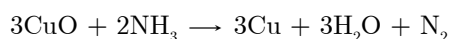
- 130.** Action of heat on AgNO_3 .

Ans : SQP 2022



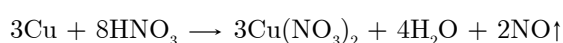
- 131.** Reduction of hot Copper(II) oxide to copper using ammonia gas.

Ans : COMP 2013



- 132.** Action of cold and dilute Nitric acid on Copper.

Ans : COMP 2017



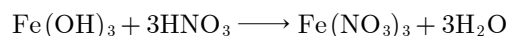
- 133.** Reaction of carbon powder and concentrated nitric acid.

Ans : COMP 2020



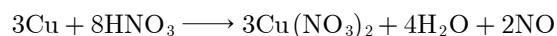
- 134.** Ferric hydroxide with nitric acid.

Ans : MAIN 2014



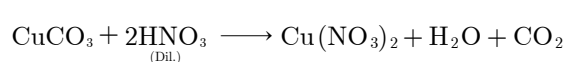
- 135.** Dilute nitric acid and copper

Ans : MAIN 2001



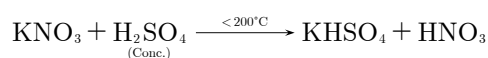
- 136.** Dilute nitric acid and copper carbonate.

Ans : COMP 2018



- 137.** Write a balanced chemical equation for the preparation of nitric acid from potassium nitrate.

Ans : COMP 2023



Ans :

SQP 2019

Thus (a) is correct option.

44. Nitric acid was also called as

- (a) aqua-regia (b) aqua nitrate
(c) aqua fortis (d) aqua hydroxide

Ans :

SQP 2005

Thus (c) is correct option.

45. A metal which reacts with very dilute nitric acid is :

- (a) Magnesium (b) Calcium
(c) Copper (d) Zinc

Ans :

MAIN 2002

Thus (a) is correct option.

ASSERTION AND REASON

46. Assertion : Nitric acid is a strong oxidizing agent.**Reason :** Nitric acid decomposes at room temperature to release oxygen.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

SQP 2002

Nitric acid is a strong oxidizing agent, but the release of oxygen from its decomposition is not the reason for its oxidizing nature.

Thus (b) is correct option.

47. Assertion : Pure nitric acid is colorless.**Reason :** The pale yellow color of commercial nitric acid is due to the presence of dissolved nitrogen dioxide.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

COMP 2010

Pure nitric acid is indeed colorless and the pale yellow color observed in commercial samples is due to dissolved nitrogen dioxide.

Thus (a) is correct option.

48. Assertion : Nitric acid reacts with most metals to produce hydrogen gas.**Reason :** Nitric acid is a strong acid and reacts with metals to produce hydrogen gas.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

MAIN 2015

Nitric acid, being a strong oxidizing agent, usually does not produce hydrogen gas when reacting with metals; instead, it produces oxides of nitrogen.

Thus (c) is correct option.

49. Assertion : Nitric acid does not liberate hydrogen gas when reacting with metals, except magnesium and manganese.**Reason :** Nitric acid is a strong oxidizing agent.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

The strong oxidizing nature of nitric acid usually prevents the liberation of hydrogen gas, except in the cases of magnesium and manganese.

Thus (a) is correct option.

50. Assertion : Nitric acid turns blue litmus paper red.**Reason :** Nitric acid is a strong acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true, but reason is false.
(d) Assertion is false, but reason is true.

Ans :

SQP 2008

Nitric acid is a strong acid and like other acids, it turns blue litmus paper red.

Thus (a) is correct option.

51. Assertion : Concentrated nitric acid renders iron passive.**Reason :** Concentrated nitric acid forms a protective oxide layer on iron, preventing further reaction.

77. Action of cold and dilute nitric acid on copper.

Ans : MAIN 2000

Nitrogen monoxide.

78. The gas produced by the action of dilute nitric acid on copper.

Ans : COMP 2009

Nitric oxide (NO)

79. The gas produced on heating sodium nitrate.

Ans : SQP 2009

Oxygen (O₂)

80. Action of concentrated nitric acid on copper.

Ans : MAIN 2018

Nitrogen dioxide.

81. Heating of ammonium nitrate (name only the nitrogen containing compound)

Ans : COMP 2022

Nitrous oxide (N₂O).

DIRECTION : Identify the following :

82. The acid on mixing with lead nitrate solution produces a white precipitate which is insoluble even on heating.

Ans : MAIN 2015

Sulphuric acid.

83. Sulphur is treated with concentrated nitric acid.

Ans : SQP 2013

Nitrogen dioxide.

84. The dilute acid which is an oxidizing agent.

Ans : SQP 2019

Nitric acid

85. sulphur is treated with concentrated nitric acid.

Ans : MAIN 2013

Nitrogen dioxide

86. a few crystals of KNO₃ are heated in a hard glass test tube.

Ans : COMP 2013

Oxygen

DIRECTION : Some word/words are missing in the following statement. You are required to rewrite the statement in the correct form using the appropriate word/words:

87. Aqua regia contains one part by volume of nitric acid and three parts by volume of hydrochloric acid.

Ans : MAIN 2012

Aqua regia contains one part of concentrated nitric acid and three parts of concentrated hydrochloric acid.

88. Magnesium reacts with nitric acid to liberate hydrogen gas.

Ans : SQP 2017

Magnesium reacts with very dilute nitric acid (1%) to liberate hydrogen gas.

DIRECTION : Complete and balance the following equations.

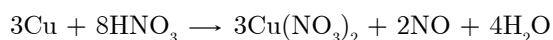
89. S + conc. HNO₃ →

Ans : MAIN 2009



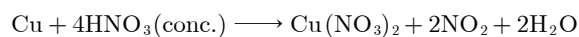
90. Cu + dil.HNO₃ →

Ans : SQP 2009



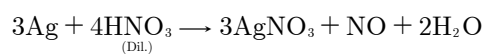
91. Cu + HNO₃ → ----- + NO₂ + -----

Ans : MAIN 2010



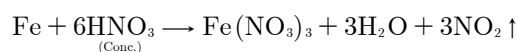
92. Ag + HNO₃ →
(Conc.)

Ans : COMP 2010



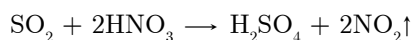
93. Fe + HNO₃ →
(Conc.)

Ans : MAIN 2015



94. SO₂ + HNO₃ →

Ans : SQP 2005



Ans : COMP 2017
Silver nitrate

60. A nitrate which on heating leaves no residue behind.

Ans : MAIN 2022
Ammonium nitrate

61. Name two metals which react with very dilute nitric acid.

Ans : SQP 2023
Magnesium and manganese.

62. Name a nitrate which on heating gives oxygen as the only gaseous product.

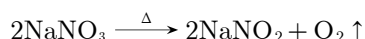
Ans : COMP 2017
Sodium or potassium nitrate.

63. Name a solution which gives nitrogen dioxide with copper.

Ans : COMP 2011
Concentrated nitric acid.

64. Name a nitrate of a metal which on heating does not give nitrogen dioxide.

Ans : MAIN 2019
Sodium nitrate



65. Name all the products formed when : ammonium nitrate is heated.

Ans : SQP 2010
The products formed when ammonium nitrate is heated are nitrous oxide and water (steam).



DIRECTION : Fill in the blank from the choices given within bracket:

66. Cold, dilute nitric acid reacts with copper to give _____. (Sulphur dioxide, Nitric oxide, Sulphuric acid, Nitrogen dioxide,)

Ans : MAIN 2016
nitric oxide

67. Hot concentrated nitric acid reacts with sulphur to form _____. (Sulphur dioxide, Nitrogen dioxide, Nitric oxide, Sulphuric acid)

Ans : MAIN 2016
sulphuric acid.

68. Cold, dilute nitric acid reacts with copper to form _____ (Hydrogen, nitrogen dioxide, nitric oxide).

Ans : SQP 2014
Nitric oxide.

69. Nitric acid is a _____, _____ acid.

Ans : COMP 2022
strong, mono-basic

70. The salts of nitric acid are called _____.

Ans : MAIN 2023
nitrates

71. Rain water contains the traces of _____ acid.

Ans : COMP 2008
nitric

72. Sulphur on reaction with concentrated Nitric acid produces _____ acid.

Ans : COMP 2012
sulphuric

73. Nitric acid in laboratory is prepared by the reaction of _____ and _____ acid.

Ans : SQP 2021
Potassium nitrate, concentrated Sulphuric

DIRECTION : Name the gas in the following :

74. The gas produced when copper reacts with concentrated nitric acid.

Ans : MAIN 2012
Nitrogen dioxide

75. The catalyst used in the manufacture of nitric acid by Ostwald's process.

Ans : COMP 2011
Platinum.

76. Sulphur is oxidized by concentrated nitric acid.

Ans : SQP 2018
Nitrogen dioxide

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2018

The passive state of iron in concentrated nitric acid is due to the formation of a protective oxide layer on its surface.

Thus (a) is correct option.

- 52. Assertion :** Nitric acid can be used to oxidize non-metals such as carbon and sulfur.

Reason : Nitric acid reacts with non-metals to form their respective oxides and nitrogen dioxide.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2009

Nitric acid oxidizes non-metals such as carbon and sulfur, producing their oxides and nitrogen dioxide.

Thus (a) is correct option.

- 53. Assertion :** Nitric acid is used in the manufacture of fertilizers.

Reason : Nitric acid provides nitrogen, which is an essential nutrient for plant growth.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2020

Nitric acid is used in fertilizer production because it provides nitrogen, which is vital for plant growth.

Thus (a) is correct option.

- 54. Assertion :** Aqua regia can dissolve gold and platinum.

Reason : Aqua regia is a mixture of concentrated hydrochloric acid and concentrated nitric acid.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.

- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2010

Aqua regia, a mixture of concentrated hydrochloric acid and nitric acid, can dissolve noble metals like gold and platinum due to its highly reactive nature.

Thus (a) is correct option.

- 55. Assertion :** Nitric acid decomposes upon exposure to light.

Reason : Nitric acid is a strong acid and decomposes into nitrogen dioxide, water and oxygen.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2004

Nitric acid decomposes upon exposure to light, releasing nitrogen dioxide, water and oxygen, but this decomposition is not because it is a strong acid.

Thus (b) is correct option.

NODIA

ONE MARK QUESTIONS

DIRECTION : Name the following :

- 56.** A solution which absorbs nitric oxide.

Ans :

SQP 2002

Ferrous-sulphate solution

- 57.** A nitrate of metal which on heating does not give nitrogen dioxide.

Ans :

MAIN 2010

Sodium nitrate

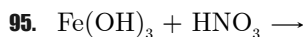
- 58.** A metal nitrate which on heating is changed into metal oxide.

Ans :

SQP 2017

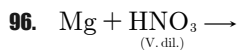
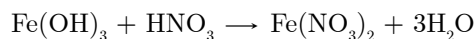
Copper nitrate

- 59.** A metal nitrate which on heating is changed into metal.



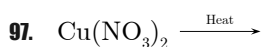
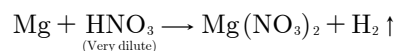
Ans :

MAIN 2007



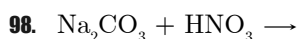
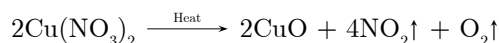
Ans :

COMP 2020



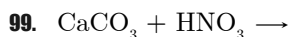
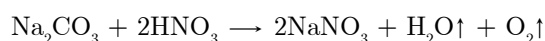
Ans :

COMP 2018



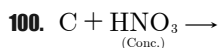
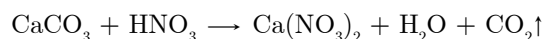
Ans :

SQP 2007



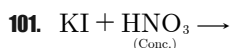
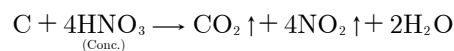
Ans :

MAIN 2002



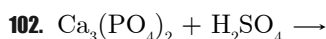
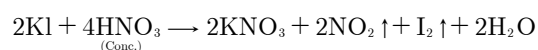
Ans :

MAIN 2002



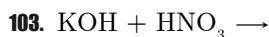
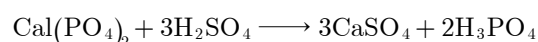
Ans :

COMP 2019



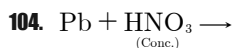
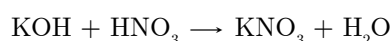
Ans :

SQP 2010



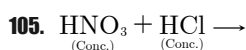
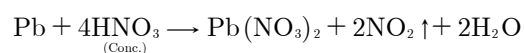
Ans :

MAIN 2016



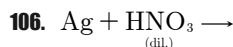
Ans :

COMP 2002



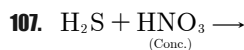
Ans :

SQP 2013



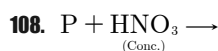
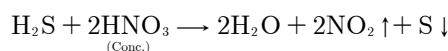
Ans :

COMP 2010



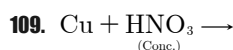
Ans :

MAIN 2005



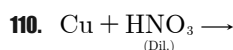
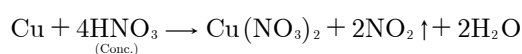
Ans :

SQP 2008



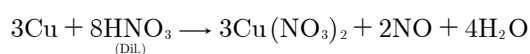
Ans :

COMP 2016



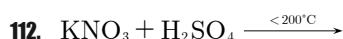
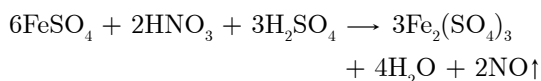
Ans :

MAIN 2009



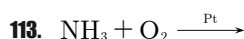
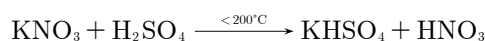
Ans :

SQP 2000



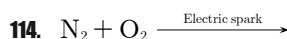
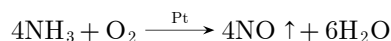
Ans :

COMP 2014



Ans :

MAIN 2005



Ans :

MAIN 2004



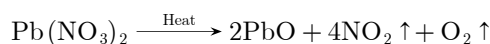
Ans :

COMP 2013



Ans :

SQP 2018



32. Chloride formed when nitric acid and hydrochloric acid reacts together.

(a) Ammonium chloride
(b) Hydrochloric acid
(c) Nitrosyl Chloride
(d) Ammonia

Ans :

COMP 2021

Thus (c) is correct option.

33. The molecular formula of nitric acid is

(a) NaNO_3 (b) KNO_3
(c) HNO_3 (d) None of these

Ans :

SQP 2013

Thus (c) is correct option.

34. Nitric acid turns orange coloured methyl orange.

(a) Red (b) Orange
(c) Pink (d) Blue

Ans :

COMP 2018

Thus (c) is correct option.

35. Catalyst used in Ostwald's process.

(a) Gold (b) Silver
(c) Platinum (d) Silver Nitrate

Ans :

MAIN 2004

Thus (c) is correct option.

36. How many lone pair(s) involved in the formation of coordinate bond(s) in nitric acid?

(a) 4 (b) 2
(c) 3 (d) 1

Ans :

COMP 2014

Thus (d) is correct option.

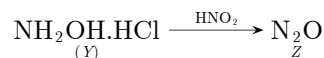
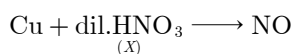
37. Copper on reduction with dilute HNO_3 produces a gas 'X'. This gas on reduction with SnCl_2/HCl forms 'Y', which on further oxidations gives Z. Identify X, Y, Z

(a) $\text{X} = \text{NO}$, $\text{Y} = \text{NH}_2\text{OH}$, $\text{Z} = \text{N}_2\text{O}$
(b) $\text{X} = \text{NO}$, $\text{Y} = \text{NH}_2\text{OH}.\text{HCl}$, $\text{Z} = \text{N}_2\text{O}$
(c) $\text{X} = \text{NO}_2$, $\text{Y} = \text{NH}_2\text{OH}$, $\text{Z} = \text{N}_2\text{O}$
(d) $\text{X} = \text{NO}$, $\text{Y} = \text{NH}_2\text{OH}.\text{HCl}$, $\text{Z} = \text{NO}_2$

Ans :

MAIN 2018

Cu produces NO gas when treated with dil. HNO_3 . This gas is reduced by SnCl_2/HCl and then oxidised by HNO_2 to give N_2O . The reactions are as follows



Thus (c) is correct option.

38. Molecular formula of chile salt petre.

(a) NaNO_3 (b) Na_2SO_4
(c) CaCO_3 (d) CH_3NH_2

Ans :

SQP 2007

Thus (a) is correct option.

39. Which acid does not evolve H_2 gas with metals?

(a) H_2SO_4 (b) HNO_3
(c) HCl (d) All of these

Ans :

MAIN 2015

Thus (b) is correct option.

40. Black insoluble compound which on reacting with nitric acid turns into blue solution.

(a) Zinc Oxide $[\text{NH}_4\text{NO}_3]$
(b) Ferric Oxide Fe_2O_3
(c) Titanium Oxide TiO_2
(d) Copper Oxide CuO

Ans :

SQP 2003

Thus (d) is correct option.

41. Hard crust formed when chile salt petre and sulphuric acid reacts together.

(a) Na_2SO_4 (b) Na_2CO_3
(c) NaSiO_3 (d) NaCl

Ans :

MAIN 2021

Thus (a) is correct option.

42. Nitric acid turns a paper soaked in potassium iodide solution brown due to liberation of :

(a) Hydrogen iodide (b) Nitrogen dioxide
(c) Copper (d) Iodine

Ans :

COMP 2020

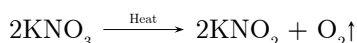
Thus (d) is correct option.

A fertiliser containing ammonium sulphate and calcium carbonate is sometimes used by agricultural farmers. Why is the fertiliser useful?

(a) It provides nitrogen required for plant growth while reducing the acidity of the soil.
(b) It provides all the essential nutrients required for plant growth
(c) It provides both nitrogen and carbon dioxide required for plant growth
(d) It helps to reduce excess acidity of the soil.

- 138.** Write an equation for the following reaction :
Action of heat on potassium nitrate.

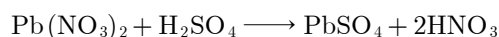
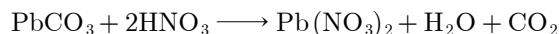
Ans : SQP 2022



- 139.** Give balanced chemical equations to produce the following salts:

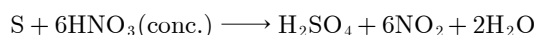
Lead sulphate from lead carbonate.

Ans : MAIN 2020



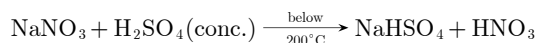
- 140.** Sulphur and hot concentrated nitric acid

Ans : MAIN 2012



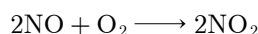
- 141.** Sodium nitrate and concentrated sulphuric acid

Ans : MAIN 2023



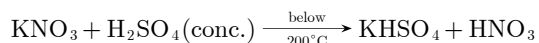
- 142.** Nitric oxide comes in contact with atmosphere.

Ans : SQP 2010



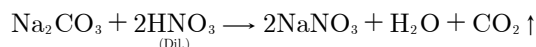
- 143.** Nitre reacts with concentrated Sulphuric acid.

Ans : SQP 2023



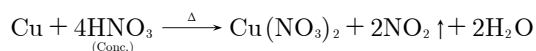
- 144.** Sodium carbonate reacts with dil. HNO_3 .

Ans : COMP 2015



- 145.** Between copper and concentrated nitric acid.

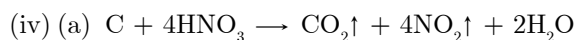
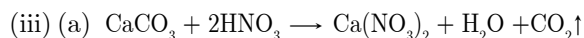
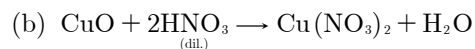
Ans : MAIN 2018



- 146.** Give two chemical equations for each one of the following :

- Reactions of nitric acid with non-metals.
- Nitric acid showing as acidic character.
- Reactions between nitric acid and inorganic compounds.
- Nitric acid acting as oxidising agent.

Ans : COMP 2003



DIRECTION : State one relevant observation for the following reaction :

- 147.** Action of concentrated nitric acid on copper.

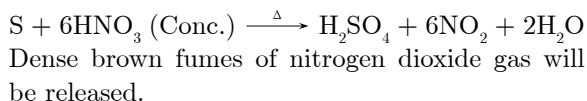
Ans : COMP 2011



The solution turns blue with the liberation of a dark brown gas.

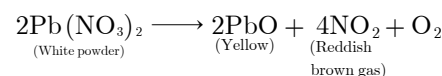
- 148.** Concentrated nitric acid is reacted with sulphur.

Ans : SQP 2019



- 149.** Lead nitrate is heated strongly in a test tube.

Ans : MAIN 2019



White powder of lead nitrate decompose to form yellow coloured lead oxide and liberating dense brown fumes of nitrogen dioxide gas.

DIRECTION : Correct the following, if required :

- 150.** HNO_3 is a strong reducing agent.

Ans : SQP 2017

HNO_3 is a strong oxidising agent.

- 151.** Nitric acid remains colourless even when exposed to light.

Ans : COMP 2015

Nitric acid becomes yellow when exposed to light.

- 152.** Constant boiling nitric acid contains 80% HNO_3 by weight.

Ans : MAIN 2001

Constant boiling nitric acid contains 68% HNO_3 by weight.

153. NaNO_3 gives NO_2 and O_2 on heating.

Ans :

SQP 2023

NaNO_3 gives O_2 on heating.

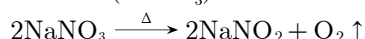
DIRECTION : Give one example of each one of the following:

154. A nitrate of metal which on heating does not give nitrogen dioxide.

Ans :

SQP 2007

Sodium nitrate (NaNO_3)

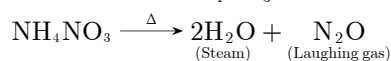


155. A nitrate which on heating leaves no residue behind.

Ans :

MAIN 2021

Ammonium nitrate (NH_4NO_3)

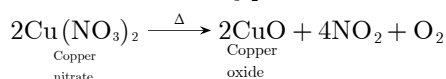


156. A metal nitrate which on heating is changed into metal oxide.

Ans :

SQP 2020

Copper nitrate [$\text{Cu}(\text{NO}_3)_2$]



157. A metal nitrate which on heating is changed into metal.

Ans :

COMP 2009

Silver nitrate (AgNO_3)



DIRECTION : Give reason for the following :

158. Iron is rendered passive with fuming nitric acid.

Ans :

MAIN 2012

Iron is rendered passive with fuming HNO_3 because of formation of reddish brown layer of iron oxide which prevents its further reaction with the acid.

DIRECTION : Answer the following :

159. Identify the reactant and write the balanced equation for the following:

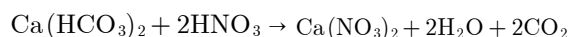
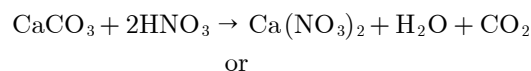
Nitric acid reacts with compound Q to give a salt

$\text{Ca}(\text{NO}_3)_2$, water and carbon dioxide.

Ans :

SQP 2025

Q is Calcium carbonate/ calcium bicarbonate



160. Choose from the following list of substances, as to what matches the description given below :

[Acetylene gas, aqua fortis, coke, brass, barium chloride, bronze, platinum]

A catalyst used in the manufacture of nitric acid by Ostwald's process.

Ans :

COMP 2011

Platinum.

161. Correct the following statements.

For Example : 'Chlorine is a bleaching agent'.

Should read : 'Moist chlorine is a bleaching agent'.

Copper reacts with nitric acid to produce nitrogen dioxide.

Ans :

SQP 2009

Copper reacts with concentrated nitric acid to produce nitrogen dioxide.

162. State one relevant observation for the following :
When crystals of copper nitrate are heated in a test tube.

Ans :

MAIN 2015



163. State two relevant observations for each of the following :

Lead nitrate crystals are heated in a hard glass test tube.

Ans :

MAIN 2013

1. A yellow coloured compound (PbO) is formed which fuses with the walls of the test tube.
2. A reddish brown gas (NO_2) is evolved.

164. What do you observe when copper is added to concentrated nitric acid.

Ans :

SQP 2011

Pinkish red metal dissolves to give blue or bluish green solution with the liberation of reddish brown coloured gas having pungent suffocating smell.

- 165.** What is the property of nitric acid which allows it to react with copper ?

Ans : MAIN 2008
Oxidising agent.

- 166.** What is observed when concentrated nitric acid is added to copper ?

Ans : SQP 2017
A reddish brown gas having pungent smell is evolved (NO_2).

- 167.** How can you obtain nitrous oxide from sodium nitrate ?

Ans : SQP 2002
Nitrous oxide can be obtained from sodium nitrate by heating it with ammonium sulphate.
 $(\text{NH}_4)_2\text{SO}_4 + 2\text{NaNO}_3 \rightarrow \text{Na}_2\text{SO}_4 + 4\text{H}_2\text{O} + 2\text{N}_2\text{O} \uparrow$
 (Nitrous oxide)

- 168.** Identify the substance:
A dilute acid (B) which does not normally give hydrogen when reacted with metals but does give a gas when it reacts with copper.

Ans : MAIN 2016
Nitric acid

- 169.** What do you observe when nitric acid is kept in a reagent bottle for a long time?

Ans : COMP 2015
It turns brown in colour.

- 170.** What is the property of nitric acid which allows it to react with copper?

Ans : SQP 2013
Oxidizing agent.

- 171.** What is the type of salt formed when the reactants are heated at a suitable temperature for the preparation of Nitric acid?

Ans : MAIN 2019
Acid salt

- 172.** State why for the preparation of Nitric acid, the complete apparatus is made up of glass.

Ans : COMP 2018
All glass apparatus is used because nitric acid vapours are corrosive and may attack rubber, cork or metal.

- 173.** Copy and complete the following table relating to the important industrial process. Output refers to the product of the process and not the intermediate steps.

Name of the process	Inputs	Catalyst	Equation for Catalysed reaction	Output
	Ammonia + air			Nitric acid

Ans : COMP 2015

Name of the process	Inputs	Catalyst	Equation for Catalysed reaction	Output
Ostwald's process	Ammonia + air	Platinum	$4\text{NH}_3 + 5\text{O}_2$ $\xrightarrow[800^\circ\text{C}]{\text{Pt}}$ $4\text{NO} + 6\text{H}_2\text{O} + \text{heat}$	Nitric acid

- 174.** What is the special feature of the apparatus that is used in the laboratory preparation of nitric acid?

Ans : SQP 2011
The apparatus must be made of all glass.

- 175.** Why should the temperature of the reaction mixture of nitric acid not allowed to rise above 200°C .

Ans : MAIN 2011
Nitric acid decomposes at higher temperature and the sodium sulphate formed sticks to the glass apparatus and cannot be removed.

- 176.** Write a chemical equation to illustrate the acidic nature of nitric acid.

Ans : MAIN 2008
 $\text{NaOH} + \text{HNO}_3 \longrightarrow \text{NaNO}_3 + \text{H}_2\text{O}$ (Neutralisation)

- 177.** Explain why only all glass apparatus should be used for the preparation of nitric acid by heating concentrated sulphuric acid and potassium nitrate.

Ans : COMP 2000
The vapours of nitric acid are highly corrosive in nature, therefore, it destroys or damages the rubber cork.

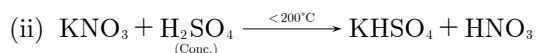
is temperature maintained below 200°C ?

- (v) Why all glass apparatus is used ?
 (vi) What do you know about the nature of reaction ?

Ans :

COMP 2001

- (i) 1 : 1 or better we can say equal parts by weight.



- (iii) This is because at about 200°C , a part of nitric acid decomposes to give brown coloured gas (nitrogen dioxide). This gas dissolves in pure nitric acid giving yellow colour.

- (iv) Removal of yellow colour

(a) By flushing of CO_2 : It expels NO_2 out of the solution.

(b) By bubbling dry air : It oxidises nitrogen dioxide to nitric acid.



(c) By diluting it with water : It oxidises nitrogen dioxide to nitric acid.



Because at temp. above 200°C , Na_2SO_4 is produced which sticks to the walls and is difficult to remove. As a result, decomposition of nitric acid takes place, fuel is wasted and it may lead to cracking of glass apparatus.

- (v) All glass apparatus is used because nitric acid vapours are corrosive and may attack rubber, cork or metal.
 (vi) Exothermic reaction.

- 221.** (i) Name the process by which nitric acid is obtained on a large-scale.
 (ii) Name the reactants used.
 (iii) State the ratio in which reactants are taken.
 (iv) (a) Name the catalyst used.
 (b) Upto which temperature catalyst is heated ?
 (c) Give the reaction taking place in the catalyst chamber.
 (d) Name the products formed.

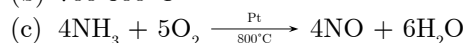
Ans :

SQP 2004

- (i) Ostwald's process.
 (ii) Ammonia and air.
 (iii) Dry ammonia and dry dust free air are taken in the ratio 1 : 10 by volume.

- (iv) (a) Platinum

(b) $700-800^{\circ}\text{C}$



(d) Nitric oxide and water vapour.

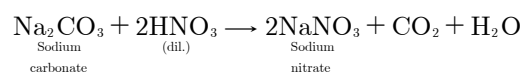
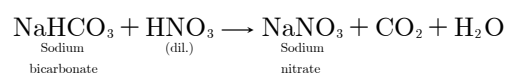
- 222.** How will you prepare the following from nitric acid ?

- (i) Sodium nitrate
 (ii) Copper nitrate
 (iii) Lead nitrate
 (iv) Magnesium nitrate
 (v) Aqua regia.

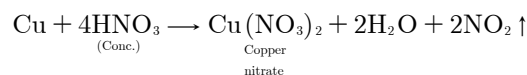
Ans :

SQP 2018

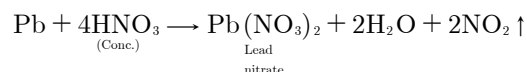
- (i) Sodium nitrate can be prepared by the action of dil. HNO_3 on sodium bicarbonate or sodium carbonate.



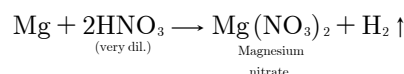
- (ii) Copper nitrate can be obtained by the action of conc. HNO_3 on copper.



- (iii) Lead nitrate can be obtained by the action of hot conc. HNO_3 on lead.



- (iv) Magnesium nitrate can be obtained by the action of very dil. HNO_3 on magnesium.



- (v) Aqua regia can be obtained by mixing conc. HNO_3 with conc. HCl in the ratio 1 : 3 (by volume). This mixture reacts even with gold and platinum to give their chlorides. It is because aqua regia contains nascent chlorine, which attacks these metals.

CASE BASED QUESTION

- 223.** A chemical manufacturing company is planning to produce Nitric acid using the Ostwald process. The company needs to ensure that the process is efficient and environmentally friendly. The Ostwald process involves several steps, including the catalytic oxidation of ammonia, cooling of the gases and the absorption of nitrogen dioxide in water to form Nitric acid. The company must also consider the storage and handling of Nitric acid, as it is a highly corrosive and strong oxidizing agent. Additionally, the company plans to use the

- (c) The chemical which provides nitrogen dioxide.

Ans :

MAIN 2022

- (a) Ammonium nitrate
 (b) Potassium nitrate
 (c) Lead nitrate.

187. Give three characteristics of nitrates.

Ans :

COMP 2016

Three characteristics of nitrates are as follows :

- (i) These are normal salts and crystalline in nature.
 (ii) They decompose on heating.
 (iii) These are soluble in water.

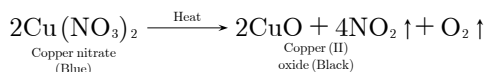
188. Explain briefly or give balanced equations to show how would you obtain :

- (i) Copper (II) oxide from copper nitrate ?
 (ii) Ammonia from ammonium chloride ?

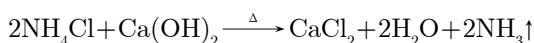
Ans :

COMP 2002

- (i) Copper (II) oxide can be obtained by heating copper nitrate.



- (ii) Ammonia can be obtained from ammonium chloride by heating it with slaked lime.



189. Give reasons for the following :

The apparatus for the preparation of nitric acid by heating concentrated sulphuric acid and potassium nitrate, should be all glass.

Ans :

SQP 2021

The apparatus for the preparation of nitric acid by heating conc. sulphuric acid and potassium nitrate should be all glass because nitric acid vapours are corrosive and hence attack rubber and cork but not glass.

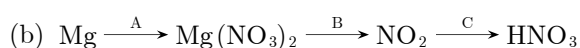
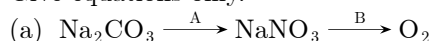
190. (a) Name the process used for the manufacture of nitric acid and
 (b) raw materials required for it.

Ans :

SQP 2017

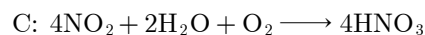
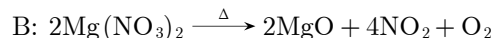
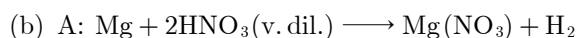
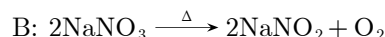
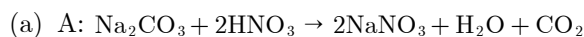
- (a) Ostwald's process
 (b) Raw materials required are ammonia and air.

191. How are the following conversions carried out? Give equations only.



Ans :

COMP 2011



192. (i) Dilute nitric acid is generally considered a typical acid except for its reaction with metals. In what way is dilute nitric acid different from other acids when it reacts with metals?
 (ii) Account for the yellow colour that appears in concentrated nitric acid when it is left standing in an ordinary glass bottle.

Ans :

SQP 2003

- (i) Dilute nitric acid is an oxidizing agent, therefore, it reacts with metals to produce oxides of nitrogen and not hydrogen.
 (ii) Concentrated nitric acid appears yellow because of the presence of dissolved Nitrogen dioxide.

193. Give the chemical name and the formula of the substance formed as a brown ring in the test tube in the test for nitrate radical.

Ans :

MAIN 2009

The chemical name of the substance formed as a brown ring in the test tube in the test for nitrate radical of nitroso ferrous sulphate. Its chemical formula is $\text{FeSO}_4 \cdot \text{NO}$.

194. Name the products formed when:

- (a) A mixture of Carbon and concentrated Nitric acid is heated
 (b) Dilute Nitric acid is added to Copper.

Ans :

SQP 2019

- (a) Carbon dioxide, Water and Nitrogen dioxide.
 (b) Copper nitrate, Water and Nitric oxide.

195. What is passive iron ?

Ans :

MAIN 2007

When iron is treated with pure concentrated nitric acid, a thin layer of insoluble iron oxide is formed on it due to which further reaction stops. This iron is called passive (inert) iron. Passivity can be removed by rubbing the surface layer with sandpaper or by treating with strong reducing agents.

- 178.** What compounds are required for the laboratory preparation of nitric acid ?

Ans : SQP 2013
Potassium nitrate and concentrated sulphuric acid.

- 179.** Why does pure nitric acid take on a yellowish brown colour when exposed to light ?

Ans : MAIN 2002
This is because when exposed to light HNO_3 decomposes to give NO_2 which is a reddish brown gas and dissolves in un-decomposed nitric acid to give a yellowish brown colour.

- 180.** The first step in the manufacture of nitric acid is the catalytic oxidation of ammonia. What is the name of the catalyst ?

Ans : COMP 2019
Platinum

- 181.** How would you separate Gold from a mixture of gold and copper filings ?

Ans : COMP 2001
Treat both with conc. HNO_3 and filter. Copper will dissolve forming blue solution of copper nitrate. Gold does not react and is separated by filtration.

nitrogen dioxide to nitric acid.

Ans : SQP 2025
(i) 800°C and Pt
(ii) $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$

- 183.** Give balanced equation for the following reactions:
(a) Copper reacts with concentrated Nitric acid.
(b) Aluminium nitride is treated with warm water.

Ans : MAIN 2024
(a) The reaction of copper with nitric acid results in the formation of copper nitrate that can be shown as:
$$3\text{Cu(s)} + 8\text{HNO}_3\text{(aq)} \longrightarrow 3\text{Cu(NO}_3)_2\text{(aq)} + 2\text{NO(g)} + 4\text{H}_2\text{O(l)}$$

(b) The reaction of aluminium nitride with warm water forms aluminium hydroxide that can be shown as:
$$\text{AlN(s)} + 3\text{H}_2\text{O(l)} \longrightarrow \text{Al(OH)}_3\text{(s)} + \text{NH}_3\text{(g)}$$

- 184.** State one relevant reason for the following : Concentrated nitric acid appears yellow, when it is left for a while in a glass bottle.

Ans : MAIN 2020
$$4\text{HNO}_3 \longrightarrow 2\text{H}_2\text{O} + 4\text{NO}_2 + \text{O}_2$$

A part of concentrated nitric acid splits to form water, nitrogen dioxide and oxygen. Nitrogen dioxide formed is brown in colour but when it dissolves in nitric acid it gives yellow colouration to it.

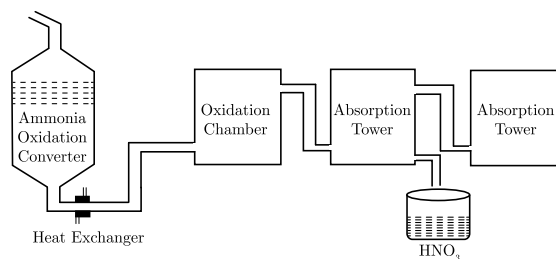
- 185.** Give a chemical test to distinguish between the following pair of compounds:
Sodium chloride solution and sodium nitrate solution.

Ans : COMP 2004
Add AgNO_3 solution to both the solutions of salt in water.
 NaCl solution – curdy white precipitates of AgCl are formed which are insoluble in HNO_3 but soluble in NH_4OH .
 NaNO_3 solution – no reaction.

- 186.** A. Potassium nitrate
B. Lead nitrate
C. Ammonium nitrate
Choose the chemicals from A, B and C to answer the following questions when they are heated.
(a) The chemical which leaves behind no residue.
(b) The chemical which gives oxygen as the only gas.

TWO MARKS QUESTIONS

- 182.** The diagram given below is a representation of the Industrial preparation of Nitric acid by Ostwald's process. With respect to the process answer the following questions:



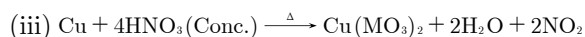
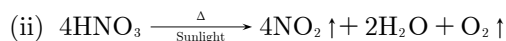
- (i) Write the temperature and the catalyst required during the catalytic oxidation of ammonia.
(ii) Give balanced chemical equation for the reaction occurring during the conversion of

- (i) Name *A* (a liquid), *B* (a solid) and *C* (a liquid). (Do not give the formulae)
 (ii) Write an equation to show how nitric acid undergoes decomposition.
 (iii) Write the equation for the reaction in which copper is oxidised by concentrated nitric acid.

Ans :

COMP 2017

- (i) A – Sulphuric acid
 B – Sodium nitrate
 C – Nitric acid



- 202.** During thunderstorm, rainwater contains nitric acid. Explain with reactions.

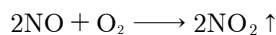
Ans :

MAIN 2023

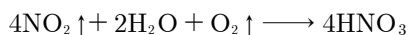
During lightening discharge or thunderstorm, the nitrogen present in the atmosphere reacts with the oxygen to form nitric oxide.



This nitric oxide is further oxidised to nitrogen dioxide.



The nitrogen dioxide dissolves in atmospheric moisture and in the presence of oxygen of the air and forms nitric acid in the free state which is washed down by the rain.



That is why during thunderstorm, rainwater contains nitric acid.

- 203.** What do you observe when:

- (a) Nitric acid is dropped over heated saw dust.
 (b) Nitrogen dioxide is passed through acidified freshly prepared Ferrous sulphate solution.
 (c) Concentrated Sulphuric acid is slowly added from the sides of the test-tube containing a solution of Nitrate and equal volume of freshly prepared Ferrous sulphate solution.

Ans :

SQP 2020

- (a) Heated saw dust catches fire, i.e. bursts into flame.
 (b) The solution turns brown black.
 (c) A brown ring is formed at the junction of two liquids.

- 204.** Nitric acid cannot be concentrated beyond 68% by the distillation of a dilute solution of HNO_3 . Explain why ?

Ans :

COMP 2015

Nitric acid forms a constant boiling mixture with water containing 68% acid. This mixture boils constantly at the constant boiling point without any change in its composition. At this temperature, the gas and the water vapour escape together. Hence, the composition of the solution remains unchanged. That is why nitric acid cannot be concentrated beyond 68% by the distillation of dilute solution of HNO_3 .

- 205.** Explain the following :

- (i) Dilute nitric acid is generally considered a typical acid but not so in its reaction with metals.
 (ii) Concentrated nitric acid appears yellow when it is left standing in a glass bottle.
 (iii) An all glass apparatus is used in the laboratory preparation of nitric acid.

Ans :

SQP 2010

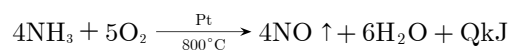
- (i) All metals on reaction with acids liberate hydrogen gas but metals on reaction with nitric acid do not liberate hydrogen. Nitric acid being a strong oxidising agent oxidises hydrogen to water.
 (ii) In the laboratory, the nitric acid stored in a bottle appears yellow, this is due to dissolved NO_2 in the undecomposed HNO_3 . The colour of NO_2 is brown but when it dissolves slightly it appears to be yellow.
 (iii) All glass apparatus is used because nitric acid vapours are corrosive and may attack rubber cork or metal.

- 206.** (a) Name the catalyst which is used in the oxidation of ammonia to nitric oxide. Name the other product of the oxidation reaction.
 (b) A gas '*A*' reacts with another gas '*B*' in the presence of a catalyst to give a colourless gas '*C*'. The gas '*C*' when comes in contact with air produces a brown gas '*D*'. The solution of '*A*' in water turns red litmus blue. Explain the observations.

Ans :

MAIN 2002

- (a) The catalyst used in the oxidation of ammonia to nitric oxide is platinum gauze.
 The product of the oxidation reaction are nitric oxide and water.



- (b) The gas *A* is ammonia (NH_3), the gas *B* is oxygen (O_2) and the colourless gas *C* is

- (b) When X is heated, it melts and given off only one gas which relights a glowing splint.

Inference 2 : The cation in X is either

_____ or _____.

- (c) The action of heat on Y produces a reddish-brown gas and a yellow residue which fuses with the glass of the test tube.

Inference 3 : The metal ion present in Y is the _____ ion.

- (d) When Z is heated, it leaves no residue. Warming Z with sodium hydroxide solution, liberates a gas which turns moist red litmus paper blue.

Inference 4 : Z contains the _____ cation.

- (e) Write the equations for the following reactions:

(i) X and concentrated sulphuric acid (below 200°C)

(ii) Action of heat on Y .

Ans :

MAIN 2004

(a) NO_3^-

(b) K^+ or Na^+

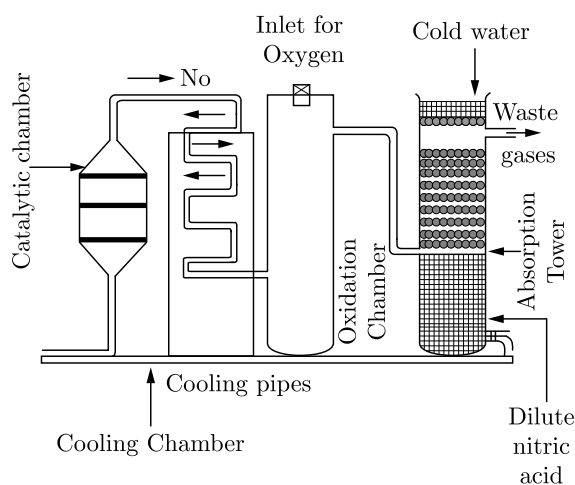
(c) Pb^{2+}

(d) NH_4^+

(e) (i) $\text{KNO}_3 + \text{H}_2\text{SO}_4 \xrightarrow[\text{(Conc.)}]{<200^\circ\text{C}} \text{KHSO}_4 + \text{HNO}_3$

(ii) $2\text{Pb}(\text{NO}_3)_2 \xrightarrow{\Delta} 2\text{PbO} + 4\text{NO}_2 \uparrow + \text{O}_2 \uparrow$

215. The given diagram shows industrial preparation of nitric acid.



- What is the ratio of the reactants taken in the above process ?
- Name the common name of this process.
- Name the catalyst used.
- Why gases entering the apparatus must be pure?
- Where do they react ? Also give balanced reactions.

- (vi) Which acid - resistant material is packed in absorption tower ?

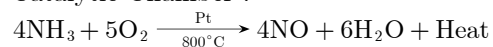
Ans :

SQP 2023

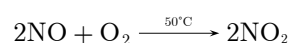
- 10 vol. of air + 1 vol. of NH_3
- Ostwald's process
- Platinum
- Gases entering the apparatus must be pure as impurities poison the catalyst hence, lowering the efficiency.

- (v) Reactions take place as follow :

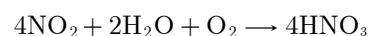
(a) Catalytic Chamber :



(b) Oxidation Chamber :



(c) Absorption Tower



- (vi) Quartz

216. (i) Write a balanced equation for the reaction of sulphur with hot concentrated nitric acid.
- (ii) Write the equation for the reaction of dilute nitric acid with copper.
- (iii) Account for the yellow colour that appears when concentrated nitric acid is left standing in an ordinary glass bottle.
- (iv) Dilute nitric acid is considered a typical acid except for its reaction with metals. In what way is dilute nitric acid different from other acids when it reacts with metals ?

Ans :

MAIN 2011

(i) $\text{S} + 6\text{HNO}_3 \xrightarrow[\text{(Conc.)}]{} \text{H}_2\text{SO}_4 + 6\text{NO}_2 + 2\text{H}_2\text{O}$

(ii) $3\text{Cu} + 8\text{HNO}_3 \xrightarrow[\text{(Dil.)}]{} 3\text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$

(iii) Nitric acid slowly decomposes even at room temperature, especially in the presence of sunlight.



NO_2 so produced dissolves in acid to give a yellow colour.

(iv) Nitric acid is a strong oxidising agent and the hydrogen produced by the action of metal with dilute nitric acid is immediately oxidised to water. Hence, no hydrogen is obtained.

217. Give reasons for the following:

- During the manufacture of Nitric acid by Ostwald's process, excess of Oxygen is taken.
- Before the gases are allowed to enter the oxidation chamber the gases are sufficiently cooled.

Ans :

COMP 2008

- (i) A — Concentrated sulphuric acid,
B — Potassium nitrate,
C — Nitric acid
- (ii) $4\text{HNO}_3 \xrightarrow{\Delta} 2\text{H}_2\text{O} + 4\text{NO}_2 + \text{O}_2$
- (iii) $\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$

- 210.** (i) Fill in the blank spaces in the following statements:

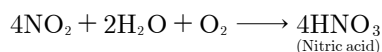
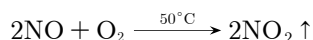
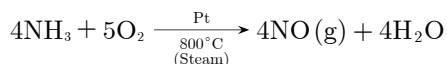
Most of the nitric acid today is manufactured by Ostwald's Process. In this process a mixture of pure dry ammonia and air in the ratio of _____ by volume is first compressed and then _____ passed over _____ at about _____ °C. This results in the oxidation of ammonia into _____ which combines with _____ of the air to give _____. This is an acidic gas from which nitric acid can be obtained by simply dissolving in _____.

- (ii) Give all the equations involved in above process.

Ans :

MAIN 2003

- (i) 1 : 10, platinum gauze, 800°C, nitric oxide, oxygen, nitrogen dioxide, water.
- (ii) The chemical equations involved in the above process are :



- 211.** With respect to the brown ring test for nitrates, explain :

- (i) Freshly prepared ferrous sulphate solution is used.
- (ii) The brown ring disappears if the test tube is disturbed.
- (iii) Lead nitrate does not respond well to the brown ring test.

Ans :

COMP 2016

- (i) This is because on standing in air ferrous sulphate is oxidised to ferric sulphate.
- (ii) This is because the $\text{FeSO}_4 \cdot \text{NO}$ (Brown ring complex) is unstable and disappears on shaking.
- (iii) This is because lead nitrate forms insoluble lead sulphate when conc. H_2SO_4 is added in this test.

FOUR MARKS QUESTIONS

- 212.** Nitric acid is manufactured by Ostwald's process.

- (i) Give the source of ammonia gas used in the manufacture.
- (ii) What is the ratio of ammonia air taken in this process ?
- (iii) Name the catalyst used in the process.
- (iv) Name the oxidising agent used in this process.

Ans :

MAIN 2001

- (i) Ammonia gas used in the manufacture of nitric acid by Ostwald's process is obtained by Haber's process.
- (ii) 1 : 10
- (iii) Platinised wire gauze or Platinum.
- (iv) Air (oxygen).

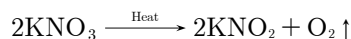
- 213.** (i) When nitric acid is prepared by the action of concentrated sulphuric acid on potassium nitrate, what is the special feature of the apparatus used?

- (ii) Write the equation for the laboratory preparation of nitric acid from potassium nitrate and concentrated sulphuric acid.
- (iii) Potassium nitrate is prepared from potassium hydroxide and nitric acid. Name the type of this reaction.
- (iv) Which gas is produced when potassium nitrate is heated ? Write the equation for the reaction.

Ans :

COMP 2003

- (i) It is made-up of all glass.
- (ii) $\text{KNO}_3 + \text{H}_2\text{SO}_4 \xrightarrow[(\text{Conc.})]{< 200^\circ\text{C}} \text{KHSO}_4 + \text{HNO}_3$
- (iii) Neutralisation.
- (iv) Oxygen



- 214.** X, Y and Z are three crystalline solids which are soluble in water and have a common anion.

To help you to identify X, Y and Z you are provided with the following experimental observations. Copy and complete the corresponding inferences in (i) to (iv) :

- (a) A reddish brown gas is obtained when X, Y and Z are separated warmed with concentrated sulphuric acid and copper turnings are added to the mixture.
- Inference 1 : The common anion is the _____ ion.

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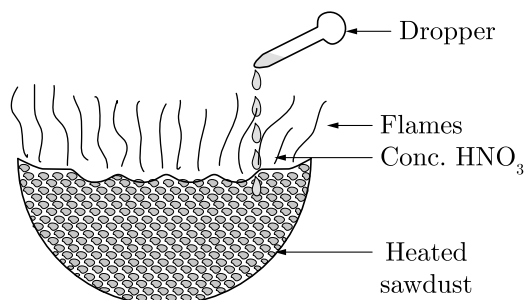
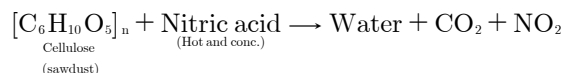
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196. What do you observe when nitric acid is added to sawdust ?

Ans :

COMP 2013

Nitric acid is a strong oxidising agent. When hot and concentrated nitric acid is added to cellulose, it oxidises it to carbon dioxide and water along with flames.



197. Copy and complete the following table relating to important industrial process :

Name of the process	Temperature	Catalyst	Equation for the catalysed reaction
Haber's process			

Ans :

COMP 2001

Name of the process	Temp.	Catalyst	Equation
Haber's process	450-500°C	Finely divided iron + Mo as promoter	$\text{N}_2 + 3\text{H}_2 \xrightarrow[200-900 \text{ atm}]{450-500^\circ\text{C}} 2\text{NH}_3 + 22.4 \text{ kcal}$

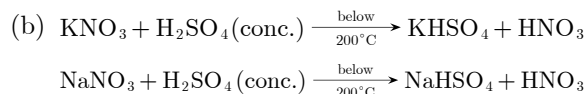
198. The following questions are related with the Laboratory preparation of Nitric acid

- Name the two compounds used for the preparation of Nitric acid in laboratory.
- Write balanced chemical equation for the laboratory preparation of Nitric acid from the above named compounds.

Ans :

COMP 2004

- Potassium nitrate or Sodium nitrate and concentrated Sulphuric acid.



THREE MARKS QUESTIONS

199. Abhishek was given a salt 'X' which was white in colour for analysis. On strong heating it produced a yellow residue, a colourless gas and also a reddish-brown gas. The solution of the salt 'X' when tested with excess of ammonium hydroxide produced a chalky white insoluble precipitate.

- Name the coloured gas evolved when Abhishek heated the salt strongly.
- Which cation was present in the sample given to Abhishek?
- Identify the salt given to Abhishek for analysis.

Ans :

SQP 2025

- Nitrogen dioxide
- Lead ions
- Lead nitrate

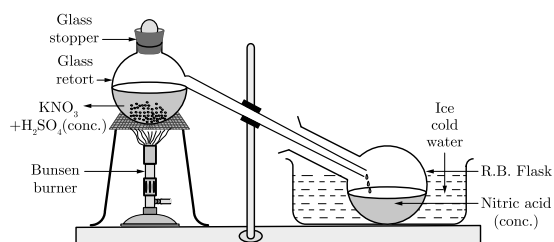
200. (i) Explain why only all glass apparatus should be used for the preparation of nitric acid by heating concentrated sulphuric acid and potassium nitrate.
- Write a chemical equation to illustrate the acidic nature of nitric acid.
 - Name the products formed when ammonium nitrate is heated.

Ans :

MAIN 2006

- Because the nitric acid produced reacts with almost all the materials including cork and rubber except glass.
- $\text{Na}_2\text{O} + 2\text{HNO}_3 \longrightarrow \text{NaNO}_3 + \text{H}_2\text{O}$
- Nitrous oxide (N_2O) and water (H_2O)

201. The figure given below illustrates the apparatus used in the laboratory preparation of nitric acid.



- (iii) The gases entering the catalytic chamber must be pure.
- (iv) Commercial Nitric acid is pale yellow in colour.

Ans :

COMP 2015

- (i) Excess of Oxygen is taken because each and every step requires Oxygen.
- (ii) The gases are cooled so that the complete oxidation of Nitric oxide takes place as the rate of forward reaction increases or to minimize the decomposition of Nitrogen dioxide.
- (iii) Gases entering the catalytic chamber must be pure, otherwise, it would poison the catalyst.
- (iv) Commercial Nitric acid is pale yellow in colour because of the presence of dissolved Nitrogen dioxide.

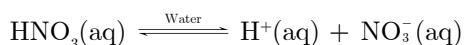
218. What happens when (give balanced equation):

- (i) Sulphur is added to hot and conc. HNO_3 ?
- (ii) Nitric acid is added to KI (aq) ?
- (iii) Sodium hydrogen carbonate is added to nitric acid ?
- (iv) Nitric acid is dissolved in large amount of water ?
- (v) Nitric acid is added to washing soda and the resulting gas is passed through a freshly prepared lime water ?

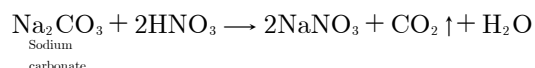
Ans :

COMP 2000

- (i) When sulphur is added to hot and conc. HNO_3 , it (sulphur) is oxidised to sulphuric acid and dense brown fumes of NO_2 are evolved.
- $$\text{S} + 6\text{HNO}_3 \xrightarrow{\Delta} \text{H}_2\text{SO}_4 + 2\text{H}_2\text{O} + 6\text{NO}_2\uparrow$$
- (ii) When nitric acid is added to KI (aq), it is oxidised to iodine.
- $$2\text{KI} + 4\text{HNO}_3 \rightarrow 2\text{KNO}_3 + 2\text{H}_2\text{O} + 2\text{NO}_2 + \text{I}_2\uparrow$$
- Violet vapours
- (iii) When sodium hydrogen carbonate is added to nitric acid, carbon dioxide gas is evolved.
- $$\text{NaHCO}_3 + \text{HNO}_3 \rightarrow \text{NaNO}_3 + \text{H}_2\text{O} + \text{CO}_2\uparrow$$
- (iv) When nitric acid is dissolved in large amount of water, it ionises almost completely to produce hydrogen and nitrate ions.

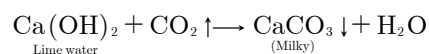


- (v) When nitric acid is added to washing soda (sodium carbonate), carbon dioxide gas is evolved.



When carbon dioxide gas is passed through freshly prepared lime water (calcium hydroxide), it turns milky due to the

formation of insoluble calcium carbonate.



When the gas is passed in excess, the milkiness disappears due to the formation of soluble calcium bicarbonate.

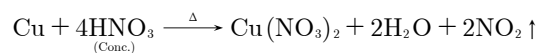
**219.** What happens when (give balanced equation):

- (i) Limestone reacts with nitric acid ?
- (ii) Nitric acid (conc.) is heated with copper?
- (iii) Cupric oxide reacts with nitric acid ?
- (iv) Zinc reacts with dilute nitric acid ?
- (v) Concentrated nitric acid is heated ?

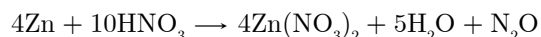
Ans :

MAIN 2009

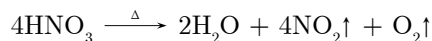
- (i) Limestone (calcium carbonate) reacts with nitric acid, calcium nitrate is formed with the evolution of carbon dioxide gas.
- $$\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{CO}_2\uparrow + \text{H}_2\text{O}$$
- (ii) When conc. nitric acid is heated with copper, copper nitrate, nitrogen dioxide gas are formed.



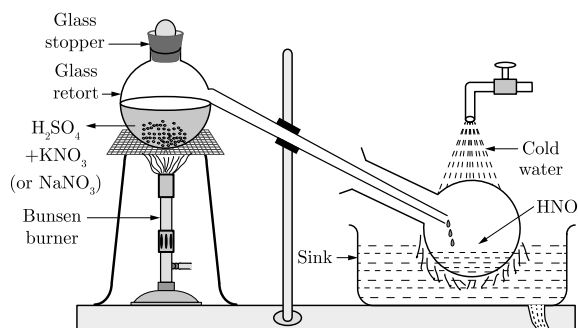
- (iii) When cupric oxide reacts with nitric acid, copper nitrate is formed.
- $$\text{CuO} + 2\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{O}$$
- (iv) Zinc reacts with dilute nitric acid to form nitrous oxide.



- (v) When conc. nitric acid is heated, it rapidly decomposes to form reddish brown gas nitrogen dioxide, water and oxygen.

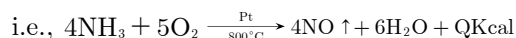


- 220.** (i) What is the ratio of potassium nitrate and sulphuric acid ?
- (ii) Give the reaction which takes place in the above retort.

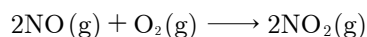


- (iii) Why product obtained is yellow in colour ?
- (iv) How can this yellow colour be removed? Why

nitrogen monoxide (NO).



When gas C i.e., NO comes in contact with air (O_2) a brown gas D is produced, which is nitrogen dioxide (NO_2).



The solution of A in water is ammonium hydroxide (NH_4OH) which turns red litmus blue.

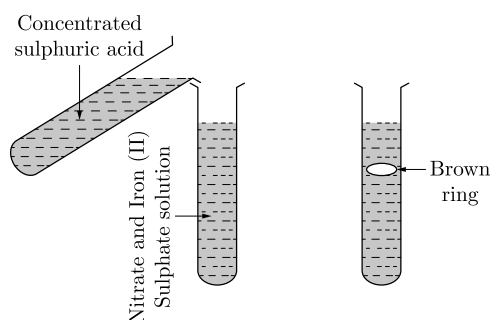


- 207.** (i) Explain with the help of a balanced equation the brown ring test for nitric acid.
 (ii) Why is freshly prepared ferrous sulphate solution used for testing the nitrate radical in the brown ring test.
 (iii) Name the solution which absorbs nitric oxide.

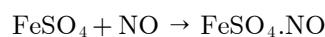
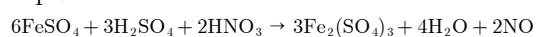
Ans :

COMP 2008

- (i) Brown Ring Test : Take HNO_3 in a test tube and add an equal quantity of freshly prepared solution of Iron (II) sulphate and pour slowly a few drops of concentrated sulphuric acid along the walls of the tilted test tube as shown in figure. A brown ring will appear at the junction of the two liquids.



Equations :



- (ii) Because on exposure to atmosphere it is oxidised to ferric sulphate which does not give brown ring test.
 (iii) Freshly prepared ferrous sulphate.

208. Give reasons for the following :

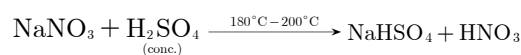
- (i) Commercial concentrated nitric acid is yellow in colour, but when it is diluted with water, it turns colourless.
 (ii) In the laboratory preparation of nitric acid,

the mixture of concentrated sulphuric acid and sodium nitrate should not be heated very strongly above 200°C .

Ans :

SQP 2000

- (i) Commercial nitric acid is yellow in colour due to the presence of dissolved nitrogen dioxide in it. When it is diluted with water, it turns colourless because nitrogen dioxide dissolves in water to form nitric acid which is colourless.
 (ii) In the laboratory, nitric acid is prepared by heating sodium nitrate with conc. sulphuric acid to a temp. of 180°C – 200°C in a glass retort.

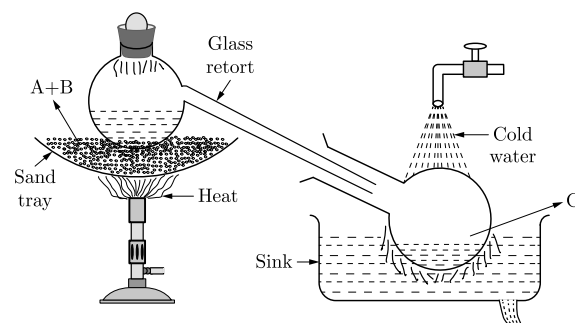


The mixture of sodium nitrate and conc. sulphuric acid should not be heated very strongly above 200°C because it has the following disadvantages :

- (a) The sodium sulphate formed at higher temperatures forms a hard crust which sticks to the walls of the retort and is difficult to remove.
 (b) The glass apparatus may crack at higher temperature.
 (c) The decomposition of nitric acid occurs to a great extent at higher temperatures, thereby imparting brown colour to nitric acid.

Thus, the mixture of conc. sulphuric acid and sodium nitrate should not be heated very strongly above 200°C .

209. The figure given below illustrates the apparatus used in the laboratory preparation of nitric acid.



- (i) Name A (a liquid), B (a solid) and C (a liquid). (Do not give the formulae)
 (ii) Write an equation to show how nitric acid undergoes decomposition.
 (iii) Write the equation for the reaction in which copper is oxidized by concentrated nitric acid.

produced Nitric acid to manufacture fertilizers, specifically ammonium nitrate, which is a crucial component in agricultural applications.



- (i) What is the significance of cooling the gases before they enter the oxidation chamber in the Ostwald process?
- (ii) Why must the Nitric acid produced be handled with care during storage and transportation?
- (iii) What is the primary use of the Nitric acid produced in this process for the company?
- (iv) How does the company ensure that the Ostwald process is environmentally friendly?

Ans :

- (i) Cooling the gases ensures complete oxidation of Nitric oxide to nitrogen dioxide, which is essential for efficient Nitric acid production.
- (ii) Because Nitric acid is highly corrosive and a strong oxidizing agent it can cause severe chemical burns and react violently with certain substances.
- (iii) The primary use is to manufacture ammonium nitrate, which is used as a fertilizer in agriculture.
- (iv) By optimizing the process to minimize emissions and ensuring that the gases are fully oxidized, reducing the release of harmful nitrogen oxides into the environment

224. A fertilizer production plant is using Nitric acid to produce ammonium nitrate. The plant must monitor the reaction conditions closely to ensure that the process is safe and efficient. Additionally, they need to store large quantities of Nitric acid securely due to its corrosive nature.

- (i) What reaction is used to produce ammonium nitrate in the fertilizer plant?
- (ii) Why is it important to monitor the reaction

conditions in the production of ammonium nitrate?

- (iii) What safety measures should be in place for storing large quantities of Nitric acid?
- (iv) What potential environmental issue could arise from improper handling of Nitric acid?

Ans :

- (i) Ammonium nitrate is produced by reacting ammonia with Nitric acid.
- (ii) To ensure the reaction is safe and to prevent any uncontrolled release of gases or heat.
- (iii) The Nitric acid should be stored in corrosion-resistant containers, away from incompatible substances, in a well-ventilated area.
- (iv) It could lead to acid spills, contaminating soil and water sources.

225. A laboratory is conducting experiments to understand the decomposition of Nitric acid at different temperatures. The researchers aim to determine the safest temperature range for storing Nitric acid to prevent decomposition and release of toxic gases.

- (i) What is the primary concern when storing Nitric acid at elevated temperatures?
- (ii) At what temperature should Nitric acid be stored to minimize the risk of decomposition?
- (iii) What gases are released during the decomposition of Nitric acid?
- (iv) Why is it important for the laboratory to understand the decomposition process of Nitric acid?

Ans :

- (i) The primary concern is that Nitric acid may decompose, releasing toxic gases like nitrogen dioxide.
- (ii) Nitric acid should be stored at or below room temperature to minimize decomposition.
- (iii) Nitrogen dioxide, water and oxygen are released.
- (iv) To ensure safe handling and storage practices that prevent the release of harmful gases.

226. A chemical plant uses the Ostwald process to produce Nitric acid, which is then supplied to various industries. The plant is reviewing its processes to improve efficiency and reduce energy consumption during the production of Nitric acid.

- (i) How can the chemical plant improve energy efficiency in the Ostwald process?
- (ii) What role does the catalyst play in the Ostwald process?

23. Assertion : Concentrated sulphuric acid can cause charring of sugar.

Reason : Concentrated sulphuric acid acts as a dehydrating agent and removes water from sugar, leaving behind carbon.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2016

Concentrated sulphuric acid dehydrates sugar by removing water, resulting in the formation of carbon, which appears as a black mass.

Thus (a) is correct option.

24. Assertion : Sulphuric acid is not suitable for drying ammonia gas.

Reason : Sulphuric acid reacts with ammonia to form ammonium sulphate.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2001

Sulphuric acid cannot be used to dry ammonia because it reacts with ammonia to form ammonium sulphate.

Thus (a) is correct option.

25. Assertion : Sulphuric acid acts as a strong oxidizing agent.

Reason : Sulphuric acid can oxidize both metals and non-metals to their respective oxides.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

MAIN 2012

Sulphuric acid's strong oxidizing nature allows it to oxidize metals and non-metals to form oxides.

Thus (a) is correct option.

26. Assertion : Sulphuric acid is used in the manufacture of fertilizers.

Reason : Sulphuric acid is a source of sulfate ions, which are essential for plant growth.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

COMP 2015

Sulphuric acid is commonly used in the manufacture of fertilizers due to its role in providing sulfate ions.

Thus (a) is correct option.

27. Assertion : Sulphuric acid is used in the preparation of esters.

Reason : Sulphuric acid acts as a catalyst in esterification reactions.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
- (c) Assertion is true, but reason is false.
- (d) Assertion is false, but reason is true.

Ans :

SQP 2004

Sulphuric acid catalyzes esterification reactions by protonating the alcohol, facilitating the reaction with carboxylic acids to form esters.

Thus (a) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following :

28. Gas obtained by dehydration of Ethanol.

Ans :

COMP 2021

Ethene or Ethylene

29. A black coloured substance formed when Sugar is dehydrated.

Ans :

MAIN 2023

Carbon/Sugar Charcoal

30. An organic acid which on reaction with concentrated Sulphuric acid, produces two oxides of Carbon.

Ans :

COMP 2015

Oxalic acid.

applied in industrial processes.

- (i) What product is formed when Nitric acid reacts with a metal like zinc?
- (ii) Why do some metals like iron become passive when reacting with concentrated Nitric acid?
- (iii) What safety precautions should researchers take when handling Nitric acid during these experiments?
- (iv) How could the findings from these experiments be applied in an industrial context?

Ans :

- (i) Zinc nitrate and hydrogen gas are formed.
- (ii) Iron forms a protective oxide layer that prevents further reaction.
- (iii) They should use protective equipment work in a fume hood and ensure proper disposal of waste materials.
- (iv) The findings could help optimize processes for producing specific metal nitrates used in various applications.

231. An environmental agency is investigating the impact of acid rain, which contains traces of Nitric acid, on local ecosystems. They are particularly concerned about the effect on soil composition, water quality and plant life in affected areas.

- (i) How does Nitric acid form in the atmosphere, leading to acid rain?
- (ii) What impact does Nitric acid in acid rain have on soil composition?
- (iii) Why is Nitric acid in acid rain a concern for water quality?
- (iv) What measures can be taken to reduce the production of Nitric acid in the atmosphere?

Ans :

- (i) Nitric acid forms when nitrogen oxides react with water in the atmosphere.
- (ii) It can lower the pH of the soil, leading to nutrient depletion and harming plant growth.
- (iii) It can acidify water bodies, affecting aquatic life and making the water unsafe for consumption.
- (iv) Reducing emissions of nitrogen oxides from vehicles and industrial processes can help lower the amount of Nitric acid in the atmosphere.

232. A company manufacturing explosives relies on Nitric acid as a key component in their production process. They need to ensure that the Nitric acid they produce is of high purity to maintain the effectiveness and stability of the explosives.

- (i) Why is high-purity Nitric acid crucial in the production of explosives?
- (ii) What method can the company use to ensure the Nitric acid they produce is pure?
- (iii) What are the risks associated with using impure Nitric acid in explosives production?
- (iv) How should the company handle and store the Nitric acid to prevent contamination?

Ans :

- (i) Impurities can affect the stability and effectiveness of the explosives.
- (ii) They can use distillation to purify the Nitric acid and remove any contaminants.
- (iii) Impurities could lead to unpredictable reactions, increasing the risk of accidental detonation.
- (iv) They should store it in clean, sealed containers made of corrosion-resistant materials and in a controlled environment.

233. A pharmaceutical company is exploring the use of Nitric acid in synthesizing active pharmaceutical ingredients (APIs). They need to understand the reactivity of Nitric acid with various organic compounds and ensure that the reactions are controlled to avoid unwanted by-products.

- (i) Why is it important to control the concentration of Nitric acid when synthesizing APIs?
- (ii) How does Nitric acid typically react with organic compounds?
- (iii) What precautions should the company take when using Nitric acid in the synthesis process?
- (iv) How can the company ensure the consistency of the reactions involving Nitric acid?

Ans :

- (i) To avoid over-oxidation of the organic compounds, which can lead to unwanted by products.
- (ii) It can oxidize the organic compounds, adding oxygen atoms to the molecular structure.
- (iii) They should conduct reactions in controlled environments, use appropriate protective equipment and have emergency procedures in place.
- (iv) By carefully controlling reaction conditions such as temperature, concentration and time.

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7. A compound which on hydrolysis will give two acids
(a) Ferrous chloride (b) Sulphuryl chloride
(c) Nitrosyl chloride (d) Ferrous nitrate

Ans :

COMP 2018

Thus (b) is correct option.

8. Glauber prepared oil of vitriol by distilling which compound :
(a) Ferrous sulphate
(b) Ferrous hydroxide
(c) Ferric hydroxide
(d) Ferrous nitrate.

Ans :

MAIN 2010

Glauber prepared oil of vitriol by distilling which compound of ferrous sulphate.

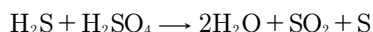
Thus (a) is correct option.

9. Sulphuric acid oxidises hydrogen sulphide to :
(a) Sulphur (b) Sulphur dioxide
(c) Sulphates (d) Sulphites

Ans :

COMP 2020

Sulphuric acid in its concentrated form, oxidises hydrogen sulphide to sulphur according to the following reaction.



Thus (a) is correct option.

10. Superphosphate of lime is a :
(a) Fertiliser (b) Detergent
(c) Explosive (d) Battery

Ans :

SQP 2023

The mixture of calcium dihydrogen phosphate and calcium sulfate (gypsum) is called superphosphate of lime. Superphosphate of lime is a necessary fertilizer, obtained from the action of sulphuric acid on phosphate rock.

Thus (c) is correct option.

11. Chemical name of oleum is:
(a) Hydrated sulphuric acid
(b) Pyrosulphuric acid
(c) Acetyl aldehyde
(d) Ortho sulphuric

Ans :

MAIN 2021

The chemical name of oleum is pyrosulphuric acid. When sulfur trioxide reacts with sulfuric acid, the formation of oleum takes place.

Thus (b) is correct option.

12. Green vitriol is :
(a) Hydrated ferrous sulphate
(b) Hydrated copper sulphate
(c) Hydrated magnesium sulphate
(d) Hydrated copper hydroxide

Ans :

SQP 2017

Green vitriol is the chemical name used for Ferrous sulfate. The green vitriol exist mostly in hydrated form hence, chemically it is known as Ferrous sulfate heptahydrate. The chemically used formula for Green vitriol is $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

Thus (a) is correct option.

13. Promoter used in contact process:
(a) vanadium pentaoxide
(b) quartz
(c) potassium oxide
(d) ferric hydroxide

Ans :

COMP 2013

Promoter is a substance that enhance the activity of catalyst. Potassium oxide is a promoter on the contact process.

Thus (c) is correct option.

14. Corrosive action of sulphuric action on skin is due to its:
(a) Oxidising nature
(b) Volatile nature
(c) Reducing nature
(d) Dehydrating nature

Ans :

SQP 2002

The corrosive action of H_2SO_4 on skin is due to its dehydrating action.

Thus (d) is correct option.

15. An organic acid which on dehydration releases both CO and CO_2 gas is :
(a) Oxalic acid (b) Acetic acid
(c) Ethanoic acid (d) Carbonic acid

Ans :

COMP 2005

The name of organic acid is oxalic acid $(\text{COOH})_2$ that reacts with conc. H_2SO_4 (sulfuric acid) to give a mixture of CO (carbon monoxide), (carbon dioxide) CO_2 and water H_2O .

Thus (a) is correct option.

16. Number of hydrogen ions produced per molecule of the acid in aqueous solution is :
(a) Basicity (b) Acidity
(c) Normality (d) Equality

Ans :

MAIN 2014

CHAPTER 11

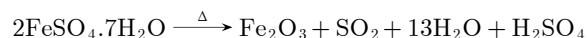
SULPHURIC ACID

SUMMARY

1. SULPHURIC ACID

Sulphuric acid is called as king of chemicals. It is commonly called as oil of vitriol.

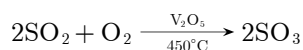
It was prepared during the distillation of green vitriol ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$).



1.1 Manufacturing of Sulphuric Acid

Sulphuric acid is manufactured by Contact process as follows:

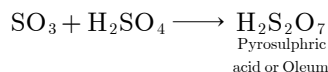
- (a) Catalytic oxidation of Sulphur dioxide in Catalytic chamber: The gases entering the catalytic chamber must be pure, otherwise it would poison the catalyst.



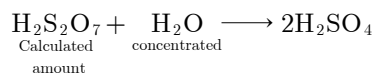
The catalyst glows red hot because the reaction is exothermic in nature. So, only initial heating of the catalyst is required.

- (b) Absorption tower: SO_3 formed in catalytic chamber is not directly absorbed in Water because:

- (i) The reaction is highly exothermic in nature.
(ii) A dense mist of minute particles of Sulphuric acid is formed which is not easily condensed. Instead, Sulphur trioxide formed is absorbed in concentrated Sulphuric acid to form Pyrosulphuric acid or Oleum ($\text{H}_2\text{S}_2\text{O}_7$).



- (c) Dilution of Oleum: It is diluted by adding calculated amount of water to obtain concentrated Sulphuric acid of desired concentration.



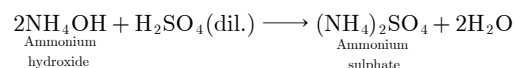
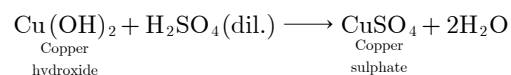
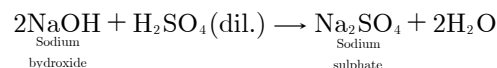
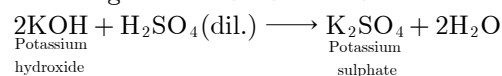
Concentrated Sulphuric acid is colourless, odourless, viscous hygroscopic liquid which is soluble in water in all proportions. It is a strong di-basic acid. The salts of sulphuric acid are called as sulphates and bi-sulphates.

1.2 Typical Properties of Dilute Acid

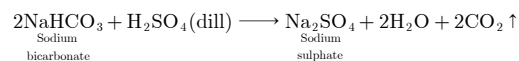
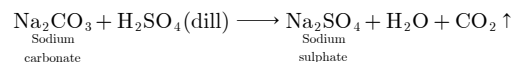
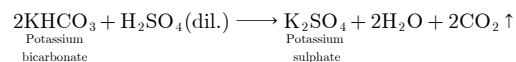
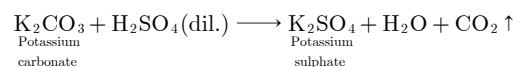
Dilute Sulphuric acid shows the typical properties of dilute acids mentioned below:

- (a) Reaction with bases: It forms salt and water.

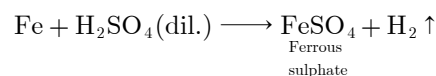
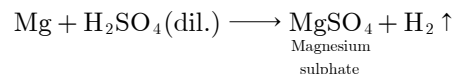
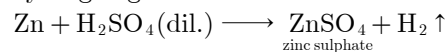
It undergoes neutralization reaction.



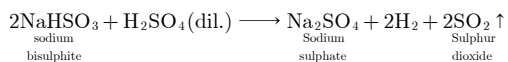
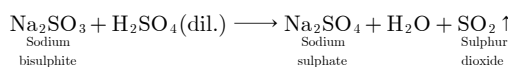
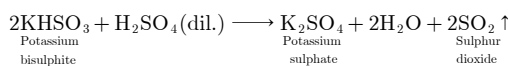
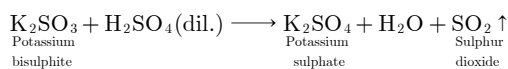
- (b) Reaction with metallic carbonates and bicarbonates: On reaction of metallic carbonates/bicarbonates with dilute H_2SO_4 , Carbon dioxide gas is liberated.



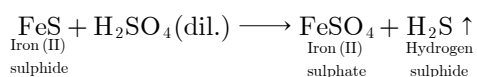
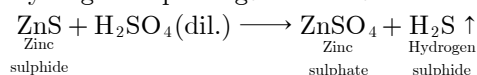
- (c) Reaction with Active metals: On reaction of active metals with dilute sulphuric acids, hydrogen gas is liberated.



- (d) Reaction with metallic sulphites and bisulphites: On reaction of metallic sulphites and bisulphites with dilute Sulphuric acid, Sulphur dioxide is liberated.

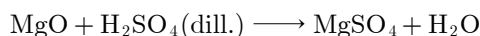
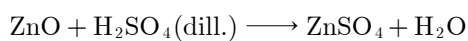
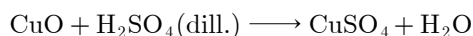
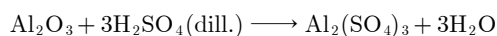


- (e) Reaction with metallic sulphides: On reaction Hydrogen sulphide gas is liberated.



- (f) Reaction with metallic oxide:

It forms salt and water.



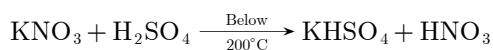
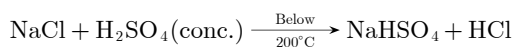
- (g) It shows characteristic colour change with indicators:

Indicators	Colour change
Blue litmus	Red
Phenolphthalein	Remains colourless
Methyl orange	Red or Pink

2. CONCENTRATED SULPHURIC ACID

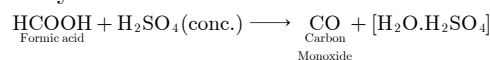
Concentrated Sulphuric acid acts as

- (a) Least volatile acid: Nitrates and chlorides on reaction with concentrated sulphuric acid form their corresponding acids, which are more volatile than sulphuric acid.

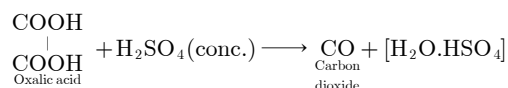


- (b) Dehydrating agent: Concentrated Sulphuric acid acts as dehydrating agent as it has strong affinity for Water. Dehydrating agent is a chemical compound which removes chemically combined elements of Water, Hydrogen and Oxygen in the ratio of 2 : 1.

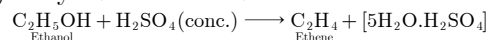
- (i) Dehydration of Formic acid:



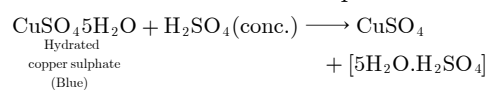
- (ii) Dehydration of Oxalic acid:



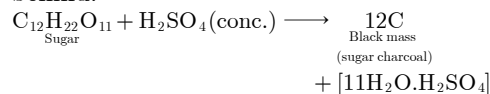
- (iii) Dehydration of Ethanol:



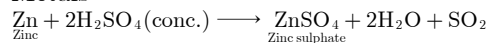
- (iv) Dehydration of Blue vitriol ($\text{CuSO}_4.5\text{H}_2\text{O}$): Blue coloured crystalline Copper sulphate on coming in contact with concentrated H_2SO_4 becomes white and crumbles down to form powder.



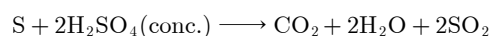
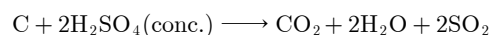
- (v) Dehydration of Sugar: On adding concentrated Sulphuric acid to Sugar, initially the crystals become brown, steam is released causing a lot of frothing and finally a black porous mass is left behind.



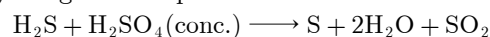
- (c) (i) Metals



- (ii) Non-metals



- (iii) Inorganic compounds



- (d) Drying agent: Concentrated Sulphuric acid acts as a drying agent, i.e. it is used to remove moisture from the gases and other compounds, without undergoing any chemical reaction.

3. DIFFERENCE BETWEEN DRYING AGENT AND DEHYDRATING AGENT

Difference between drying agent and dehydrating agent are as follows :

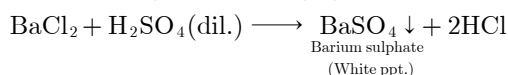
	Drying agent	Dehydrating agent
(i)	It removes moisture from the gases and other compounds.	It removes chemically combined elements of water in the ratio of 2 : 1.

	Drying agent	Dehydrating agent
(ii)	When drying agent is used, the chemical composition of the substance remains unaltered, i.e. a physical change takes place.	When dehydrating agent is used, the chemical composition of the substance gets totally changed or altered, i.e. a chemical change takes place.

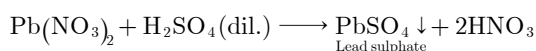
4. TEST FOR SULPHURIC ACID

Test for Sulphuric acid are as follows:

- (a) It gives a white precipitate with Barium chloride solution. White precipitate is insoluble in all the mineral acids.



- (b) It gives a white precipitate with Lead nitrate solution. White precipitate is insoluble in all the mineral acids.



MULTIPLE CHOICE QUESTION

1. The oxidising agent in the equation,
 $\text{S} + 2\text{H}_2\text{SO}_4 \longrightarrow 3\text{SO}_2 + 2\text{H}_2\text{O}$ is:
 (a) Sulphur (b) Sulphuric acid
 (c) Sulphur dioxide (d) Water

Ans :

MAIN 2024

The oxidation state of the Sulphur atom in the ground state changes from 0 to +4. Thus, sulphuric acid oxidises the ground state of the sulphur atom and hence acts as an oxidising agent.

Thus (b) is correct option.

2. In the given equation, identify the role played by concentrated sulphuric acid



- (a) Non-volatile acid
 (b) Oxidising agent
 (c) Dehydrating agent
 (d) None of these above

Ans :

MAIN 2013

It acts as an oxidizing agent. It oxidizes sulphur to sulphur dioxide. The oxidation state of sulphur changes from 0 to +4.

Thus (b) is correct option.

3. The acid which can produce carbon from cane sugar, is :
 (a) Concentrated Hydrochloric acid
 (b) Concentrated Nitric acid
 (c) Concentrated Sulphuric acid
 (d) Concentrated Acetic acid

Ans :

SQP 2020

Reaction of concentrated Sulphuric acid and sugar results in the formation of a black spongy mass of carbon known as sugar charcoal.

Thus (c) is correct option.

4. When dilute sulphuric acid reacts with iron sulphide, the gas evolved is
 (a) Hydrogen sulphide
 (b) Sulphur dioxide
 (c) Sulphur trioxide
 (d) Vapour of sulphuric acid.

Ans :

SQP 2011

The reaction between dilute Sulphuric acid and Iron sulphide:

- Dilute Sulphuric acid reacts with Iron sulphide to give Iron (II) sulphate and Hydrogen sulphide gas as a product.
- During this reaction, hydrogen sulphide gas is liberated with effervescence.

Thus (a) is correct option.

5. Dilute sulphuric acid will produce a white precipitate when added to a solution of :
 (a) copper nitrate
 (b) zinc nitrate
 (c) Lead nitrate
 (d) sodium nitrate

Ans :

MAIN 2008

According to the solubility rule for sulphates, lead sulphate is not soluble in water and thus, lead sulphate precipitates out. Thus, dilute sulphuric acid produces white precipitate when added to the solution of lead nitrate.

Thus (c) is correct option.

6. Nitroglycerine and trinitrotoluene are :
 (a) Fibres (b) Fertilisers
 (c) Detergents (d) Explosives

Ans :

SQP 2000

Nitroglycerine and trinitrotoluene are Explosives. Thus (d) is correct option.

234. A waste management company is tasked with disposing of industrial waste containing Nitric acid. They need to neutralize the acid before disposal to prevent environmental contamination and comply with safety regulations.

- (i) What is a common method for neutralizing Nitric acid in industrial waste?
- (ii) Why is it important to neutralize Nitric acid before disposal?
- (iii) What safety measures should be in place during the neutralization process?
- (iv) How can the company ensure the neutralized waste is safe for disposal?

Ans :

- (i) Neutralizing with a base, such as sodium hydroxide, to form water and a salt.
- (ii) To prevent environmental contamination and protect water sources from acidification.
- (iii) Proper protective equipment, ventilation and monitoring of the reaction to avoid excessive heat or gas release.
- (iv) By testing the pH and chemical composition of the waste to confirm.

Arrhenius theory states that an acid contains hydrogen ions and produces H^+ ions in its aqueous solution.

Thus (a) is correct option.

17. Corrosive action of H_2SO_4 on skin is due to its :
- Oily nature
 - Exothermic nature
 - Volatile nature
 - Dehydrating character

Ans :

COMP 2019

H_2SO_4 acts as oxidizing agent as S is in +6 oxidation state, so can go to lower oxidation state. H_2SO_4 absorbs water and releases high amount of energy hence, it is an exothermic reaction.

Thus (d) is correct option.

ASSERTION AND REASON

18. **Assertion :** Sulphuric acid is commonly called the 'king of chemicals.'

Reason : Sulphuric acid is used in the manufacture of a wide variety of chemicals and is involved in many industrial processes.

- Both assertion and reason are true and reason is the correct explanation of assertion.
- Both assertion and reason are true, but reason is not the correct explanation of assertion.
- Assertion is true, but reason is false.
- Assertion is false, but reason is true.

Ans :

SQP 2010

Sulphuric acid is known as the 'king of chemicals' due to its extensive use in chemical manufacturing and various industrial processes.

Thus (a) is correct option.

19. **Assertion :** Sulphuric acid can be used as a dehydrating agent.

Reason : Sulphuric acid has a strong affinity for water, which allows it to remove chemically combined elements of water.

- Both assertion and reason are true and reason is the correct explanation of assertion.
- Both assertion and reason are true, but reason is not the correct explanation of assertion.
- Assertion is true, but reason is false.
- Assertion is false, but reason is true.

Ans :

MAIN 2015

The strong affinity of sulphuric acid for water enables it to act as a dehydrating agent by removing chemically combined water.

Thus (a) is correct option.

20. **Assertion :** Concentrated sulphuric acid is used in the preparation of other acids.

Reason : Concentrated sulphuric acid is less volatile than most other acids.

- Both assertion and reason are true and reason is the correct explanation of assertion.
- Both assertion and reason are true, but reason is not the correct explanation of assertion.
- Assertion is true, but reason is false.
- Assertion is false, but reason is true.

Ans :

COMP 2003

The low volatility of concentrated sulphuric acid makes it useful in displacing more volatile acids from their salts.

Thus (a) is correct option.

21. **Assertion :** Sulphuric acid turns blue litmus paper red.

Reason : Sulphuric acid is a strong dibasic acid.

- Both assertion and reason are true and reason is the correct explanation of assertion.
- Both assertion and reason are true, but reason is not the correct explanation of assertion.
- Assertion is true, but reason is false.
- Assertion is false, but reason is true.

Ans :

SQP 2018

Sulphuric acid is a strong acid and like all acids, it turns blue litmus paper red.

Thus (a) is correct option.

22. **Assertion :** Sulphuric acid reacts with active metals to produce hydrogen gas.

Reason : Sulphuric acid reacts with metals to form sulphates and liberate hydrogen.

- Both assertion and reason are true and reason is the correct explanation of assertion.
- Both assertion and reason are true, but reason is not the correct explanation of assertion.
- Assertion is true, but reason is false.
- Assertion is false, but reason is true.

Ans :

MAIN 2004

When sulphuric acid reacts with active metals, it forms sulphates and liberates hydrogen gas.

Thus (a) is correct option.

- (iii) Why is it important to cool the gases after the catalytic oxidation step?
- (iv) How could the plant reduce its environmental impact while producing Nitric acid?

Ans :

- (i) By optimizing the catalytic oxidation step to reduce the amount of external heating required.
- (ii) The catalyst facilitates the oxidation of ammonia to Nitric oxide, reducing the activation energy needed for the reaction.
- (iii) Cooling the gases ensures complete oxidation of Nitric oxide to nitrogen dioxide, which is necessary for efficient Nitric acid production.
- (iv) By capturing and recycling any unreacted gases and minimizing emissions of nitrogen oxides.

227. A team of engineers is designing a new storage facility for Nitric acid at a chemical production site. They need to consider the properties of Nitric acid, including its reactivity and potential hazards, to ensure the facility is safe and compliant with regulations.

- (i) What materials should be used for the construction of the Nitric acid storage tanks?
- (ii) Why is it important to have proper ventilation in the Nitric acid storage facility?
- (iii) What additional safety measures should be implemented in the storage facility?
- (iv) How can the design of the storage facility minimize the risk of accidental leaks?

Ans ::

- (i) The tanks should be made of corrosion-resistant materials like stainless steel or specially lined steel.
- (ii) To prevent the buildup of harmful vapors and reduce the risk of corrosion or toxic exposure.
- (iii) Emergency spill containment systems, proper signage and fire suppression systems should be in place.
- (iv) By using double-walled tanks and regular maintenance checks to detect and repair any potential leaks early.

228. A chemical plant uses the Ostwald process to produce Nitric acid, which is then supplied to various industries. The plant is reviewing its processes to improve efficiency and reduce energy consumption during the production of Nitric acid.

- (i) How can the chemical plant improve energy efficiency in the Ostwald process?

- (ii) What role does the catalyst play in the Ostwald process?
- (iii) Why is it important to cool the gases after the catalytic oxidation step?
- (iv) How could the plant reduce its environmental impact while producing Nitric acid?

Ans :

- (i) By optimizing the catalytic oxidation step to reduce the amount of external heating required.
- (ii) The catalyst facilitates the oxidation of ammonia to Nitric oxide, reducing the activation energy needed for the reaction.
- (iii) Cooling the gases ensures complete oxidation of Nitric oxide to nitrogen dioxide, which is necessary for efficient Nitric acid production.
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- (i) The tanks should be made of corrosion-resistant materials like stainless steel or specially lined steel.
- (ii) To prevent the buildup of harmful vapors and reduce the risk of corrosion or toxic exposure.
- (iii) Emergency spill containment systems, proper signage and fire suppression systems should be in place.
- (iv) By using double-walled tanks and regular maintenance checks to detect and repair any potential leaks early.

230. A research lab is studying the reaction of Nitric acid with various metals to understand the formation of metal nitrates. They are particularly interested in the reactions that occur with less common metals and how these reactions could be

31. Green coloured compound formed when SO_2 is passed through acidified Potassium dichromate.

Ans : SQP 2010
Chromium sulphates

32. A neutral oxide of Carbon formed when Formic acid reacts with concentrated Sulphuric acid.

Ans : COMP 2008
Carbon monoxide

33. Acidic gas which cannot be dried by passing through concentrated Sulphuric acid.

Ans : SQP 2000
Hydrogen sulphide

34. Catalyst used during Contact process.

Ans : MAIN 2004
Vanadium pentaoxide

35. Basicity of Sulphuric acid.

Ans : COMP 2001
Two/Dibasic

36. Normal salt and acid salt of Sulphuric acid.

Ans : SQP 2013
Sulphate and Bisulphate

37. Name one acid that is made by using concentrated sulphuric acid.

Ans : MAIN 2012
Hydrochloric acid.

38. Name the process used for the large scale manufacture of Sulphuric acid.

Ans : MAIN 2023
Contact process

DIRECTION : Fill in the blanks :

39. The black colour disappears leaving a _____ solution when adding sulphuric acid to copper oxide.

Ans : MAIN 2017
blue

40. Mixing of colourless acids, such as HBr and H_2SO_4 leads to _____ colouration.

Ans : COMP 2019
reddish brown

41. Addition of sulphuric acid to zinc sulphide flakes release a gas with _____ smell.

Ans : SQP 2007
rotten egg

42. When sulphuric acid is added to barium chloride solution, _____ is formed.

Ans : COMP 2001
white ppt

43. Dilute sulphuric acid reacts with active metals to liberate _____ and form their sulphates.

Ans : SQP 2020
hydrogen

44. Sulphuric acid is a _____ acid. (volatile/non-volatile)

Ans : MAIN 2009
Non-volatile.

45. Pure anhydrous acid is a _____ conductor of electricity. (good/bad)

Ans : COMP 2011
Bad

46. When hot concentrated sulphuric acid is added to sulphur, it gets oxidised to _____ ($\text{H}_2\text{S}/\text{SO}_2$)

Ans : SQP 2022
 SO_2

DIRECTION : Identify the substance in the following:

47. The acid that is a dehydrating as well as a drying agent.

Ans : MAIN 2020
Sulphuric acid

48. A dilute mineral acid which forms a white precipitate when treated with barium chloride solution.

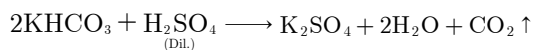
Ans : COMP 2013
Dilute sulphuric acid

49. Gas (C) has an offensive smell like rotten eggs.

Ans : SQP 2010
Hydrogen sulphide

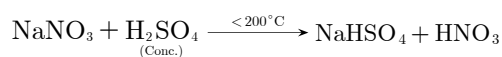
88. Potassium hydrogen carbonate and dilute sulphuric acid.

Ans : SQP 2010



89. Sodium nitrate and concentrated sulphuric acid.

Ans : COMP 2005



90. Dilute Sulphuric acid and Barium chloride

Ans : MAIN 2008



91. Dilute Sulphuric acid and Sodium sulphide

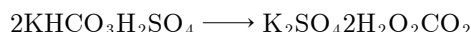
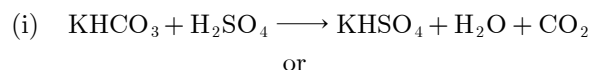
Ans : MAIN 2013



92. Give balanced chemical equations for the action of sulphuric acid on each of the following:

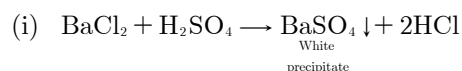
- (i) Potassium hydrogen carbonate.
(ii) Sulphur.

Ans : COMP 2015



93. Write equations for the reaction of concentrated sulphuric acid on Barium chloride and cane sugar.

Ans : SQP 2001



DIRECTION : Answer the following :

94. What do you observe when sugar crystals are added to a hard glass test tube containing concentrated sulphuric acid ?

Ans : MAIN 2011

Sugar chars to give black porous mass.

95. Name the gas evolved in each case (formula is not acceptable).

The gas produced by the action of concentrated

sulphuric acid on sodium chloride.

Ans : COMP 2009

Hydrogen chloride (HCl).

96. State the inference drawn from the following observation :

Salt S is prepared by reacting dilute sulphuric acid with copper oxide. Identify S.

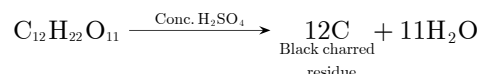
Ans : MAIN 2014

Copper Sulphate (CuSO_4).

97. What would you observe in the following case ?
Sugar crystals are added to a hard glass test tube containing conc. H_2SO_4 .

Ans : COMP 2011

Black charred residue is formed.



98. What property of concentrated sulphuric acid is depicted in action when sugar turns black in its presence ?

Ans : COMP 2008

Dehydrating agent.

99. What do you see when Barium chloride solution is added to dilute Sulphuric acid?

Ans : MAIN 2017

A white precipitate is formed which is insoluble in all the mineral acids.

100. What is the property of concentrated Sulphuric acid which allows it to be used in the preparation of Hydrogen chloride and Nitric acid?

Ans : COMP 2002

Least volatile acid.

101. In using sulphuric acid to prepare the acids such as HCl, HNO_3 ; which property of sulphuric acid is used ?

Ans : SQP 2008

The property used is that sulphuric acid is a non-volatile acid.

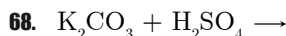
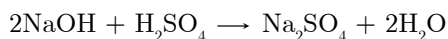
102. Which property of Sulphuric acid accounts for its use as a dehydrating agent?

Ans : MAIN 2019

Concentrated Sulphuric acid has strong affinity for water.

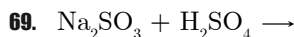
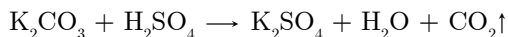
Ans :

MAIN 2018



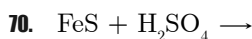
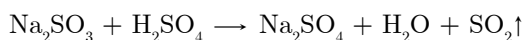
Ans :

COMP 2021



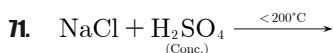
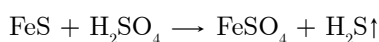
Ans :

MAIN 2014



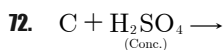
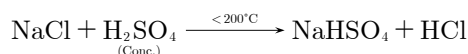
Ans :

SQP 2019



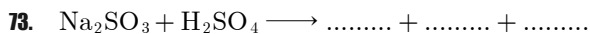
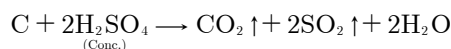
Ans :

COMP 2007



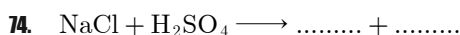
Ans :

SQP 2001



Ans :

MAIN 2022



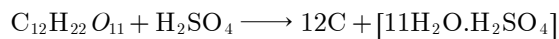
Ans :

COMP 2005



Ans :

SQP 2001



Ans :

SQP 2010



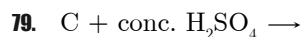
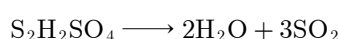
Ans :

COMP 2017



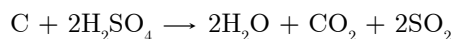
Ans :

MAIN 2002



Ans :

SQP 2019

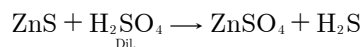


DIRECTION : Write balanced chemical equations for the following:

80. Zinc sulphide and dilute sulphuric acid.

Ans :

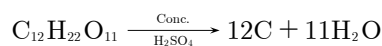
COMP 2012



81. Dehydration of concentrated sulphuric acid with sugar crystals.

Ans :

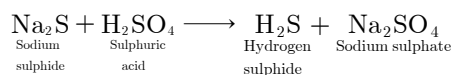
SQP 2013



82. Dilute sulphuric acid and sodium sulphide.

Ans :

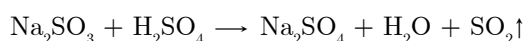
SQP 2008



83. Action of dilute Sulphuric acid on Sodium Sulphite.

Ans :

MAIN 2016



84. Sulphur dioxide acting as an oxidizing agent.

Ans :

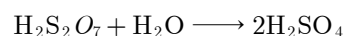
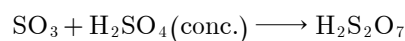
COMP 2010



85. In the contact process for the manufacture of sulphuric acid, give the equations for the conversion of sulphur trioxide to sulphuric acid.

Ans :

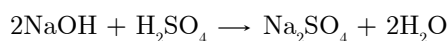
COMP 2015



86. Action of dilute sulphuric acid on sodium hydroxide.

Ans :

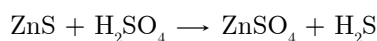
SQP 2005



87. Action of dilute sulphuric acid on zinc sulphide.

Ans :

COMP 2019



- 130.** (i) HCl , HNO_3 and H_2SO_4 are the formulae of three compounds.

Which of these compounds has the highest boiling point and which has the lowest?

- (ii) Dilute Hydrochloric acid and dilute Sulphuric acid are both colourless solutions. How will the addition of Barium chloride solution to each help to distinguish between the two?

Ans :

MAIN 2009

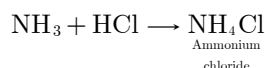
- (i) H_2SO_4 or Sulphuric acid has the highest boiling point.
 HCl or Hydrogen chloride has the lowest boiling point.
- (ii) Dilute Sulphuric acid on reaction with Barium chloride solution gives a white precipitate which is insoluble in all the mineral acids, whereas with Hydrochloric acid there is no reaction.

- 131.** Give a chemical test to distinguish between dilute sulphuric acid and dilute hydrochloric acid.

Ans :

COMP 2001

Dilute hydrochloric acid gives dense white fumes of ammonium chloride when a glass rod dipped in ammonia solution is held near the vapours of the acid.



But dilute sulphuric acid gives no such fumes when a glass rod dipped in ammonia solution is brought near the acid.

- 132.** In this question you are required to supply the word for words that will make each sentence into correct statement which is to be written down again completely.

- (i) Copper sulphate crystals are dehydrated by sulphuric acid.
- (ii) Crystals of sulphur are obtained when a solution of sulphur in carbon disulphide is allowed to evaporate.

Ans :

MAIN 2023

- (i) Copper sulphate crystals are dehydrated by concentrated sulphuric acid.
- (ii) Crystals of rhombic sulphur are obtained when a solution of sulphur in carbon disulphide is allowed to evaporate.

- 133.** Why SO_3 is not directly dissolved in water to form sulphuric acid ?

Ans :

COMP 2018

SO_3 is not directly absorbed in water as

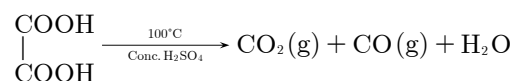
- (i) Reaction is highly exothermic.
- (ii) SO_3 does not form a homogeneous mixture with water.
- (iii) A dense fog of sulphuric acid particles is formed and it may cause disease, 'Phosy Jaw'.

- 134.** What is the function of conc. sulphuric acid in the preparation of CO from oxalic acid ?

Ans :

COMP 2005

The function of conc. H_2SO_4 is to act as a dehydrating agent. When conc. sulphuric acid is treated with oxalic acid crystals, it dehydrates them to form a mixture of carbon monoxide and carbon dioxide gas.



- 135.** Match the Column I with Column II.

	Column-I		Column-II
(i)	Sulphur dioxide	(a)	Sulphuric acid
(ii)	Oil of vitriol	(b)	Burning sulphur smell
(iii)	Oleum	(c)	Rotten egg smell
(iv)	Sulphur trioxide	(d)	Pyrosulphuric acid
(v)	Hydrogen sulphide	(e)	Anhydride of sulphuric acid.

Ans :

SQP 2000

- (i) (b), (ii) (a), (iii) (d), (iv) (e), (v) (c).

- 136.** Why are large quantities of sulphuric acid used in iron and steel industry ?

Ans :

COMP 2009

The iron and steel industries use large quantities of sulphuric acid to remove the coating of oxide from the surface of iron or steel before the metal is plated, or before it is coated with an enamel.

- 137.** Concentrated Sulphuric acid is both an oxidizing agent and a non-volatile acid. Write one equation each to illustrate the above mentioned properties of Sulphuric acid.

Ans :

SQP 2010

Oxidizing agent:



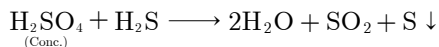
Non-volatile acid:

103. Why is conc. H_2SO_4 not a drying agent for H_2S ?

Ans :

COMP 2020

Conc. H_2SO_4 is not a drying agent for H_2S because it reacts with precipitating sulphur



104. Give reason for the following:

Carbon dioxide and Sulphur dioxide cannot be distinguished by using Lime water.

Ans :

MAIN 2008

Carbon dioxide and Sulphur dioxide cannot be distinguished by using Lime water because both turn Lime water milky.

105. What property of concentrated Sulphuric acid is in action when Sugar turns black in its presence?

Ans :

COMP 2001

Dehydrating agent

106. Why is concentrated sulphuric acid kept in airtight bottles ?

Ans :

MAIN 2012

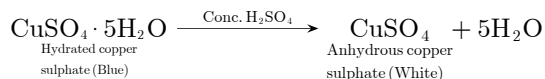
Concentrated sulphuric acid is a hygroscopic liquid. It readily absorbs moisture from the atmosphere and gets diluted. That is why it is kept in airtight bottles.

107. What happens when conc. sulphuric acid is added to a lump of blue vitriol ?

Ans :

SQP 2008

A white substance is obtained due to dehydration.



Water is absorbed by concentrated sulphuric acid.

108. How is dilute sulphuric acid made from the concentrated acid ?

Ans :

SQP 2007

Concentrated sulphuric acid is slowly added to a large volume of water with constant stirring taken in a beaker.

TWO MARKS QUESTIONS

109. What property of Sulphuric acid is exhibited in each of the following cases :

(i) In the preparation of HCl gas when it reacts with Sodium chloride.

(ii) When concentrated Sulphuric acid reacts with Copper to produce Sulphur dioxide gas.

Ans :

SQP 2025

(i) Non volatile property

(ii) Oxidising property

110. (i) HCl , HNO_3 and H_2SO_4 are the formulae of three compounds. Which of these compounds has the highest boiling point and which has the lowest ?

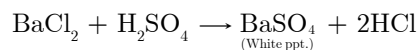
(ii) Dilute hydrochloric acid and dilute sulphuric acid are both colourless solutions. How will the addition of barium chloride solution to each, help to distinguish between the two ?

Ans :

COMP 2007

(i) H_2SO_4 has the highest boiling point and HCl has the lowest.

(ii) $\text{BaCl}_2 + \text{HCl} \longrightarrow \text{No reaction}$

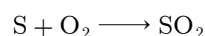


The addition of BaCl_2 will produce white precipitates in case of dilute sulphuric acid solution.

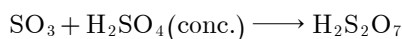
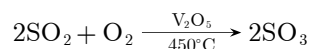
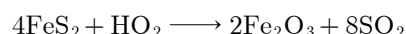
111. With the help of equations, give an outline for the manufacture of sulphuric acid by contact process.

Ans :

MAIN 2011



or



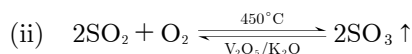
112. Copy and complete the following table which refers to the industrial method for the preparation of ammonia and sulphuric acid :

Name of the compound	Name of the process	Catalytic equations (with the catalyst)
Sulphuric acid	(i) _____	(ii) _____

Ans :

SQP 2019

(i) Contact process



- 113.** (i) Write a balanced chemical equation for the following :
Action of concentrated sulphuric acid on Sulphur.
- (ii) State one relevant observation for the following reaction :
Action of concentrated Sulphuric acid on hydrated copper sulphate.

Ans :

MAIN 2017

- (i) $S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$
- (ii) Hydrated copper sulphate which is blue in colour change to anhydrous copper sulphate which is white in colour.
- 114.** What property of sulphuric acid is shown by the reactant of concentrated sulphuric acid when heated with
- (i) Potassium nitrate
- (ii) Carbon

Ans :

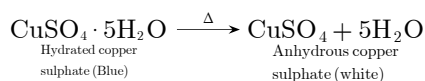
COMP 2011

- (i) non-volatile nature
- (ii) oxidizing agent

- 115.** State one relevant reason for the following :
Hydrated copper sulphate crystals turn white on heating.

Ans :

MAIN 2020



Hydrated copper sulphate loses its five molecules of water and turns anhydrous. This anhydrous copper sulphate is white in colour.

- 116.** Write the equations for the laboratory preparation of the following :
- (i) Iron sulphate from iron
- (ii) Copper sulphate from copper
- (iii) Lead sulphate from lead nitrate
- (iv) Sodium sulphate from sodium carbonate

Ans :

MAIN 2003

- (i) $Fe + H_2SO_4 \xrightarrow{(Dil.)} FeSO_4 + H_2$
- (ii) $Cu + 2H_2SO_4 \xrightarrow{(Conc.)} CuSO_4 + SO_2 + 2H_2O$
- (iii) $Pb(NO_3)_2 + H_2SO_4 \xrightarrow{(Dil.)} PbSO_4 + 2HNO_3$
- (iv) $Na_2CO_3 + H_2SO_4 \xrightarrow{(Dil.)} Na_2SO_4 + H_2O + CO_2$

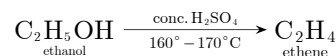
- 117.** Which property of sulphuric acid is shown by the reaction of concentrated sulphuric acid with :

- (i) Ethanol ?
- (ii) Carbon ?

Ans :

COMP 2018

- (i) Dehydrating agent



- (ii) Oxidising agent



- 118.** Identify the gas evolved and give the chemical test in each of the following cases :

- (i) Dilute hydrochloric acid reacts with sodium sulphite.
- (ii) Dilute hydrochloric acid reacts with iron (II) sulphide.

Ans :

MAIN 2016

- (i) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2 \uparrow$
Sulphur dioxide

Chemical Test : Sulphur dioxide decolourises potassium permanganate solution.

- (ii) $FeS + 2HCl \rightarrow FeCl_2 + \underset{\text{Hydrogen sulphide}}{H_2S}$

Chemical Test : Hydrogen sulphide turns lead acetate paper black.

- 119.** Give a chemical test to distinguish between the following pair of compounds :
Carbon dioxide gas and sulphur dioxide gas.

Ans :

COMP 2013

Pass both the gases through excess of lime water. CO_2 gas – turns lime water milky and even in excess of lime water, the milkyness remains. SO_2 gas turns lime water milky but on passage through excess of lime water, milkyness disappears.

- 120.** Name the gas in each of the following :

- (i) A gas which turns acidified potassium dichromate clear green.
- (ii) The gas produced on reaction of dilute sulphuric acid with a metallic sulphide.

Ans :

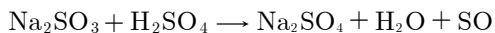
MAIN 2012

- (i) Sulphur dioxide
- (ii) Hydrogen sulphide

- 121.** Distinguish between the following pair of compounds using test given within bracket :
Sodium nitrate and sodium sulphite (using dilute sulphuric acid)

Ans :

SQP 2014

NaNO₃ (Sodium nitrate)NaNO₃ (Sodium sulphite)

- 122.** (i) Choose the correct answer from the options given below :
The catalyst used in the Contact Process is :
(a) Copper
(b) Iron
(c) Vanadium pentoxide
(d) Manganese dioxide
- (ii) Write a balanced chemical equation for the following :
Action of concentrated sulphuric acid on carbon.

Ans :

COMP 2018, 2014

- (i) (c) Vanadium pent-oxide
(ii) $\text{C} + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + 2\text{SO}_2 \uparrow + \text{CO}_2 \uparrow$

- 123.** Identify the acid which matches the following description (i) to (ii) :
(i) The acid which produces sugar charcoal from sugar.
(ii) The acid on mixing with lead nitrate solution produces a white precipitate which is insoluble even on heating.

Ans :

MAIN 2015

- (i) Sulphuric acid.
(ii) Sulphuric acid.

- 124.** Give two industrial uses of sulphuric acid.

Ans :

COMP 2011

Industrial uses of sulphuric acid :

- It is used in the manufacture of fertilisers such as ammonium sulphate superphosphate of lime, etc.
 - It is used in the manufacture of explosives, paints, dyes, drugs, disinfectants, detergents, etc.
- 125.** What would you see when a crystal of CuSO₄·5H₂O is placed in concentrated Sulphuric acid? What is the reason for the observation?

Ans :

SQP 2009

Blue coloured crystals crumble down to form white powder. Concentrated Sulphuric acid is a dehydrating agent and it removes Water of

crystallization from hydrated Copper sulphate thereby leading to above changes.

- 126.** The following statement is correct only under certain conditions. Rewrite statement including the appropriate conditions underlined in your answer.
Oxalic acid reacts with Sulphuric acid to produce Carbon monoxide and Carbon dioxide.

Ans :

MAIN 2000

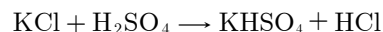
Oxalic acid reacts with concentrated Sulphuric acid to produce Carbon monoxide and Carbon dioxide.

- 127.** What happens when conc. sulphuric acid reacts with :
(i) Potassium chloride.
(ii) Zinc nitrate.
Give equation in each case.

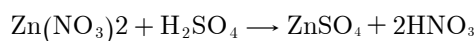
Ans :

COMP 2004

- (i) Conc. sulphuric acid reacts with potassium chloride and forms hydrogen chloride and potassium hydrogen sulphate.



- (ii) Conc. sulphuric acid reacts with zinc nitrate to form zinc sulphate and nitric acid.



- 128.** Name :

- (i) Two acids other than sulphuric acid which can be prepared by using sulphuric acid.
(ii) The catalyst used in the Contact Process.

Ans :

SQP 2013

- (i) Hydrochloric acid and nitric acid.
(ii) Vanadium pentaoxide or platinum.

- 129.** The following statements are correct only under certain conditions. Write each statement including the appropriate condition (s) underlined in your answer.

- (i) Oxalic acid reacts with sulphuric acid to produce carbon monoxide and carbon dioxide.
(ii) Sulphur dioxide is a bleaching agent.

Ans :

COMP 2017

- (i) Oxalic acid reacts with concentrated sulphuric acid to produce carbon monoxide and carbon dioxide.
(ii) Moist sulphur dioxide is a bleaching agent.

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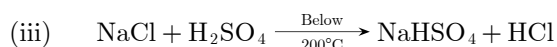
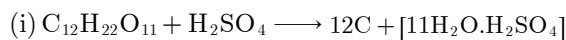
THREE MARKS QUESTIONS

145. Give one equation each to show the following properties of sulphuric acid:

- (i) Dehydrating property.
- (ii) Acidic nature.
- (iii) As a non-volatile acid.

Ans :

MAIN 2014



146. Give examples of the use of sulphuric acid.

- (a) As an electrolyte in everyday use.
- (b) As non-volatile acid.
- (c) As an oxidising agent.

Ans :

SQP 2022

- (a) Use of sulphuric acid in storage batteries.
- (b) Use of sulphuric acid in the preparation of hydrochloric acid, nitric acid and acetic acid.
- (c) Use of sulphuric acid in the preparation of sulphur dioxide.

147. Identify the acid which matches the following description:

- (i) The acid which produces sugar charcoal from sugar.
- (ii) The acid on mixing with lead nitrate solution produces a white precipitate which is insoluble even on heating.
- (iii) A dilute mineral acid which forms a white precipitate when treated with barium chloride Solution.

Ans :

COMP 2015

- (i) Cone. H_2SO_4
- (ii) Dilute sulphuric acid
- (iii) Dilute sulphuric acid

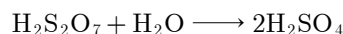
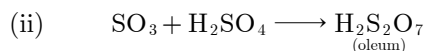
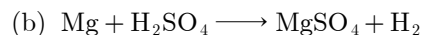
148. (i) Write balanced chemical equations to show:

- (a) The oxidizing action of conc. Sulphuric acid on Carbon.
- (b) The behaviour of H_2SO_4 as an acid when it reacts with Magnesium.
- (c) The dehydrating property of conc. Sulphuric acid with sugar.

(ii) Write balanced chemical equations to show how SO_3 is converted to Sulphuric acid in the contact process.

Ans :

MAIN 2017

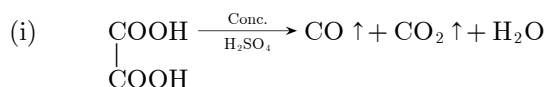


149. Give one equation each to show the following properties of sulphuric acid :

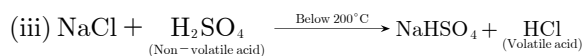
- (i) Dehydrating property.
- (ii) Acidic nature.
- (iii) As a non-volatile acid.

Ans :

COMP 2014

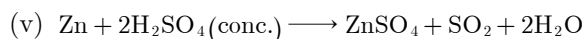
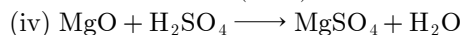
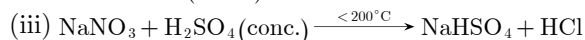
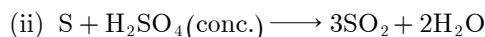


(ii) It reacts with alkalis and shows neutralisation reaction.



150. Some properties of sulphuric acid are listed below. Choose the role played by sulphuric acid as A, B, C, or D which is responsible for the reactions (i) to (v). Some role/s may be repeated.

- A. Dilute acid
- B. Dehydrating agent
- C. Non-volatile acid
- D. Oxidising agent



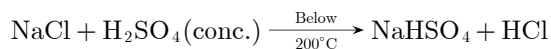
Ans :

COMP 2012

- (i) B (Dehydrating agent)
- (ii) D (Oxidising agent)
- (iii) C (Non-volatile acid)
- (iv) A (Dilute acid)
- (v) D (Oxidising agent)

151. Write the equation for each of the following reactions:

- (i) Sulphur is heated with concentrated sulphuric acid.
- (ii) Concentrated sulphuric acid is poured over sugar.

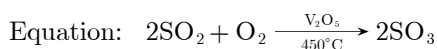


- 138.** Copy and complete the following table relating to important industrial process. Output refers to the product of the process not the intermediate steps.

Name of Process	Inputs	Catalyst	Equation for catalysed reaction	Output
Contact process	Sulphur dioxide + Oxygen			

Ans : MAIN 2008

Catalyst: Vanadium pentaoxide

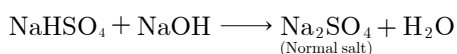
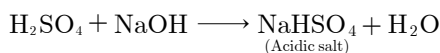


Output: Sulphuric acid.

- 139.** Why is sulphuric acid considered to be a dibasic acid?

Ans : MAIN 2002

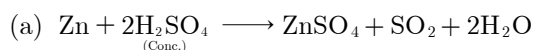
Sulphuric acid neutralises alkalies to form two series of salts (bisulphates and sulphates). For example, when sulphuric acid is treated with sodium hydroxide, first sodium bisulphate is produced and with excess of sodium hydroxide, sodium sulphate is produced.



That is why sulphuric acid is considered to be a dibasic acid.

- 140.** (i) Write the equation for the reaction between zinc and final product of the contact process.
(ii) Name the anion present in the compound D which when warmed with dilute sulphuric acid gives a gas which turns acidified potassium dichromate solution green.

Ans : SQP 2004

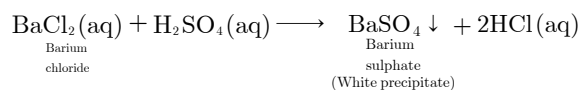


- 141.** How will you test sulphuric acid ?

Ans : COMP 2019

To test sulphuric acid, take a few drops of the given liquid in a test tube and add barium chloride

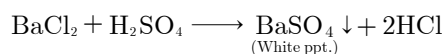
solution to it. If a white precipitate, insoluble in conc. HNO_3 , is formed the given liquid is sulphuric acid. The reaction taking place is :



- 142.** Explain how a reagent chosen from : ammonium hydroxide, barium chloride, sodium chloride, sodium hydroxide, sulphuric acid and nitric acid enables to distinguish between two acids mentioned therein.

Ans : MAIN 2003

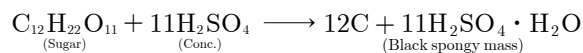
Sulphuric acid and nitric acid can be distinguished by using barium chloride solution. BaCl_2 gives white precipitate with sulphuric acid but not with nitric acid.



- 143.** Why a black spongy mass is formed when concentrated sulphuric acid is added to sugar?

Ans : SQP 2005

A black spongy mass is formed when conc. sulphuric acid is added to sugar. It is because conc. sulphuric acid removes water from sugar and hence black carbon is left behind.



- 144.** Copy and complete the following table relating to the important industrial processes. Output refers to the product of the process and not the intermediate steps.

Name of the process	Inputs	Catalyst	Equation for Catalysed reaction	Output
Contact process	Sulphur dioxide + Oxygen			

Ans : COMP 2016

Name of the process	Inputs	Catalyst	Equation for Catalysed reaction	Output
Contact process	Sulphur dioxide + Oxygen	Vanadium pentaoxide	$2\text{SO}_2 + \text{O}_2 \xrightleftharpoons[450^\circ]{\text{V}_2\text{O}_5/\text{K}_2\text{O}} 2\text{SO}_3$	Sulphuric acid

DIRECTION : Give one word or a phrase for the following statements:

50. The reaction in which carboxylic acid reacts with alcohol in the presence of conc. H_2SO_4 to form a substance having a fruity smell.

Ans :

SQP 2020

Esterification

DIRECTION : State one appropriate observation for each of the following:

51. Concentrated sulphuric acid is added drop wise to a crystal of hydrated copper sulphate.

Ans :

SQP 2013

The blue crystals (of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) change to a white powder of (CuSO_4).

52. Concentrated Sulphuric acid is added to Sugar Crystals.

Ans :

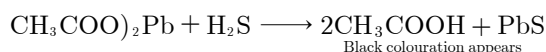
COMP 2016

When conc. sulphuric acid is added to sugar crystals black spongy mass (sugar charcoal) is formed.

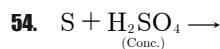
53. When hydrogen sulphide gas is passed through lead acetate solution.

Ans :

MAIN 2015

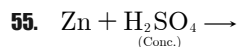
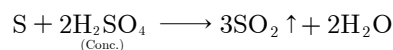


DIRECTION : Complete and balance the following equations :



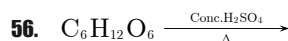
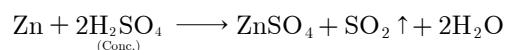
Ans :

COMP 2005



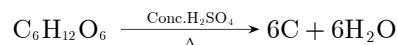
Ans :

SQP 2023



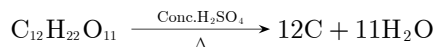
Ans :

COMP 2020



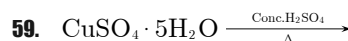
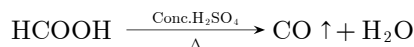
Ans :

MAIN 2011



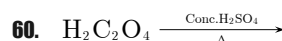
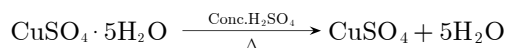
Ans :

SQP 2014



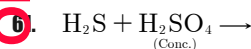
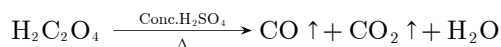
Ans :

COMP 2023



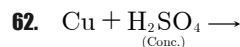
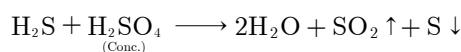
Ans :

SQP 2020



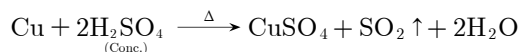
Ans :

COMP 2011



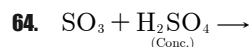
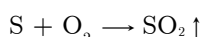
Ans :

MAIN 2000



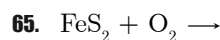
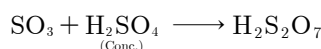
Ans :

MAIN 2008



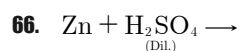
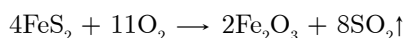
Ans :

SQP 2023



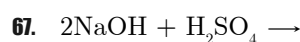
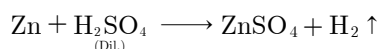
Ans :

MAIN 2012



Ans :

COMP 2017



Drying agents : The substances used for drying organic liquids, solutions and gases are called drying agents. The drying agent should not react chemically, with the gas to be dried. Commonly used drying agents are anhydrous calcium chloride, conc. sulphuric acid, phosphorus pentoxide and silica gels.

Dehydrating agents : A substance having great affinity for water is used as a dehydrating agent. For example, concentrated sulphuric acid has a great affinity for water. It removes readily, elements of water from other compounds. This is called dehydration and concentrated sulphuric acid acts as a dehydrating agent.

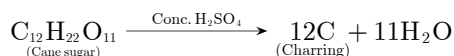
- 178.** Concentrated sulphuric acid (i) has a great affinity for water, (ii) is an oxidising agent, (iii) is the least volatile acid.

Give one reaction each with equations to show the above properties of conc. sulphuric acid.

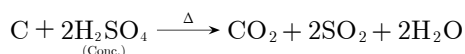
Ans :

MAIN 2007

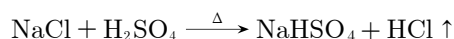
- (i) Affinity for water i.e., as dehydrating agent. When sugar is treated with conc. sulphuric acid, the latter removes all water from former and a black spongy mass of carbon is formed.



- (ii) As oxidising agent : When charcoal (carbon) is heated with conc. sulphuric acid, carbon is oxidised by sulphuric acid to carbon dioxide.



- (iii) As least volatile acid : When sodium chloride is heated with conc. sulphuric acid, volatile hydrogen chloride gas is produced.



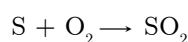
- 179.** Describe in outline the chemistry of manufacture of sulphuric acid from sulphur. (No technical details required, but equations should be given for each stage of process).

Ans :

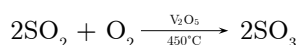
COMP 2007

Outline of Contact Process :

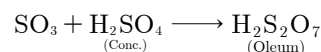
- (i) Oxidation of sulphur



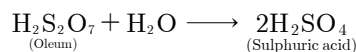
- (ii) Catalytic oxidation of sulphur dioxide



- (iii) Absorption of SO_3 in concentrated sulphuric acid



- (iv) Dilution of oleum with water



FOUR MARKS QUESTIONS

NODIA

- 180.** Write balanced equation for the following:

- Action of concentrated sulphuric acid on carbon.
- Dilute sulphuric acid is poured over sodium sulphite.
- Sulphur is heated with concentrated sulphuric acid.
- Action Dilute sulphuric acid with barium chloride.
- Potassium hydrogen carbonate with dilute sulphuric acid.
- Dehydration of concentrated sulphuric acid with sugar crystals.

Ans :

MAIN 2014, 2013, 2011, 2010

- $\text{C} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 2\text{SO}_2$
- $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2$
- $\text{S} + 2\text{H}_2\text{SO}_4 (\text{conc.}) \longrightarrow 2\text{H}_2\text{O} + 3\text{SO}_2$
- $\text{BaCl}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 \downarrow + 2\text{HCl}$
- $2\text{KHCO}_3 + \text{H}_2\text{SO}_4 (\text{dil.}) \longrightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O} + 2\text{CO}_2$
- $\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{SO}_4 \longrightarrow 12\text{C} + [11\text{H}_2\text{O} \cdot \text{H}_2\text{SO}_4]$

- 181.** (i) Select from the list given (*A* to *E*) one substance in each case which matches the description given in parts (i) to (v).

(*A*) Nitroso Iron (II) sulphate (*B*) Iron (III) chloride (*C*) Chromium sulphate (*D*) Lead (II) chloride (*E*) Sodium chloride.

The compound which is responsible for the green colouration when sulphur dioxide is passed through acidified potassium dichromate solution.

- Write the equation for each of the following reactions :
 - Sulphur is heated with concentrated sulphuric acid.
 - Concentrated sulphuric acid is poured over sugar.
 - Magnesium sulphate solution is mixed with barium chloride solution.

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- (iii) Preparation of copper sulphate from copper oxide.

Ans :

MAIN 2023

- (i) B, Non-volatile acid
(ii) D, Dehydrating agent
(iii) A, Dil. acid

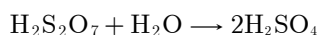
- 162.** (i) In the Contact Process for the manufacture of sulphuric acid, sulphur trioxide is not converted to sulphuric acid by reacting it with water. Instead a two step procedure is used.

Write the equation for the two steps involved.

- (ii) What type of substance will liberate sulphur dioxide from sodium sulphite ?
(iii) Write the equation for the reaction by which sodium sulphite is converted to sulphur dioxide.

Ans :

COMP 2017



- (ii) Dil. acid e.g., dilute sulphuric acid or dilute hydrochloric acid.
(iii) $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2 \uparrow$
(dil.)

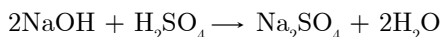
- 163.** Conc. sulphuric acid reacts in various ways

- (i) as an acid
(ii) as a dehydrating agent
(iii) as a less volatile acid. Give an equation for each of the various ways in which it reacts.

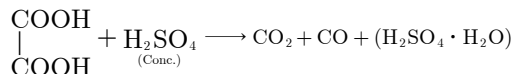
Ans :

SQP 2009

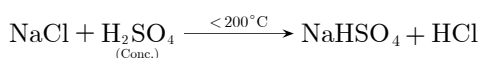
- (i) As an Acid : It is a dibasic acid. It reacts with basic oxide, alkalies to form acid salts (bisulphate) and normal salt (sulphate).



- (ii) As a dehydrating agent : It is a strong dehydrating agent and absorbs water from many reagents.



- (iii) As a less volatile acid :



- 164.** Name the products formed when hot and concentrated sulphuric acid reacts with the following :

- (i) Sulphur
(ii) NaOH

- (iii) Sugar
(iv) Carbon
(v) $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Ans :

MAIN 2015

- (i) Sulphur dioxide
(ii) Sodium sulphate
(iii) Sugar charcoal
(iv) Carbon dioxide and sulphate dioxide
(v) Anhydrous copper sulphate (white)

- 165.** Explain the following :

- (i) In the manufacture of sulphuric acid by the Contact Process, great care is taken to purify the mixture of air and sulphur dioxide, especially to free it from arsenic impurities.
(ii) Whenever water is added to concentrated sulphuric acid or concentrated sulphuric acid is added to water, a large amount of heat is liberated. But the acid dangerously spurts out only when water is added to the concentrated acid.

Ans :

SQP 2006

- (i) This is because the impurities of arsenic poison the platinum catalyst and decrease its efficiency.
(ii) This is because when water is added to acid, there is a sudden increase in temperature and the acid being in bulk tends to spurt out with the steam produced due to the heat energy given out, causing a serious accident.
But when the acid is added to water, the acid being heavier than water settles down and the evolved heat is dissipated in the water itself and therefore, the spurting of the acid is very much decreased.

- 166.** Sulphuric acid can be used to prepare a number of gases in the laboratory. Write balanced equations for the reactions in which the following gases are obtained using dilute sulphuric acid as one of the reactants : (i) hydrogen, (ii) carbon dioxide, (iii) sulphur dioxide.

Ans :

COMP 2015

- (i) $\text{Zn} + \underset{\text{(Dil.)}}{\text{H}_2\text{SO}_4} \longrightarrow \text{ZnSO}_4 + \text{H}_2 \uparrow$
(ii) $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$
(iii) $\text{Na}_2\text{SO}_3 + \underset{\text{(Dil.)}}{\text{H}_2\text{SO}_4} \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2 \uparrow$

- 167.** A, B, C and D summarize the properties of sulphuric acid depending on whether it is dilute or concentrated.

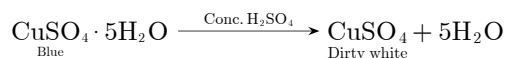
A = Typical acid property

7. Sulphur

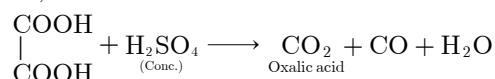
Ans :

SQP 2014

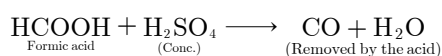
1. When hot conc. H_2SO_4 reacts with $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, its blue colour changes to dirty white because conc. H_2SO_4 absorbs water of crystallisation from $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (hydrated copper sulphate).



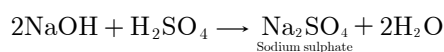
2. When hot conc. H_2SO_4 reacts with oxalic acid, it removes water from the acid.



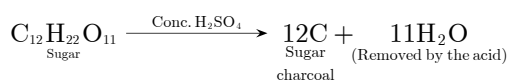
3. When hot conc. H_2SO_4 reacts with formic acid, it removes water from the acid.



4. Hot conc. H_2SO_4 neutralises NaOH to form sodium sulphate (salt) and water.



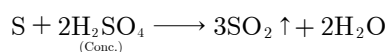
5. When hot conc. H_2SO_4 reacts with sugar, it gets charred.



6. When hot conc. H_2SO_4 reacts with carbon, carbon is oxidised to carbon dioxide by gain of oxygen and sulphuric acid is reduced to sulphur dioxide by loss of oxygen.



7. When hot conc. H_2SO_4 reacts with sulphur, sulphur is oxidised to sulphur dioxide and sulphuric acid is reduced to sulphur dioxide.

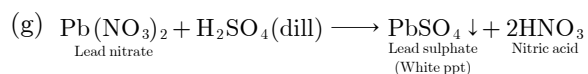
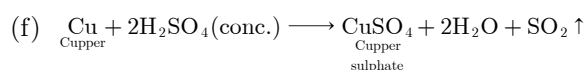
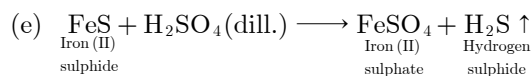
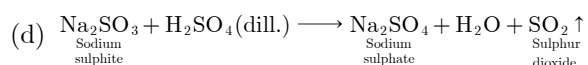
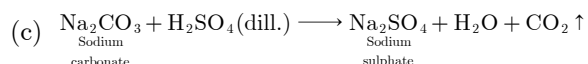
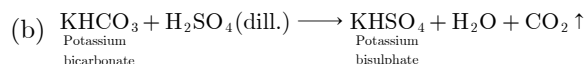
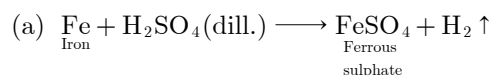


186. Write balanced chemical equations for the reaction of sulphuric acid with

(a)	Iron	(b)	Potassium bicarbonate
(c)	Sodium carbonate	(d)	Sodium sulphite
(e)	Iron (II) sulphite	(f)	Copper
(g)	Lead nitrate		

Ans :

MAIN 2019



187. Give two balanced reactions of each type (for i to iv) to show the following properties of sulphuric acid :

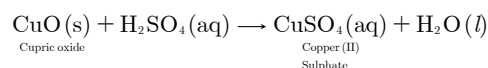
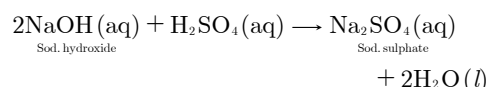
- Acidic nature.
- Oxidising agent.
- Non-volatile nature.
- Hygroscopic nature.

Ans :

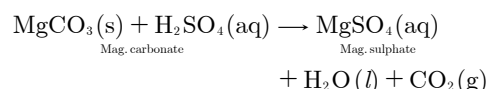
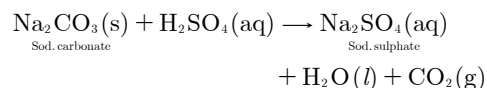
SQP 2023

- (i) Dilute sulphuric acid is a strong acid. It is proved by the following properties of sulphuric acid :

- (a) Dilute sulphuric acid reacts with bases and basic oxides forming sulphates (salts) and water.

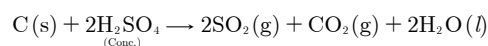


- (b) It reacts with carbonates to produce CO_2 .

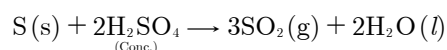


- (ii) Concentrated sulphuric acid behaves as a strong oxidising agent. For example, it oxidises:

- (a) Carbon to carbon dioxide



- (b) Sulphur to sulphur dioxide



- (iii) Concentrated sulphuric acid has a high boiling point (365°C) and is a non-volatile acid. Therefore, it is used for preparing volatile acids like hydrochloric, nitric and acetic acids

(b) Carbon dioxide

State whether the acid used in each case is dilute or concentrated.

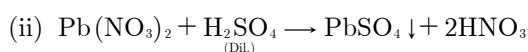
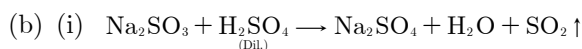
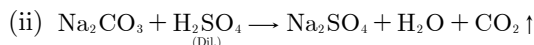
(ii) Write the equations for the laboratory preparation of :

(a) Sodium sulphate using dil. H_2SO_4

(b) Lead sulphate using dil. H_2SO_4

Ans :

COMP 2015



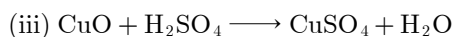
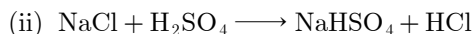
173. Some properties of sulphuric acid are listed below. Choose the property A, B, C, or D which is responsible for the reactions (i) to (v). Some properties may be repeated:

(a) Acid

(b) Dehydrating agent

(c) Non-volatile acid

(d) Oxidizing agent



Ans :

COMP 2019

(i) B or Dehydrating agent.

(ii) C or Non-volatile acid.

(iii) A or Acid.

(iv) A or Acid.

174. A colourless liquid had the following properties :

(i) It slowly turns blue copper sulphate into white powder.

(ii) When warmed with sulphur, a gas smelling of burning sulphur was given off.

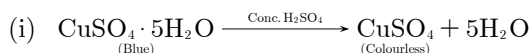
(iii) When a little liquid was poured into water, the water becomes hot.

Suggest a name for the colourless liquid and support your answer by explaining each test in turn.

Ans :

SQP 2004

The colourless liquid is concentrated sulphuric acid (H_2SO_4).



Conc. H_2SO_4 is a dehydrating agent.



Conc. H_2SO_4 acts as an oxidising agent.

(iii) An exothermic reaction occurs due to which temperature rises and water becomes hot.

175. A, B, C and D summarize the properties of Sulphuric acid depending on whether it is dilute or concentrated. Choose the property (A, B, C or D) depending on which is relevant to each of the preparations (i) to (iii).

(A) Dilute acid (typical acid property)

(B) Non-volatile acid

(C) Oxidizing agent

(D) Dehydrating agent.

(i) Preparation of Hydrogen chloride

(ii) Preparation of Ethane from Ethanol

(iii) Preparation of Copper sulphate from Copper oxide.

Ans :

MAIN 2002

(i) Non-volatile acid

(ii) Dehydrating agent

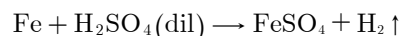
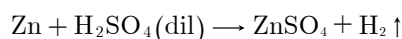
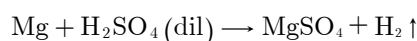
(iii) Dilute acid (typical acid properties).

176. Describe experiments to prove that sulphuric acid contains (i) hydrogen (ii) oxygen.

Ans :

MAIN 2018

(i) Dilute sulphuric acid reacts with metals above hydrogen in the activity series to form hydrogen at room temperature. For example,



It proves that sulphuric acid contains hydrogen.

(ii) Conc. sulphuric acid acts as a strong oxidising agent because it can easily supply an atom of oxygen. It oxidises metals and non-metals into salts and oxides respectively and itself gets reduced to sulphur dioxide. For example,



It proves that sulphuric acid contains oxygen.

177. Distinguish between a drying agent and dehydrating agent.

Ans :

SQP 2010

191. A chemical manufacturing plant is producing sulfuric acid using the Contact Process. The plant ensures that the sulfur dioxide gas used in the process is pure to prevent catalyst poisoning. The sulfur trioxide produced is carefully handled to avoid direct absorption in water and the final product is concentrated sulfuric acid. The plant also utilizes concentrated sulfuric acid for various reactions, including dehydrating sugar and drying gases.

- Why must the sulfur dioxide gas be pure before entering the catalytic chamber in the Contact Process?
- Why is sulfur trioxide not directly absorbed in water during the Contact Process?
- What happens when concentrated sulfuric acid is added to sugar?
- How does concentrated sulfuric acid act when used to dry gases in the manufacturing process?

Ans :

- Impurities in sulfur dioxide can poison the catalyst reducing its efficiency.
- Direct absorption of sulfur trioxide in water is avoided because the reaction is highly exothermic and forms a dense mist of sulfuric acid, which is difficult to condense.
- Concentrated sulfuric acid dehydrates sugar, turning it into a black porous mass.
- Concentrated sulfuric acid acts as a drying agent by removing moisture from the gases without undergoing a chemical reaction.

192. In a laboratory setting, a chemist is conducting a series of experiments to demonstrate the properties of concentrated sulfuric acid. The chemist begins by adding concentrated sulfuric acid to sodium chloride to produce hydrogen chloride gas. Next, the chemist uses the acid to dehydrate ethanol and observes the formation of ethene gas. The chemist then mixes the acid with blue vitriol (hydrated copper sulfate) and observes a color change. Finally, the chemist places a piece of iron into the concentrated acid and notes the reaction.

- What gas is produced when concentrated sulfuric acid reacts with sodium chloride?
- What product is formed when concentrated sulfuric acid dehydrates ethanol?
- What happens to blue vitriol (hydrated copper sulfate) when it is treated with concentrated sulfuric acid?
- What are the products formed when iron reacts with concentrated sulfuric acid?

Ans :

- Hydrogen chloride (HCl) gas is produced.
- Ethene (C_2H_4) gas is formed.
- Blue vitriol loses its water of crystallization and turns white, forming anhydrous copper sulfate.
- Iron sulfate ($FeSO_4$), sulfur dioxide (SO_2) and water (H_2O) are formed.

193. A student is studying the behavior of sulfuric acid with various carbonates. The student adds dilute sulfuric acid to separate samples of sodium carbonate, calcium carbonate and potassium bicarbonate. In each case, a gas is released and a white precipitate forms when the gas is passed through lime-water.

- What gas is released when sulfuric acid reacts with sodium carbonate?
- Why does limewater turn milky when carbon dioxide is passed through it?
- What is the observation when dilute sulfuric acid reacts with calcium carbonate?
- What is the role of potassium bicarbonate in the reaction with sulfuric acid?

Ans :

- Carbon dioxide (CO_2) gas is released.
- Limewater turns milky due to the formation of calcium carbonate ($CaCO_3$).
- Effervescence occurs and carbon dioxide gas is released.
- Potassium bicarbonate reacts with sulfuric acid to release carbon dioxide gas and form potassium sulfate.

194. In a classroom experiment, a teacher demonstrates the reactions of dilute sulfuric acid with various metals. The teacher adds dilute sulfuric acid to zinc, magnesium and iron. Each metal reacts with the acid, producing a gas, which is then tested with a burning splint.

- What gas is produced when zinc reacts with dilute sulfuric acid?
- What observation is made when a burning splint is brought near the mouth of the test tube containing the gas?
- Why does magnesium react more vigorously with dilute sulfuric acid compared to zinc?
- What is the chemical equation for the reaction between iron and dilute sulfuric acid?

Ans :

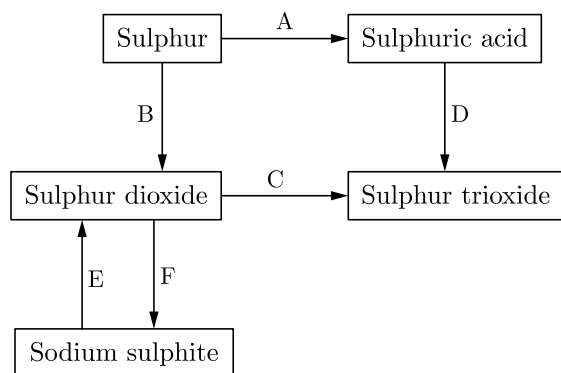
- Hydrogen (H_2) gas is produced.
- The gas burns with a 'pop' sound, confirming

Ans :

COMP 2010

- (i) Chromium sulphate
(ii) (a) $\text{S} + 2\text{H}_2\text{SO}_4 \longrightarrow 3\text{SO}_2 + 2\text{H}_2\text{O}$
(b) $\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{SO}_4 \longrightarrow 12\text{C} + 11\text{H}_2\text{O}$
(b) $\text{MgSO}_4 + \text{BaCl}_2 \longrightarrow \text{BaSO}_4 + \text{MgCl}_2$

- 182.** (i) Name the catalyst which helps in the conversion of sulphur dioxide to sulphur trioxide in step *C*.
- (ii) In the Contact Process for the manufacture of the sulphuric acid, sulphur trioxide is not converted to sulphuric acid by reacting it with water. Instead two steps procedure is used. Write the equations for the two steps involved in *D*.



- (iii) What type of substance will liberate sulphur dioxide from sodium sulphite in step *E*?
- (iv) Write the equation for the reaction by which sulphur dioxide is converted to sodium sulphite in step *F*.
- (v) Name the process used in *A*.
- (vi) What is the reaction involved in *B*?

Ans :

MAIN 2004

- (i) Platinum or vanadium pentaoxide
- (ii)
$$\text{SO}_3 + \text{H}_2\text{SO}_4 \xrightarrow[\text{Conc.}]{\text{Oleum}} \text{H}_2\text{S}_2\text{O}_7$$
$$\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} \longrightarrow 2\text{H}_2\text{SO}_4$$
- (iii) Dil. acid e.g., dil. H_2SO_4 or dil. HCl
- (iv)
$$2\text{NaOH} + \text{SO}_2 \longrightarrow \underset{\substack{\text{Sodium} \\ \text{sulphite}}}{\text{Na}_2\text{SO}_3} + \text{H}_2\text{O}$$
- (v) Contact process
- (vi)
$$\text{S} + \text{O}_2 \xrightarrow{\text{Burn}} \text{SO}_2$$

- 193.** (i) Name two acids other than Sulphuric acid which can be prepared by using Sulphuric acid.
- (ii) In using Sulphuric acid to prepare the acids as

mentioned in (a) which property of Sulphuric acid is used?

- (iii) Sulphuric acid can be used to prepare a number of gases in the laboratory. Write balanced equations for the reactions in which the following gases are obtained using dilute Sulphuric acid as one of the reactants:
- (a) Hydrogen
 - (b) Carbon dioxide
 - (c) Sulphur dioxide

Ans :

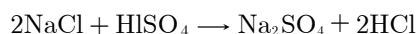
COMP 2019

- (i) Nitric acid and Hydrochloric acid.
- (ii) Least volatile acid.
- (iii) (a) $\text{Mg} + \text{H}_2\text{SO}_4 \longrightarrow \text{MgSO}_4 + \text{H}_2$
(b) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$
(c) $\text{Na}_2\text{S} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SO}_2$

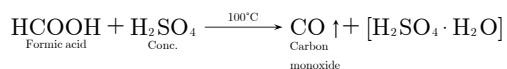
- 184.** What property of conc. sulphuric acid is made use of in each of the following cases. Give equation for the reaction in each case.
- In the production of hydrogen chloride gas when it reacts with a chloride (say, sodium chloride).
 - In the preparation of carbon monoxide gas from formic acid (HCOOH).
 - As a source of hydrogen by diluting it and adding a strip of magnesium.
 - In the preparation of sulphur dioxide by warming a mixture of conc. sulphuric acid and copper turnings.

Ans :

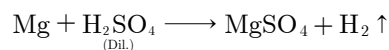
COMP 2023



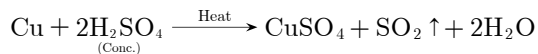
- (i) Conc. H_2SO_4 is a non-volatile acid.
- (ii) Conc. sulphuric acid acts as a dehydrating agent.



- (iii) Dil. H_2SO_4 acts as an acid.



- (iv) Conc. H_2SO_4 acts as an oxidising agent. It oxidises Cu to CuSO_4 and itself gets reduced to SO_2 .



- 195.** What happens when hot and concentrated sulphuric acid reacts with the following :
1. $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
 2. Oxalic acid
 3. Formic acid
 4. NaOH
 5. Sugar
 6. Carbon

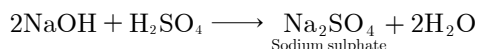
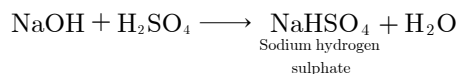
concentrated sulphuric acid is added to potassium bromide.

- (iii) Brisk effervescence is seen when sulphuric acid is added to sodium carbonate.

Ans :

MAIN 2017

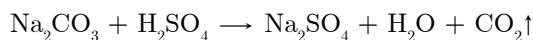
- (i) Sulphuric acid forms two types of salts with NaOH because it is a dibasic acid.



- (ii) When conc. H_2SO_4 is added to potassium bromide (KBr), red brown vapours of bromine gas are produced due to the decomposition of potassium bromide.



- (iii) Brisk effervescence is seen due to the evolution of carbon dioxide when sulphuric acid is added to sodium carbonate.



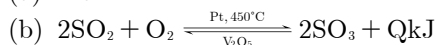
157. (i) What would you observe, when concentrated sulphuric acid is added to copper sulphate-5-water ?
- (ii) (a) Name one catalyst used industrially which speeds up the conversion of sulphur dioxide to sulphur trioxide in the production of sulphuric acid in the laboratory or industrially.
- (b) Write the equation for the conversion of sulphur dioxide to sulphur trioxide. Why does this reaction supply energy ?
- (iii) What is the name of the compound formed between sulphur trioxide and sulphuric acid ?

Ans :

COMP 2000

- (i) Blue colour of copper sulphate-5-water disappears and it becomes colourless.

- (ii) (a) Platinum



This reaction supplies energy because it is an exothermic reaction.

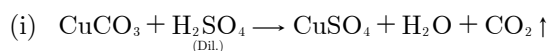
- (iii) Oleum

158. Write balanced equations for the reaction of dilute sulphuric acid with each of the following :

- (i) Copper carbonate
(ii) Lead nitrate solution
(iii) Zinc hydroxide.

Ans :

MAIN 2000



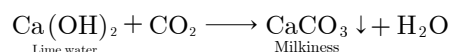
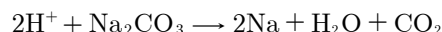
159. A colourless oily liquid was poured slowly into a large volume of cold water. With constant stirring the temperature of the water rose considerably. On testing the solution, only hydrogen and sulphate ions could be detected.

- (i) How would you carry out the test for the presence of hydrogen ions ?
- (ii) Name the oily liquid.

Ans :

COMP 2022

- (i) Treat a part of the solution in a test tube with a pinch of sodium carbonate powder, when carbon dioxide gas is evolved with brisk effervescence. Pass the evolved gas through lime water, when the latter turns milky.



- (ii) Oily liquid is concentrated sulphuric acid.

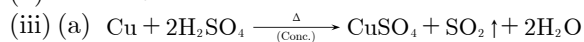
160. (i) State the name of the process by which sulphuric acid is manufactured. Name the catalyst used.
- (ii) Concentrated sulphuric acid is used in the laboratory preparation of nitric acid and hydrochloric acid because it is _____ (less volatile/stronger) in comparison to two acids.
- (iii) Write the equations for the laboratory preparation of the following salts using sulphuric acid.
- (a) Copper sulphate from copper
- (b) Lead sulphate from lead nitrate.

Ans :

SQP 2020

- (i) Contact process, platinum or vanadium penta-oxide (V_2O_5)

- (ii) less volatile



161. Choose the property of sulphuric acid (A, B, C or D), which is relevant to each of the following :

A : Dil. acid (typical acid properties)

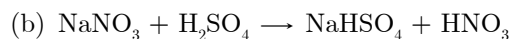
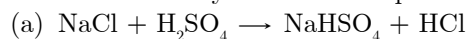
B : Non-volatile acid

C : Oxidising agent

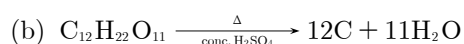
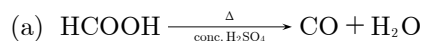
D : Dehydrating agent.

- (i) Preparation of hydrogen chloride
- (ii) Preparation of ethene from ethanol

from their salts by double decomposition.



- (iv) Sulphuric acid readily absorbs moisture from atmospheric air. Therefore, it is hygroscopic in nature. That is why the bottle of sulphuric acid should always be kept stoppered.



- 188.** In what capacity Sulphuric acid and Sulphur dioxide are acting in these reactions?

- Reaction of concentrated Sulphuric acid with Rock salt to prepare HCl.
- Reaction of concentrated Sulphuric acid with Formic acid to produce Carbon monoxide.
- Reaction of dilute Sulphuric acid with active metals to liberate Hydrogen.
- Hydrogen sulphide passed through concentrated Sulphuric acid to produce Sulphur.
- Moist Sulphur dioxide is passed through concentrated Sulphuric acid.
- Concentrated Sulphuric acid reacts with Zinc to liberate Sulphur dioxide

Ans :

COMP 2012

- Concentrated Sulphuric acid is acting as least volatile acid.
- Concentrated Sulphuric acid is acting as dehydrating agent.
- Dilute Sulphuric acid is acting as a typical acid.
- Concentrated Sulphuric acid is acting as oxidizing agent.
- Concentrated Sulphuric acid is acting as drying agent.
- Concentrated Sulphuric acid is acting as oxidizing agent.

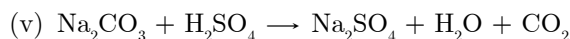
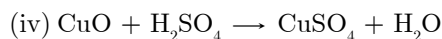
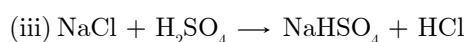
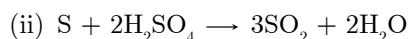
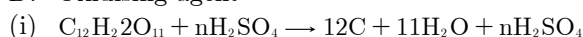
- 189.** Some properties of sulphuric acid are listed below. Choose the property *A*, *B*, *C* or *D* which is responsible for the reactions (i) to (v). Some properties may be repeated :

A. Acid

B. Dehydrating agent

C. Non-volatile acid

D. Oxidising agent



Ans :

COMP 2008

- Dehydrating agent
- Oxidising agent
- Non-volatile acid
- Acid
- Acid

CASE BASED QUESTION

- 190.** A student is performing an experiment in the chemistry lab to investigate the properties of sulfuric acid. The student adds dilute sulfuric acid to different substances to observe their reactions. In separate test tubes, the student adds zinc granules, copper oxide powder, sodium carbonate and blue litmus paper to the dilute acid. The observations are as follows:

Test tube 1 (Zinc): Gas bubbles are observed,

Test tube 2 (Copper oxide): The black powder dissolves, forming a blue solution.

Test tube 3 (Sodium carbonate): Gas bubbles are observed and the limewater turns milky.

Test tube 4 (Blue litmus paper): The paper turns red.

- What gas is released in Test Tube 1 when zinc reacts with dilute sulfuric acid?
- What is the name and color of the compound formed in Test Tube 2 when copper oxide reacts with dilute sulfuric acid?
- What gas is released in Test Tube 3 when sodium carbonate reacts with dilute sulfuric acid and what causes the limewater to turn milky?
- Why does the blue litmus paper in Test Tube 4 turn red when exposed to dilute sulfuric acid?

Ans :

- Hydrogen gas (H_2) is released.
- The compound formed is copper sulfate (CuSO_4), which is blue in color.
- Carbon dioxide (CO_2) is released, causing the lime-water to turn milky.
- The blue litmus paper turns red because sulfuric acid is an acid, which turns blue litmus red.

B = Non-volatile acid

C = Oxidizing agent

D = Dehydrating agent

Choose the property (A , B , C or D) depending on which is relevant to each of the following :

- Preparation of Hydrogen chloride gas.
- Preparation of Copper sulphate from copper oxide.
- Action of conc. Sulphuric acid on Sulphur.

Ans :

MAIN 2012

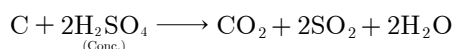
- $\rightarrow B$
- $\rightarrow A$
- $\rightarrow C$

- 168.** (i) Name the process used for the large-scale manufacture of sulphuric acid.
- (ii) Which properties of sulphuric acid account for its use as a dehydrating agent ?
- (iii) Conc. H_2SO_4 is both as an oxidising agent and a non-volatile acid. Write one equation each to illustrate the above mentioned properties of sulphuric acid.

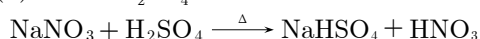
Ans :

COMP 2006

- Contact Process.
- Being hygroscopic in nature, it has strong affinity for water.
- (a) Conc. H_2SO_4 as an oxidising agent.



- (b) Conc. H_2SO_4 as a non-volatile acid.

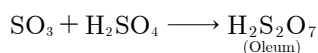


- 169.** (i) Name the oxide of sulphur which reacts with water to give sulphuric acid.
- (ii) In the Contact Process, the direct reaction between the oxide of sulphur and water is avoided. In this process, what does the oxide of sulphur react with instead of water and what is the name of the product ?
- (iii) Give the name and formula of the acid salt which can give sodium ions and sulphate ions in solution.

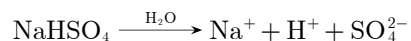
Ans :

COMP 2019

- Sulphur trioxide (SO_3)
- The oxide of sulphur (SO_3) reacts with conc. sulphuric acid. The name of the product is oleum.



- (iii) Sodium bisulphate ($NaHSO_4$)

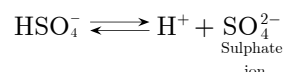
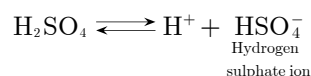


- 170.** "Sulphuric acid" behaves as an acid when diluted with water. Why is this so ?

Ans :

MAIN 2008

Concentrated sulphuric acid has strong covalent bonds with less ions but when sulphuric acid is diluted with water it ionises almost completely into hydrogen ions (H^+) and sulphate ions.



Since presence of H^+ ions imparts acidic character, therefore, solution of sulphuric acid in water behaves as an acid.

- 171.** (i) Outline the steps required to convert hydrogen chloride to anhydrous iron (III) chloride. Write the equations for the reaction which take place.
- (ii) (a) What are the two steps necessary to change lead carbonate into lead chloride?
- (b) Give the name of a soluble lead salt and write the equation for the action of heat on this salt.
- (c) Write the equation for the preparation of nitric acid from potassium nitrate.

Ans :

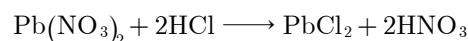
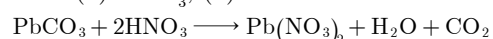
SQP 2001

- (i) Hydrogen chloride can be converted into anhydrous iron (III) chloride by treating it with ferric hydroxide.

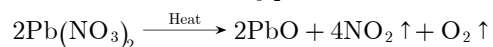
Equation :



- (ii) (a) Lead carbonate can be changed to lead chloride by treating it with hydrochloric acid. (1) HNO_3 , (2) HCl



- (b) Lead nitrate, $Pb(NO_3)_2$



- (c) $KNO_3 + H_2SO_4 \xrightarrow[200^\circ C]{\text{Potassium nitrate (Conc.)}} \underset{\text{Potassium bisulphate}}{KHSO_4} + HNO_3$

- 172.** (i) State the substance/s reacted with dilute or concentrated sulphuric acid to form the following gases :

- (a) Hydrogen

the presence of hydrogen.

- (iii) Magnesium is more reactive than zinc, leading to a more vigorous reaction.
- (iv) $\text{Fe} + \text{H}_2\text{SO}_4 \longrightarrow \text{FeSO}_4 + \text{H}_2$.

195. A factory uses concentrated sulfuric acid to produce oleum by absorbing sulfur trioxide into sulfuric acid. This oleum is then diluted with water to produce more concentrated sulfuric acid as needed. The factory also uses concentrated sulfuric acid to remove water from organic substances.

- (i) What is the chemical formula of oleum?
- (ii) Why is sulfur trioxide not directly absorbed in water during oleum production?
- (iii) What happens when oleum is diluted with water?
- (iv) How does concentrated sulfuric acid act as a dehydrating agent with organic substances?

Ans :

- (i) The chemical formula of oleum is $\text{H}_2\text{S}_2\text{O}_7$.
- (ii) Direct absorption of sulfur trioxide in water forms a dense mist, making it difficult to condense.
- (iii) Diluting oleum with water produces concentrated sulfuric acid.
- (iv) It removes water from organic substances, often leading to charring.

196. In a laboratory, a chemist uses concentrated sulfuric acid to dry hydrogen chloride gas before it is collected in a gas jar. Later, the chemist demonstrates the difference between sulfuric acid and hydrochloric acid by adding them to samples of barium chloride solution.

- (i) Why is concentrated sulfuric acid used to dry hydrogen chloride gas?
- (ii) What observation is made when barium chloride is added to dilute sulfuric acid?
- (iii) Why does hydrochloric acid not produce a precipitate with barium chloride?
- (iv) What is the role of sulfuric acid in this drying process?

Ans :

- (i) Concentrated sulfuric acid absorbs moisture, drying the gas without reacting with it,
- (ii) A white precipitate of barium sulfate (BaSO_4) is formed.
- (iii) Hydrochloric acid forms soluble barium chloride, not a precipitate.

It acts as a drying agent, removing water vapor from the gas.

197. During an industrial process, concentrated sulfuric acid is used to dehydrate oxalic acid. The workers notice that a colorless gas is released, which is later identified as carbon dioxide. The remaining product is tested and found to be sulfur dioxide.

- (i) What happens to oxalic acid when concentrated sulfuric acid is added?
- (ii) What are the two gases produced when concentrated sulfuric acid dehydrates oxalic acid?
- (iii) Why does sulfuric acid act as a dehydrating agent in this reaction?
- (iv) What is the significance of sulfur dioxide being one of the products?

Ans :

- (i) It undergoes dehydration, releasing carbon dioxide (CO_2) and forming sulfur dioxide (SO_2).
- (ii) Carbon dioxide (CO_2) and sulfur dioxide (SO_2) are produced.
- (iii) Sulfuric acid has a strong affinity for water, removing it from oxalic acid.
- (iv) It indicates that sulfuric acid is acting as both a dehydrating agent and an oxidizing agent in this reaction.

198. A chemistry student is conducting an experiment to explore the reactions of dilute sulfuric acid with various bases. The student adds dilute sulfuric acid to solutions of potassium hydroxide, sodium hydroxide and ammonium hydroxide. The student observes that the temperature of the solutions increases slightly and that no gases are released.

- (i) What type of reaction occurs when sulfuric acid reacts with potassium hydroxide?
- (ii) Why does the temperature of the solutions increase during these reactions?
- (iii) What is the chemical equation for the reaction between sulfuric acid and sodium hydroxide?
- (iv) Why is no gas released when ammonium hydroxide reacts with sulfuric acid?

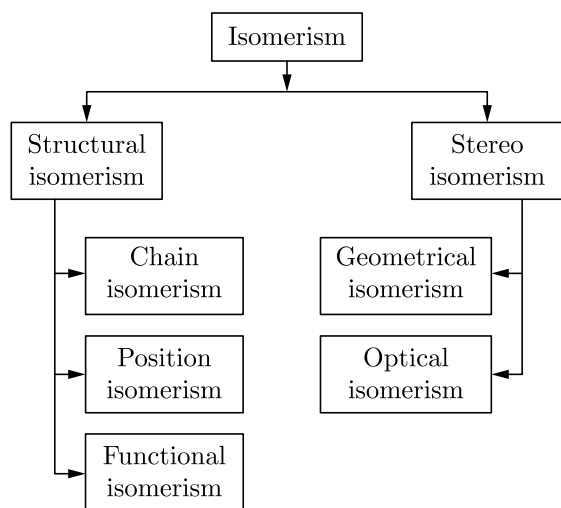
Ans :

- (i) A neutralization reaction occurs, forming potassium sulfate and water.
- (ii) The reactions are exothermic, releasing heat as the acid neutralizes the base.
- (iii) The equation is



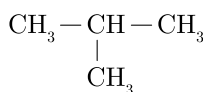
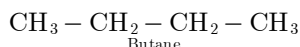
- (iv) The reaction only produces water and ammonium sulfate, with no gas involved.

6. The two isomers differ either in their spatial arrangement of atoms or the groups of atoms or the structure. The difference in structure gives rise to structural isomerism, whereas the different spatial arrangement of atoms or groups of atoms gives rise to stereoisomerism.



- (a) Chain isomerism: The Compounds having the same molecular formula but different arrangement of carbon atoms in Main chain or parent chain are called as chain isomers and the phenomenon is termed chain isomerism.

For example: Butane C_4H_{10}



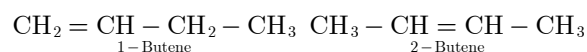
2-Methylpropane

Alkanes only exhibit chain isomerism due to the absence of multiple bonds or functional groups.

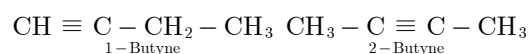
- (b) Position isomerism: The Compounds having the same molecular formula but different positions of multiple bonds (double bond or triple bond) or the functional group are called as position isomers and the phenomenon is termed position isomerism.

For example:

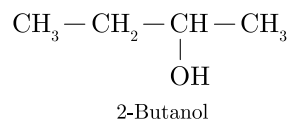
(i) Butene: C_4H_8



(ii) Butyne: C_4H_6

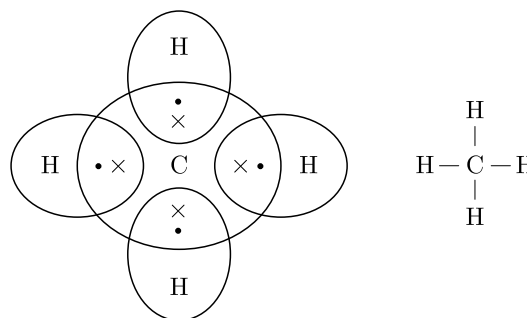


(iii) Butanol: C_4H_9OH



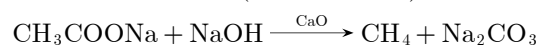
9. METHANE

- Methane is the simplest hydrocarbon. It is commonly called as Marsh gas.
- The four valency of one Carbon atom is satisfied by four Hydrogen atoms by a single covalent bond in methane.

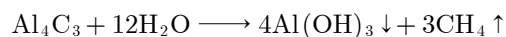


- Generally, Methane is prepared by the following methods:

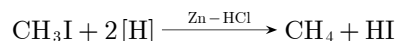
(a) By decarboxylation of Sodium acetate with soda lime ($\text{NaOH} + \text{CaO}$).



(b) By reaction of Aluminium carbide with water.

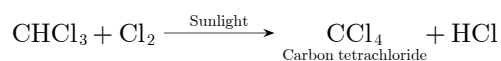
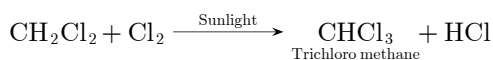
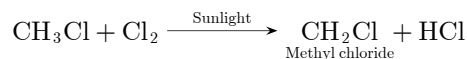
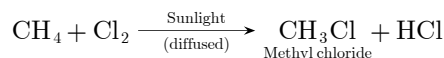


(c) By the reduction of Methyl iodide or Iodomethane.



Methane obtained is collected over water as it is insoluble in water.

- Methane is a colourless, odourless gas which is insoluble in water. Methane is lighter than air and it contributes towards Greenhouse effect.
- As Methane is a saturated hydrocarbon, therefore, it undergoes only substitution reaction.



CHAPTER 12

ORGANIC CHEMISTRY

SUMMARY

1. ORGANIC CHEMISTRY

Organic chemistry is a special branch of chemistry which deals with the study of Compounds of Carbon (hydrocarbon) other than Carbonates, Bicarbonates, Oxides of Carbon, Cyanides, etc.

Earlier it was regarded that organic Compounds could only be produced by nature under the influence of living force called vital force.

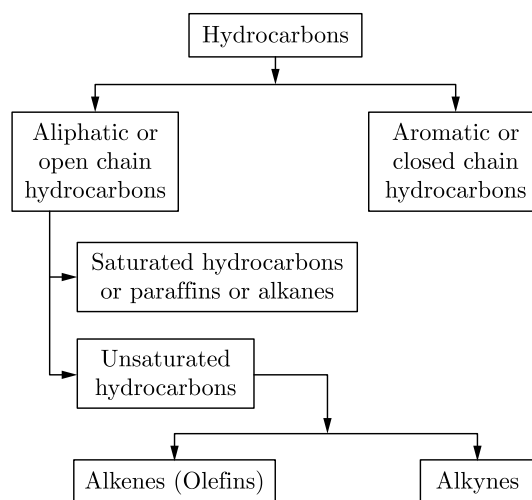
1. The vital force theory got the deathblow after the synthesis of Urea by Wohler in 1828 by heating Ammonium cyanate in laboratory.
2. Carbon atom has a unique property to link with each other so as to form long chains or ring structures. This property is called catenation.
3. All organic compounds essentially contain carbon. Carbon has 4 valence electrons. Therefore, to satisfy its valency, it forms single, double and triple covalent bonds by sharing its electrons with other carbon atoms or with the atoms of other elements. As a result of sharing, it leads to the formation of straight chain, branched chain, closed chain or the ring structures.

	Type of chain	Figure
1.	Straight chain	$\begin{array}{ccccccc} & & & & & & \\ & C & - & C & - & C & \\ & & & & & & \end{array}$ Straight chain
2.	Branched chain	$\begin{array}{ccccccc} & & & & & & \\ & C & - & C & - & C & \\ & & & & & & \\ & & & C & & & \end{array}$ Branched chain

3.	Closed chain	$\begin{array}{c} \\ -C=C-C- \\ \quad \\ -C=C-C- \\ \end{array}$ Ring structure or Closed chain of carbon atoms
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2. HYDROCARBON

The simplest organic compound is called hydrocarbon. These are the Compounds of Hydrogen and Carbon only. The classification of hydrocarbon is shown in the below flow chart



2.1 Characteristics of Organic Compounds

The characteristics of organic Compounds are as follows :

- (i) All organic Compounds are covalent in nature.
- (ii) Almost all the organic Compounds are insoluble in water but soluble in organic solvents like benzene, ether, carbon tetrachloride.
- (iii) Organic Compounds have relatively low melting point and boiling point.

- (iv) All organic Compounds are combustible in nature.

2.2 Differences between Organic and Inorganic Compounds

Differences between Organic and Inorganic Compounds are as follows :

	Organic Compounds	Inorganic Compounds
1.	The essential element present in all the organic Compounds is carbon.	Carbon is not an essential element in inorganic Compounds.
2.	Organic Compounds are insoluble in water but soluble in organic solvents.	Inorganic Compounds are soluble in water.
3.	Organic Compounds are covalent in nature.	Inorganic Compounds are either ionic or polar covalent in nature.
4.	They have low melting point and boiling point.	They have high melting point and boiling point.
5.	They are poor conductor of heat and electricity.	They conduct electricity in fused molten state and in its aqueous solutions.

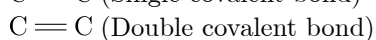
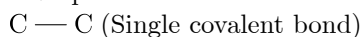
3. IUPAC NOMENCLATURE

Earlier the organic compounds were known by their common names. However, with the discovery of large number of organic compounds, a proper scheme for naming them was formulated by the chemists of International Union of Pure and Applied Chemistry. In short, this scheme is referred to as IUPAC nomenclature.

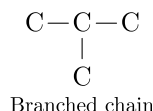
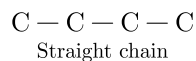
The various guidelines given by IUPAC for the naming of organic Compounds are:

- The chain having the maximum number of Carbon atoms is selected, i.e. the number of carbon atoms present in one molecule of an organic Compound.
- The kind of covalent bonds present between the carbon atoms in the molecule.

For example



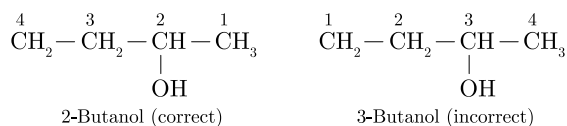
- (iii) The spatial arrangement of carbon atoms, i.e. straight chain or branched chain.



- (iv) On the basis of the number of carbon atoms in one molecule the numbering is assigned from Greek language as shown in the table given below:

Number of Carbon atoms	Greek name
One	meth
Two	eth
Three	prop
Four	but
Five	pent
Six	hex
Seven	hept
Eight	oct
Nine	non
Ten	Dec

- (v) In case, a functional group is present then the chain containing the functional group is selected (no matter it is longest or not). The numbering of carbon chain is done in such a way that the functional group gets the lowest number, e.g.



4. SATURATED HYDROCARBONS OR ALKANES

The Compounds of carbon and hydrogen in which the valencies of all the carbon atoms are satisfied by single covalent bonds are called as saturated hydrocarbons or alkanes (Paraffins). The Compounds having only carbon to carbon single bonds are called as saturated hydrocarbons. The general formula for alkanes is $\text{C}_n\text{H}_{2n+2}$ where n = number of carbon atoms. In alkane, alk — number of carbon atoms present in the hydrocarbon — ane is the single covalent bond present in the hydrocarbon.

For example:

The hydrocarbon with one carbon atom Meth-ane

The hydrocarbon with two carbon atoms Eth-ane
The hydrocarbon with three carbon atoms Prop-ane

The hydrocarbon with four carbon atoms But-ane
For deriving the molecular formula of alkane, the general formula C_nH_{2n+2} is used. The names and formulae of the first four saturated hydrocarbons are given in the table.

No. of Carbon atoms	IUPAC name	Molecular formula	Structural formula	Condensed formula
1	Methane	CH_4	$\begin{array}{c} H \\ \\ H-C-H \\ \\ H \end{array}$	CH_4
2	Ethane	C_2H_6	$\begin{array}{c} H & H \\ & \\ H-C & -C-H \\ & \\ H & H \end{array}$	CH_3-CH_3
3	Propane	C_3H_8	$\begin{array}{c} H & H & H \\ & & \\ H-C & -C & -C-H \\ & & \\ H & H & H \end{array}$	$CH_3-CH_2-CH_3$
4	Butane	C_4H_{10}	$\begin{array}{c} H & H & H & H \\ & & & \\ H-C & -C & -C & -C-H \\ & & & \\ H & H & H & H \end{array}$	$CH_3-CH_2-CH_2-CH_3$

The difference between two consecutive members of alkane is $-CH_2$ group or 14 a.m.u. The $-CH_2$ group is called as the methylene group.

5. HOMOLOGUES

The members of the same class of organic compounds which have a similar structure and similar chemical properties and differ by a CH_2

group are called as homologues and the group of such organic compound is called a homologous series. The characteristics of a homologous series are:

- The homologues are represented by the same general formula.
For example,
Alkanes — C_nH_{2n+2}
Alkenes — C_nH_{2n}
Alkynes — C_nH_{2n-2}
- Each member of a homologous series differs from the next by $-CH_2$ group or by molecular mass of 14 a.m.u.
- All homologues can be prepared by the same general method of preparation.
- All homologues have similar chemical properties but different physical properties due to the change in molecular mass.

6. HYDROCARBONS

The hydrocarbons in which the valency between at least two carbon atoms is satisfied with a double or a triple bond are called as unsaturated hydrocarbons.

Alkenes and Alkynes are the unsaturated hydrocarbons.

The hydrocarbons which contain atleast one double covalent bond between two carbon atoms are called as alkenes.

- The general formula for deriving an alkene is C_nH_{2n} . (where n = number of the carbon atoms).
- The names and the formulae of the first five alkenes are given below in the table.

Common names	No. of Carbon atoms	IUPAC name	Molecular formula	Structural formula	Condensed formula
	1	-	-	Not possible	-
Ethylene	2	Ethene	C_2H_4	$\begin{array}{c} H & & H \\ & & \\ H-C & = & C-H \\ & & \\ H & & H \end{array}$	$CH_2=CH_2$
Propylene	3	Propene	C_3H_6	$\begin{array}{c} H & H & H \\ & & \\ H-C & -C & =C-H \\ & & \\ H & & \end{array}$	$CH_3-CH=CH_2$
Butylene	4	Butene	C_4H_8	$\begin{array}{c} H & H & H & H \\ & & & \\ H-C & -C & -C & =C-H \\ & & & \\ H & H & & \end{array}$	$CH_3-CH_2-CH=CH_2$

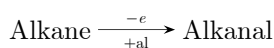
Butane	Butanol	C_4H_9OH	$ \begin{array}{cccc} H & H & H & H \\ & & & \\ H-C & -C- & C- & C-OH \\ & & & \\ H & H & H & H \end{array} $	$CH_3-CH_2-CH_2-CH_2OH$
Pentane	Pentanol	$C_5H_{11}OH$	$ \begin{array}{ccccc} H & H & H & H & H \\ & & & & \\ H-C & -C- & C- & C- & C-OH \\ & & & & \\ H & H & H & H & H \end{array} $	$CH_3-CH_2-CH_2-CH_2-CH_2OH$

7.2 Aldehydic Group

The compounds belonging to aldehydic group

have $\begin{array}{c} O \\ || \\ -C-H \end{array}$ group as the functional group of Compounds of alkanes.

Aldehydes are named as alkanal



The general formula for aldehydes is $C_nH_{2n+1}CHO$ (where n = number of carbon atoms).

For the first member, the value of 'n' must be taken as zero, i.e. the fourth of valency of carbon should be satisfied by hydrogen.

The names and the formulae of the first four members of an aldehyde group are given below in the table.

Alkane	IUPAC name	Molecular formula	Structural formula	Condensed formula
Methane	Methanal	HCHO	$ \begin{array}{c} O \\ \\ H-C-H \end{array} $	$H-CHO$
Ethane	Ethanal	CH_3CHO	$ \begin{array}{c} H & O \\ & \\ H-C & -C-H \\ \\ H \end{array} $	CH_3-CHO
Propane	Propanal	C_2H_5CHO	$ \begin{array}{c} H & H & O \\ & & \\ H-C & -C- & C-H \\ & \\ H & H \end{array} $	CH_3-CH_2-CHO
Butane	Butanal	C_3H_7CHO	$ \begin{array}{c} H & H & H & O \\ & & & \\ H-C & -C- & C- & C-H \\ & & \\ H & H & H \end{array} $	$CH_3-CH_2-CH_2-CHO$

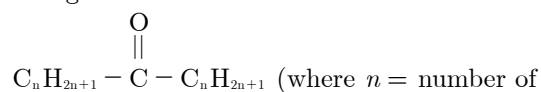
7.3 Ketonic Group

The compounds belonging to ketonic group have

$\begin{array}{c} \diagup \\ C=O \\ \diagdown \end{array}$ group as the functional group of

compounds of alkanes.

The general formula for ketone series is

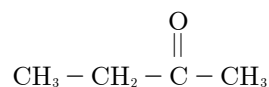


carbon atoms), $R-\begin{array}{c} O \\ || \\ C \end{array}-R$, $R-\begin{array}{c} O \\ || \\ C \end{array}-R'$ (where R and R' are alkyl groups). Ketones are named as

alkanones.

The simplest ketone is propan-2-one having

formula $CH_3-\begin{array}{c} O \\ || \\ C \end{array}-CH_3$ and butan-2-one having formula



Propan-2-one is commonly called acetone.

8. ALKANES

The compounds belonging to ether group have $-O-$ group as the functional group of compounds of alkanes.

2	Ethyl	$-C_2H_5$	$\begin{array}{c} H & H \\ & \\ -C & -C- H \\ & \\ H & H \end{array}$	$=CH_2-CH_3$
3	Propyl	$-C_3H_7$	$\begin{array}{c} H & H & H \\ & & \\ -C & -C & -C- H \\ & & \\ H & H & H \end{array}$	$-CH_2-CH_2-CH_3$
4	Butyl	$-C_4H_9$	$\begin{array}{c} H & H & H & H \\ & & & \\ -C & -C & -C & -C- H \\ & & & \\ H & H & H & H \end{array}$	$-CH_2-CH_2-CH_2-CH_3$

12. The letter '*n*' — (normal) denotes a straight chain of carbon atoms in a given molecule.
13. The letter —*iso* indicates a branch of alkyl group on the second carbon atom from the end of the straight chain of carbon atoms.
14. All organic Compounds are broadly classified in two parts:
- Alkyl group or the hydrocarbon skeleton.
 - the functional group.

- (b) Aldehydes $\begin{array}{c} H \\ | \\ -C=O \end{array}$
- (c) Ketones $\begin{array}{c} \diagup \\ C=O \\ \diagdown \end{array}$
- (d) Ethers $-O-$
- (e) Carboxylic acids $\begin{array}{c} OH \\ | \\ -C=O \end{array}$

7. FUNCTIONAL GROUP

An alkyl group maintains its identity during a chemical reaction, whereas the atoms or the group of atoms attached to the alkyl group which takes part in the chemical reaction is called as the functional group.

The functional groups are

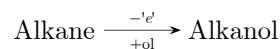
- (a) Alcohols $-OH$

7.1 Alcohol

If $-OH$ (hydroxyl) is the reactive or the functional group present in the molecule of an alkane, then such compound is said to belong to alcoholic group.

The general formula of alcohol is $C_nH_{2n+1}OH$ (where n = number of carbon atoms).

In IUPAC, alcohols are named as alkanols.



The names and the formulae of the first five members of alcohols are given below in the table.

Alkane	IUPAC name	Molecular formula	Structural formula	Condensed formula
Methane	Methanol	CH_3OH	$\begin{array}{c} H \\ \\ H-C-OH \\ \\ H \end{array}$	CH_3-OH
Ethane	Ethanol	C_2H_5OH	$\begin{array}{c} H & H \\ & \\ H-C & -C-OH \\ & \\ H & H \end{array}$	CH_3-CH_2OH
Propane	Propanol	C_3H_7OH	$\begin{array}{c} H & H & H \\ & & \\ H-C & -C & -C-OH \\ & & \\ H & H & H \end{array}$	$CH_3-CH_2-CH_2OH$

199. During a lab session, a teacher demonstrates the reaction between dilute sulfuric acid and various metal carbonates. The teacher adds the acid to samples of sodium carbonate, calcium carbonate and magnesium carbonate. In each case, the reaction produces gas bubbles, which are passed through limewater.

- What gas is released when sulfuric acid reacts with metal carbonates like calcium carbonate?
- What happens when the gas produced is passed through limewater?
- What is the balanced chemical equation for the reaction between sulfuric acid and sodium carbonate?
- Why is the reaction between sulfuric acid and magnesium carbonate considered a double displacement reaction?

Ans :

- Carbon dioxide (CO_2) gas is released.
- The limewater turns milky, indicating the presence of carbon dioxide.
- The equation is
$$\text{H}_{25}\text{O}_4 + \text{Na}_2\text{CO}_2 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$$
- The add and carbonate exchange ions, forming a salt, water and carbon dioxide.

200. A student is asked to identify an unknown solution by performing a series of reactions. The student adds barium chloride solution to the unknown liquid, which results in the formation of a white precipitate. The student then adds dilute hydrochloric acid, but the precipitate remains insoluble.

- What could be the identity of the unknown solution based on the formation of a white precipitate with barium chloride?
- Why does the precipitate remain insoluble in dilute hydrochloric acid?
- What is the chemical equation for the reaction between the unknown solution and barium chloride?
- What further test could confirm the presence of sulfuric acid in the unknown solution?

Ans :

- The unknown solution is likely sulfuric acid or a sulfate solution.
- The white precipitate is barium sulfate, which is insoluble in dilute hydrochloric acid.
- The equation is



- Adding lead nitrate to the solution would

produce a white precipitate of lead sulfate, confirming sulfuric acid.

201. A laboratory technician is testing the corrosive properties of concentrated sulfuric acid. The technician adds the acid to samples of sugar, paper and cloth. In each case, the materials char and turn black, with some releasing steam.

- What property of concentrated sulfuric acid causes the charring of sugar, paper and cloth?
- Why does steam release when concentrated sulfuric acid is added to these materials?
- What chemical change occurs in sugar when it is treated with concentrated sulfuric acid?
- What safety precautions should be taken when handling concentrated sulfuric acid in such experiments?

Ans :

- Concentrated sulfuric acid acts as a dehydrating agent, removing water from the materials.
- The steam is water vapor released as the acid dehydrates the materials.
- Sugar is dehydrated, forming carbon and water.
- Protective gear, such as gloves and goggles, should be worn and the experiment should be conducted in a well-ventilated area.

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The general formula for ether series is

- (a) $C_nH_{2n+1}-O-C_nH_{2n+1}$ (where n = no. of carbon atoms),
 (b) $R-O-R$, $R-O-R'$ (where R and R' are alkyl groups).

Ethers are named as alkoxy alkane. Oxy part is given to the smaller alkyl group, whereas higher alkyl group forms alkane (the parent chain).

The simplest ether is methoxy methane having formula CH_3-O-CH_3 .

1. The Compounds belonging to carboxylic acid

$$\begin{array}{c} O \\ || \\ -C-OH \end{array}$$
 group have

Alkane	IUPAC name	Molecular formula	Structural formula	Condensed formula
Methane	Methanoic acid	HCOOH	$\begin{array}{c} O \\ \\ H-C-OH \end{array}$	B - COOH
Ethane	Ethanoic acid	CH ₃ COOH	$\begin{array}{c} H & O \\ & \\ H-C-C-OH \\ \\ H \end{array}$	CH ₃ - COOH
Propane	Propanoic acid	C ₂ H ₅ COOH	$\begin{array}{c} H & H & O \\ & & \\ H-C-C-C-OH \\ & \\ H & H \end{array}$	CH ₃ - CH ₂ - COOH
Butane	Butanoic acid	C ₃ H ₇ COOH	$\begin{array}{c} H & H & H & O \\ & & & \\ H-C-C-C-C-OH \\ & & \\ H & H & H \end{array}$	CH ₃ - CH ₂ - CH ₂ - COOH

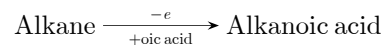
5. The Compounds having the same molecular formula but different structural formula are referred to as isomers and the phenomenon as isomerism.

Isomers of Butane

Common name	IUPAC name	Molecular formula	Structural formula	Condensed formula
<i>n</i> - Butane	Butane	C ₄ H ₁₀	$\begin{array}{c} H & H & H & H \\ & & & \\ H-C-C-C-C-H \\ & & & \\ H & H & H & H \end{array}$	CH ₃ - CH ₂ - CH ₂ - CH ₃
<i>iso</i> - Butane	2-Methylpropane	C ₄ H ₁₀	$\begin{array}{c} H & H & H \\ & & \\ H-C-C-C-H \\ & & \\ H & C & H \\ \\ H \end{array}$	CH ₃ - CH - CH ₃ $\begin{array}{c} \\ CH_3 \end{array}$

of Compounds of alkanes.

2. Carboxylic acids are named as alkanoic acids.



3. The general formula of alkanoic acid is $C_nH_{2n+1}COOH$ (where n = number of carbon atoms).

For the first member, the value of 'n' must be taken as zero, i.e. the fourth valency of carbon atom must be satisfied by hydrogen.

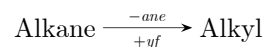
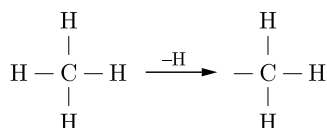
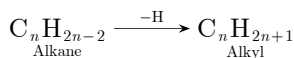
4. The names and the formulae of the first four members of carboxylic acid series are given below in the table.

	5	Pentene	C_5H_{10}	$ \begin{array}{ccccccc} & H & & H & & H & & H & & H \\ & & & & & & & & & \\ H & - C & - & C & - & C & - & C & = & C - H \\ & & & & & & & & & \\ & H & & H & & H & & & & \end{array} $	$CH_3-CH_2-CH_2-CH=CH_2$
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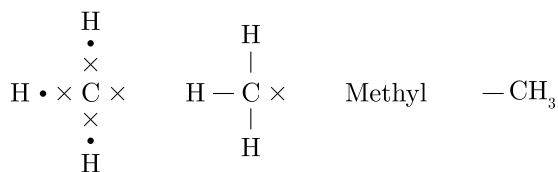
3. The aliphatic hydrocarbons which contain a triple bond between two carbon atoms are called as alkynes. (where n = number of carbon atoms).
4. The general formula for alkynes is C_nH_{2n-2}
5. The names and the formulae of the first five alkynes are given below in the table.

No. of Carbon atoms	IUPAC name	Molecular formula	Structural formula	Condensed formula
1	-	-	Not possible	-
2	Ethyne	C_2H_2	$H-C \equiv C-H$	$HC \equiv CH$
3	Propyne	C_3H_4	$ \begin{array}{c} H \\ \\ H-C \equiv C-C-H \\ \\ H \end{array} $	$HC \equiv C-CH_3$
4	Butyne	C_4H_6	$ \begin{array}{c} H \quad H \\ \quad \\ H-C-C-C \equiv C-H \\ \quad \\ H \quad H \end{array} $	$CH_3-CH_2-C \equiv CH$

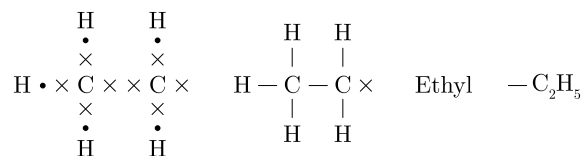
6. An alkyl radical or an alkyl group is the part of an alkane molecule from which one hydrogen atom is removed.



10. An alkyl group has one unpaired electron which is shown by a line.



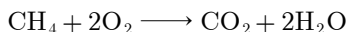
7. An alkyl group is represented by R . It is the hydrocarbon skeleton of any organic Compound.
8. The general formula of alkyl group is C_nH_{2n+1} (where, n = number of carbon atoms).
9. In IUPAC, an alkyl group is named by replacing suffix — 'ane' of the alkane the by suffix — 'yl'.



11. The names and the formulae of the first four members of the alkyl group are given below in the table:

No. of Carbon atoms	IUPAC name	Molecular formula	Structural formula	Condensed formula
1	Methyl	$-CH_3$	$ \begin{array}{c} H \\ \\ -C-H \\ \\ H \end{array} $	$-CH_3$

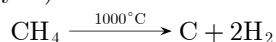
6. Methane burns in free supply of air or oxygen with pale blue flame.



However, in insufficient supply of air, it gives carbon monoxide and water vapour.



7. Methane breaks down into its elements when heated to 1000 °C in the absence of air (Pyrolysis).

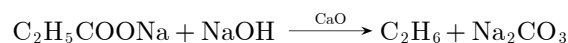


Methane is used:

- as a fuel because it has high calorific value.
- in the preparation of methyl alcohol, formaldehyde and methyl chloride.
- Methane is a greenhouse gas. Along with carbon dioxide, water vapour, nitrous oxide, etc. methane also contributes towards global warming. Greenhouse gases greatly affect the temperature of the earth.

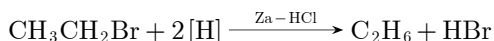
10. ETHANE

1. In laboratory, Ethane is prepared by the reaction of soda lime with Sodium propionate.



It is collected over water.

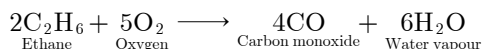
2. Ethane can also be prepared by the reduction of Ethyl bromide or Bromoethane.



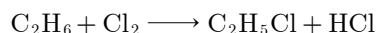
- Ethane is a colourless and odourless gas.
- Ethane is slightly heavier than air and is insoluble in water.
- Ethane burns in sufficient supply of air or oxygen to form carbon dioxide and water vapour.



6. Ethane burns in insufficient supply of air or oxygen to form Carbon monoxide and Water vapour.



7. Ethane is a saturated hydrocarbon, therefore, it undergoes substitution reaction.



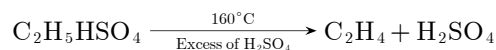
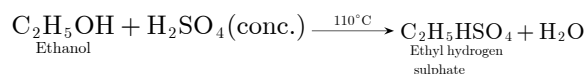
8. Alkanes or saturated hydrocarbons do not show any colour change with bromine solution in carbon tetrachloride and Baeyer's reagent (1% alkaline KMnO₄ solution).

Ethane is used:

- as a fuel.
- in the preparation of ethyl bromide, acetaldehyde and acetic acid.

11. ETHENE

- Ethane or Ethylene is the first member of alkene series. The formula of Ethane is $\text{CH}_2 = \text{CH}_2$.
- (i) It is obtained by dehydration of Ethanol, i.e. Ethyl alcohol.



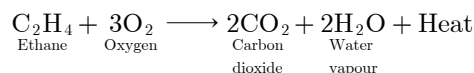
- (ii) The dehalogenation of 1,2-dibromoethane.



- (iii) The dehydrohalogenation of alkyl halide (Ethyl bromide)

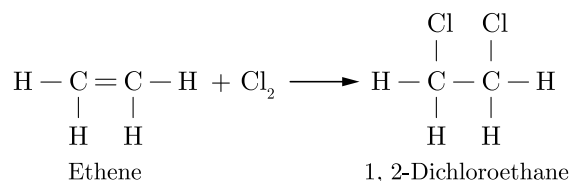


- Ethene is a colourless gas having characteristic smell. It is insoluble in water and slightly lighter than air.
- Ethene burns in sufficient supply of air or oxygen with pale blue flame.



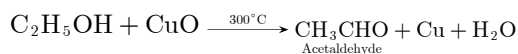
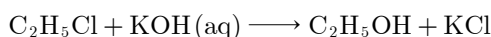
5. As Ethene is an unsaturated hydrocarbon, therefore, it readily undergoes addition reaction.

(a) Addition of Chlorine:

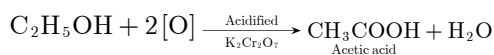
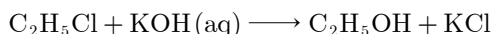


- (b) Addition of Bromine: Ethene decolourises Bromine solution in Carbon tetrachloride. This reaction detects the presence of unsaturation in a given hydrocarbon.

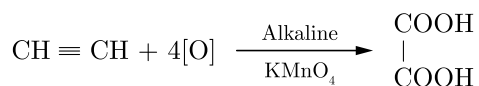
(h) Ethene to Ethanal or Acetaldehyde.



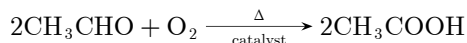
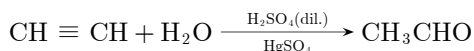
(i) Ethene to Ethanoic acid or Acetic acid.



(j) Ethyne to oxalic acid:



(k) Ethyne to acetic acid : Ethyne (Acetylene) is first converted to acetaldehyde by passing dil. H_2SO_4 in presence of catalyst HgSO_4 which oxidises to acetic acid by passing a mixture of acetaldehyde vapour and air over manganous acetate.



2. Oxyacetylene flame is widely used for welding and cutting of metals. Ethyne is also used for artificial ripening of fruits.

3. (a) Physical properties of alcohols:

- They are inflammable volatile liquids.
- They are soluble in water as well as in organic solvents.
- They are colourless and has characteristic odour and burning taste.
- They are toxic. Methanol when consumed can prove fatal. Ethanol can damage liver and kidney.

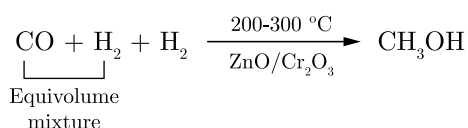
(b) Methyl alcohol or Methanol is commonly called as wood spirit.

It is prepared by:

(i) By reaction of aqueous Sodium hydroxide with Methyl iodide.

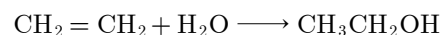


(ii) By the reaction of water gas with half of its volume of Hydrogen.

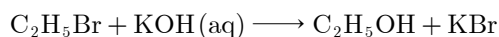


4. Ethanol is prepared by the following methods:

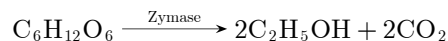
(i) By the hydration of Ethene.



(ii) By the hydrolysis of Ethyl bromide.



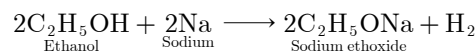
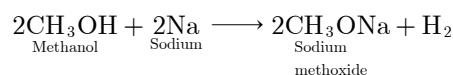
(iii) By the fermentation of Carbohydrates.



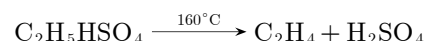
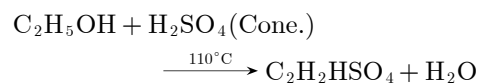
5. Methanol and ethanol are Completely miscible in water.

Methanol is highly poisonous in nature. Ethanol is denatured by adding Methanol, Copper sulphate and Pyridine to make it unfit for human consumption. This is called as Spurious Alcohol (Denatured Alcohol).

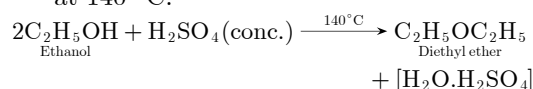
6. Both Methanol and Ethanol react with metal Sodium to liberate a colourless gas which burns with a popping sound.



7. (a) Ethanol gets dehydrated when reacted with conc. H_2SO_4 .



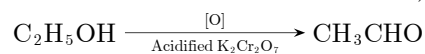
(b) When Ethanol is in excess, it combines with Sulphuric acid to form Diethyl ether at 140°C .



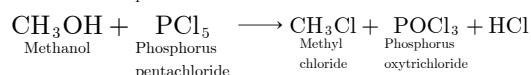
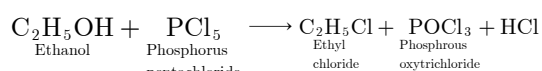
(c) Combustion of ethanol:



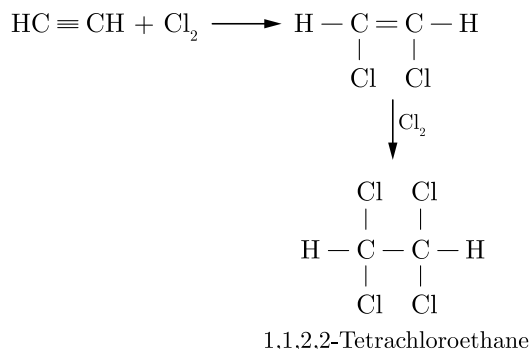
(d) Oxidation of ethanol with $\text{K}_2\text{Cr}_2\text{O}_7$ (preparation of acetic acid from ethanol):



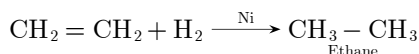
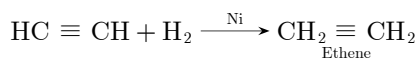
8. Ethanol and Methanol react with PCl_5 :



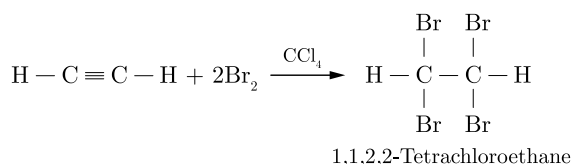
9. Methanol and Ethanol react with acetic acid in the presence of conc. H_2SO_4 to form an



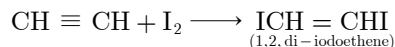
(b) Addition of Hydrogen:



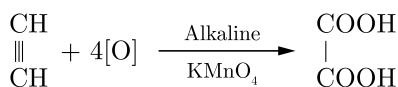
(c) Addition of Bromine: Ethyne decolorizes Bromine solution in carbon tetrachloride. Showing that it is unsaturated hydrocarbon.



(d) Reaction with iodine: Ethyne reacts slowly with iodine in presence of alcohol to form di-iodo ethene.

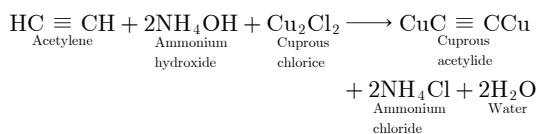


- Ethyne decolorizes Baeyer's reagent. (1% alkaline KMnO_4 solution)

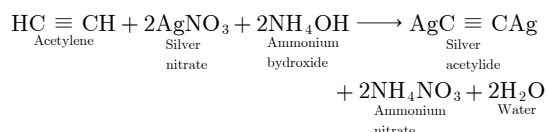


7. Acetylene reacts with Fehling's solution and Tollens' reagent.

(a) With Fehling's solution it gives red precipitate of Cuprous acetylde.

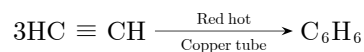


(b) With Tollens' reagent it gives white precipitate of Silver acetylide.



These two reactions distinguish Ethyne from Ethene.

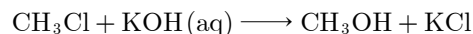
8. Ethyne polymerises to give Benzene.



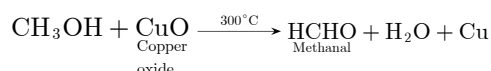
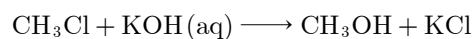
13. IMPORTANT CONVERSIONS OF METHANE, ETHANE AND ETHENE

1. Important conversions of Methane, Ethane, Ethene and Ethyne are as follows :

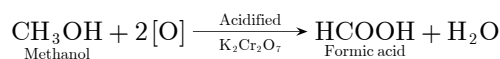
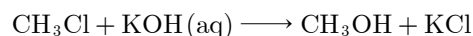
(a) Methane to Methyl alcohol or Methanol.



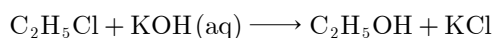
(b) Methane to Formaldehyde or Methanal.



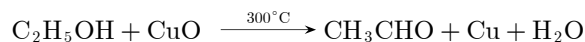
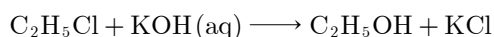
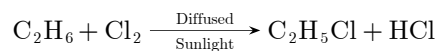
(c) Methane to Methanoic acid or Formic acid.



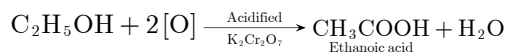
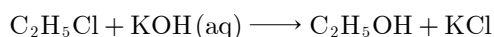
(d) Ethane to Ethyl alcohol or Ethanol.



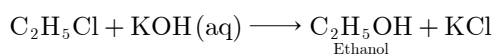
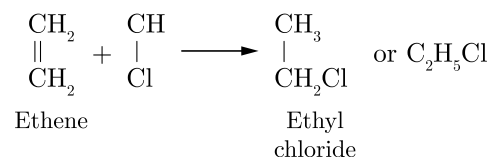
(e) Ethane to Ethanal or Acetaldehyde

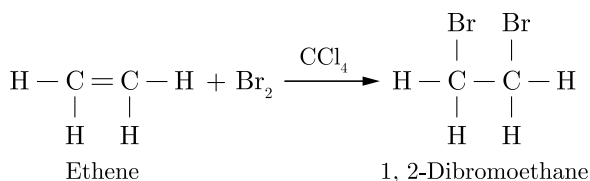


(f) Ethane to Ethanoic acid or Acetic acid.

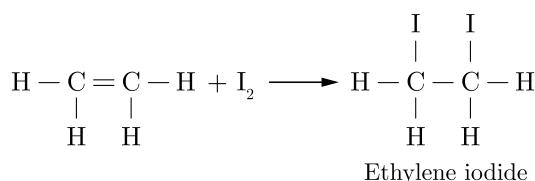


(g) Ethene to Ethanol or Ethyl alcohol.

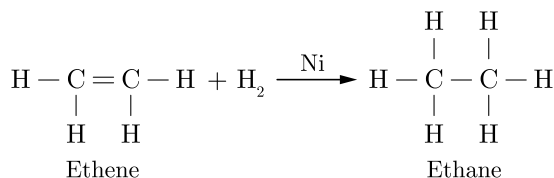




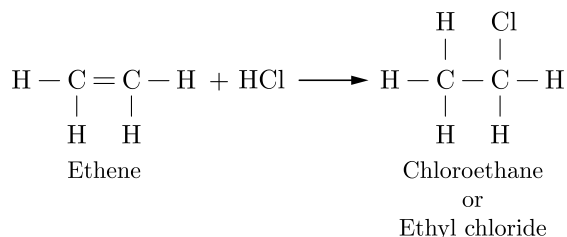
(c) Addition of Iodine: Ethene reacts with iodine slowly and forms ethylene iodide (1, 2 di-iodoethane).



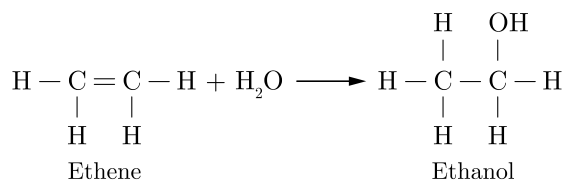
(d) Catalytic hydrogenation: Hydrogen is added to ethene in the presence of Nickel to give ethane.



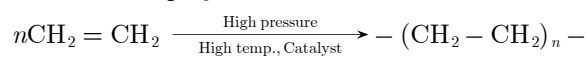
(e) Addition of HCl:



(f) Addition of water:



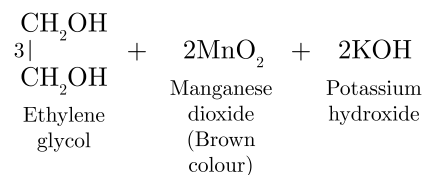
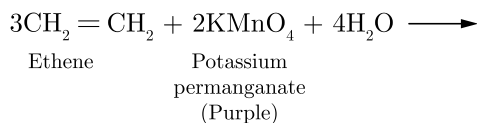
6. Ethene polymerizes to give polythene. The process in which the smaller units (monomer) combine to form a bigger unit (polymer) is called as polymerization.



7. Ethene is used for the manufacture of glycol, acetaldehyde and polythene.

8. Ethene when passed through alkaline Potassium permanganate solution, it

decolourises the purple colour solution.

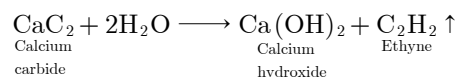


12. ETHYNE

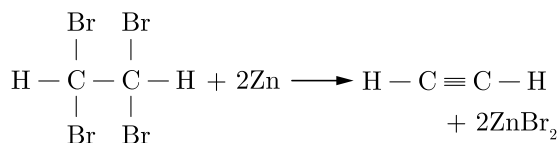
1. Ethyne or Acetylene is the first member of alkyne homologous series.

2. Preparation of Acetylene by the following methods:

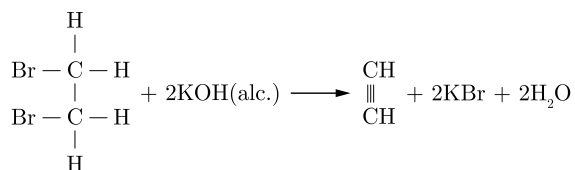
(a) Acetylene is produced by the reaction of Calcium carbide with water. The gas thus obtained is collected over water.



(b) It can also be prepared by the dehalogenation of 1, 1, 2, 2-Tetrabromoethane with Zinc dust.

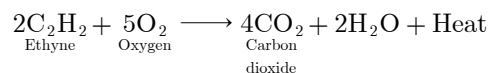


(c) By the dehydrohalogenation of Ethylene dibromide.



3. Acetylene is a colourless gas having characteristic garlic odour. It is insoluble in water but soluble in organic solvents. It is slightly lighter than air.

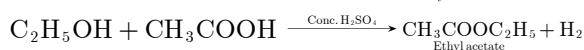
4. Acetylene burns with brilliant white flame when the supply of air is in excess.



5. Ethyne being unsaturated hydrocarbon undergoes addition reaction.

(a) Addition of Chlorine:

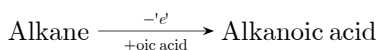
ester. This reaction is called as esterification reaction.



10. (i) Methyl alcohol is used
 - (a) as a solvent
 - (b) in the manufacture of organic Compounds like formaldehyde
 - (c) as an antifreeze
- (ii) Ethyl alcohol is used
 - (a) as a drink
 - (b) in the manufacture of organic Compounds like acetic acid, chloroform, etc.
 - (c) as a solvent.
11. Carboxylic acids are acidic Compounds having

O
 $\parallel$
 — C — OH

 one or more carboxylic group
12. The name carboxyl is derived by the combination of carbonyl group and the hydroxyl group.
13. In IUPAC carboxylic acids are named as alkanoic acid.



14. Aliphatic carboxylic acids can be further classified as mono, di, tri carboxylic acids depending upon the number of carboxylic acid groups present in their respective molecules.
15. Acetic acid or ethanoic acid is an aliphatic monocarboxylic acid.
16. It is the Main constituent of vinegar.
17. Physical properties of acetic acid are:
 - (i) At ordinary temperature, acetic acid is colourless, corrosive liquid with sharp penetrating (pungent irritating) odour.
 - (ii) It has sour taste.
 - (iii) Below 16.5 °C, it solidifies into a glassy mass or ice like crystals and hence called as glacial acetic acid.
 - (iv) It is soluble in water as well as in alcohol and ether.
 - (v) It is heavier than water.
18. The chemical properties of carboxylic acid

O
 $\parallel$
 — C — OH

 due to — C — OH in their molecules.
 - (i) Acidic nature:

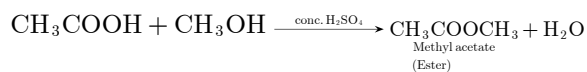
$$\text{CH}_3\text{COOH} + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$$
 Being acidic in nature, acetic acid turns blue litmus red.
 - (ii) Reaction with metals:



(iii) Reaction with alkalis:



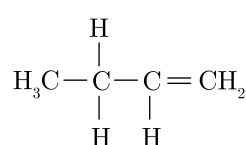
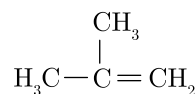
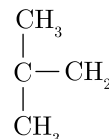
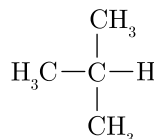
(iv) When heated with alcohol in the presence of concentrated sulphuric acid, it forms an ester. The reaction is reversible in nature and is known as esterification.



19. Acetic acid is used
 - (i) as a solvent and laboratory reagent.
 - (ii) in the form of vinegar in pickles (preservative)
 - (iii) in the manufacture of acetone, acetyl chloride, acetic anhydride, etc.
 - (iv) for making dyes, perfumes and medicines.

MULTIPLE CHOICE QUESTION

1. The structures of four hydrocarbons are shown below:



How many isomers of butene are there?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

Ans :

SQP 2025

Thus (b) is correct option.

2. Element 'P' has electronic configuration 2,8,8,1. The number of chlorine atoms present in the chloride of 'P' is:

- (a) 2
- (b) 1
- (c) 3
- (d) 4

Ans :

SQP 2025

Element 'P' has electronic configuration 2,8,8,1. The number of chlorine atoms present in the chloride of 'P' is 1.

Thus (b) is correct option.

40. Active metals react with carboxylic acid liberating gas.

(a) oxygen (b) hydrogen
(c) methane (d) carbon dioxide

Ans :

COMP 2000

When carboxylic acid reacts with active metals, the products formed are salt and hydrogen gas is liberated. The presence of hydrogen gas can be tested if the burning splinter is brought near the mouth of the test tube, the hydrogen gas will burn with a pop sound.

Thus (b) is correct option.

41. Organic Compounds are in polar solvents.

(a) insoluble (b) soluble
(c) partially soluble (d) partially insoluble

Ans :

MAIN 2002

Generally organic Compounds are non-polar so, most of them are insoluble in water as water is a polar solvent.

Thus (a) is correct option.

42. A saturated Compound having six carbon atoms will be known as

(a) benzene (b) hexane
(c) dibenzene (d) naphthalene

Ans :

SQP 2007

The number of carbon atoms in an organic Compound is given by the word root for it. The root word for a hydrocarbon Compound with 6 carbon atoms is Hex. So, if an alkane has 6 carbon atoms in it in a straight line it will be called hexane.

Thus (b) is correct option.

43. Pure acetic acid is called acetic acid.

(a) dilute (b) concentrated
(c) glacial (d) hydrated

Ans :

COMP 2009

Pure acetic acid is known as glacial acetic acid because it freezes into white crystals that look like glaciers when the temperature drops below room temperature.

Thus (c) is correct option.

44. The Compound that should be heated with soda lime to obtain ethane gas in the laboratory is

(a) sulphuric acid (b) ethane
(c) sodium propionate (d) None of these

Ans :

MAIN 2010

Sodium propionate is heated with soda lime to obtain ethane gas in the laboratory.

Thus (c) is correct option.

45. C_3H_7 is named as radical.

(a) Alkyl (b) Ethyl
(c) Propyl (d) Butyl

Ans :

COMP 2015

The molecular formula C_3H_7 can refer to both the isopropyl radical and the n-propyl radical.

Thus (c) is correct option.

46. Urea was first obtained by heating ammonium cyanate by :

(a) Lavoisier (b) Haber
(c) Berzelius (d) Wohler

Ans :

SQP 2019

Urea was first prepared by Friedrich Wohler.

Thus (d) is correct option.

47. Dehydration of ethyl alcohol gives

(a) Ethane (b) Ethene
(c) Ethanoic acid (d) Ethyne

Ans :

COMP 2010

Dehydration of ethanol gives Ethene. Ethanol undergo dehydration to give Ethene by heating with concentrated Sulphuric acid by the removal of water.

Thus (b) is correct option.

48. The property of carbon to form chains and rings is called :

(a) Polymerisation (b) Catenation
(c) Cracking (d) Hydrogenation

Ans :

MAIN 2015

Carbon has a unique property of self-linking called catenation, in which it can form numerous types of molecules by Carbon-Carbon bonding.

Thus (b) is correct option.

49. Which of the following forms a homologous series?

(a) Butane, 2-methylbutane, 2, 3-dimethylbutane
(b) Ethane, propane, butanone
(c) Methanol, ethanol, propanoic acid
(d) Ethane, ethylene, acetylene

Ans :

SQP 2018

A homologous series is a group of organic Compounds (Compounds that contain C atoms) that differ from each other by one methylene (CH_2) group. For e.g. butane, 2-methylbutane, 2,

and -yne is used to represent the presence of triple covalent bond between the carbon atoms.

Thus (d) is correct option.

12. 3-phenylprop-2-enoic acid is IUPAC name of
 (a) Cinnamic acid (b) Pivalic acid
 (c) Succinic acid (d) Mendallic acid

Ans :

MAIN 2016

3-phenyl prop-2-enoic acid is IUPAC name of cinnamic acid.

Thus (a) is correct option.

13. Which of the following decolourise bromine water as well as Baeyer's reagent ?
 (a) Propyne (b) Cyclopropane
 (c) Propane (d) Benzene

Ans :

SQP 2000

Propyne decolourise bromine water as well as Baeyer's reagent.

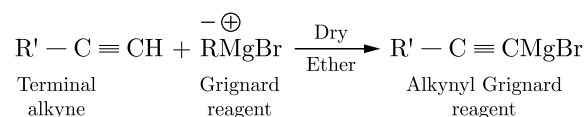
Thus (a) is correct option.

14. The treatment of $R-MgBr$ with $R'C \equiv CH$ produces
 (a) $R-R'$ (b) $R'H$
 (c) $R-R$ (d) RH

Ans :

COMP 2005

$R'C \equiv CH$ on reaction with $R-MgBr$ forms alkane.



Thus (d) is correct option.

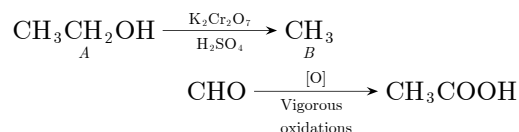
15. $A \xrightarrow[H_2SO_4]{K_2Cr_2O_7} B \xrightarrow[\text{Vigorous oxidation}]{[O]} CH_3COOH$

Identify the reactant A

- (a) Propyl alcohol
 (b) Isopropyl alcohol
 (c) Ethyl alcohol
 (d) tent-pentyl alcohol

Ans :

MAIN 2006



Here 'A' is C_2H_5OH (ethanol).

Thus (c) is correct option.

16. The reactivity of carboxylic acid towards esterification is highest in

- (a) formic acid (b) propionic acid
 (c) acetic acid (d) iso-butyric acid

Ans :

SQP 2010

The reactivity of carboxylic acid towards esterification is less due to presence of alkyl group hence, formic acid shows highest esterification reactivity.

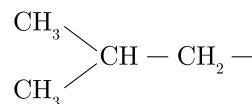
Thus (a) is correct option.

17. The IUPAC name for iso-butyl group is
 (a) 2-methylethyl (b) 1, 1-dimethylethyl
 (c) 1-methylpropyl (d) 2-methylpropyl

Ans :

COMP 2011

Formula of isobutyl group



IUPAC name: 2-methyl propyl

Thus (d) is correct option.

18. What will be the final oxidation product of ethyl alcohol ?
 (a) Acetic acid (b) Acetone
 (c) Acetaldehyde (d) None of these

Ans :

MAIN 2017

The final oxidation product of ethyl alcohol, or ethanol (CH_3-CH_2OH), is acetic acid (CH_3-COOH). This happens when ethanol is oxidized by adding oxygen atoms or bonds, usually using a strong oxidizing agent like chromic acid or potassium dichromate

Thus (a) is correct option.

19. The family to which methoxy ethene belongs is
 (a) hydrocarbon (b) ketone
 (c) ester (d) unsaturated ether

Ans :

COMP 2019

The formula of methoxy ethene is $CH_3OCH=CH_2$. It contains a double bond. So, it belongs to unsaturated ether.

Thus (d) is correct option.

20. A gas which is also known as marsh gas.
 (a) Ethane (b) Ethene
 (c) Methane (d) None of these

Ans :

SQP 2020

Methane is called marsh gas because it is found at the surface of marshy places

Thus (c) is correct option.

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3. Unsaturated hydrocarbons undergo:

- (a) Addition reaction
- (b) Substitution reaction
- (c) Oxidation reaction
- (d) Redox reaction

Ans :

MAIN 2024

Unsaturated hydrocarbons such as alkenes and alkynes, undergo addition reactions because being highly reactive, the unsaturated bonds are broken with the addition of new atoms or groups to form the saturated molecule.

Thus (a) is correct option.

4. Reaction of an alcohol with a carboxylic acid in the presence of concentrated H_2SO_4 is termed as:

- (a) Halogenation
- (b) Esterification
- (c) Hydrogenation
- (d) Dehydrohalogenation

Ans :

MAIN 2024

The reaction of an alcohol with a carboxylic acid in the presence of sulphuric acid (H_2SO_4) is called an esterification reaction.

Thus (b) is correct option.

5. Conversion of Ethanol to Ethene by the action of concentrated sulphuric acid involves:

- (a) Dehydration
- (b) Dehydrogenation
- (c) Dehydrohalogenation
- (d) Hydrolysis

Ans :

MAIN 2024

Elimination of the water molecule usually from an alcohol is known as dehydration reaction.

Thus (a) is correct option.

6. The organic Compound mixed with ethanol to make it spurious is:

- (a) Methanal
- (b) Methanoic acid
- (c) Methanol
- (d) Ethanoic acid

Ans :

MAIN 2010

Methanol is the organic Compound mixed with ethanol to make it spurious. Ethanol mixed with small amounts of methanol is called spurious alcohol. Spurious alcohol is an illicit liquor produced through improper distillation.

Thus (c) is correct option.

7. The organic Compound having a triple carbon-carbon covalent bond, is :

- (a) C_3H_8
- (b) C_3H_6
- (c) C_3H_4
- (d) C_4H_{10}

Ans :

MAIN 2020

Organic Compounds that have a triple carbon-carbon covalent bond are called alkynes. Alkynes are unsaturated hydrocarbons with the general formula $\text{C}_n\text{H}_{2n-2}$.

Thus (c) is correct option.

8. The formation of 1, 2-dibromo ethane from ethene and bromine is an example of

- (a) Substitution
- (b) Addition
- (c) Dehydrohalogenation
- (d) Dehydration

Ans :

SQP 2008

It's an example of addition reaction. Bromine reacts with alkene and forms dibromoalkane by breaking the double bond.

Thus (b) is correct option.

9. The reaction of ethanol with concentrated H_2SO_4 does not give.

- (a) Ethene
- (b) Diethyl ether
- (c) Ethyl hydrogen sulphate
- (d) Acetylene

Ans :

COMP 2002

When alcohols react with Acetic acid in the presence of concentrated Sulphuric acid, it commonly results in the formation of Ester Compounds, sometimes alkenes based on the alcohol that is reacting. Hence, the reaction of Ethanol with concentrated Sulphuric acid does not form acetylene.

Thus (d) is correct option.

10. A hydrocarbon which is a greenhouse gas is:

- (a) Acetylene
- (b) Methane
- (c) Ethane
- (d) Ethylene

Ans :

COMP 2020

Methane (CH_4) is a hydrocarbon that is a greenhouse gas. It is the simplest hydrocarbon, made up of one carbon atom and four hydrogen atoms.

Thus (b) is correct option.

11. The IUPAC name of acetylene is :

- (a) propane
- (b) propyne
- (c) ethene
- (d) ethyne

Ans :

SQP 2014

The IUPAC of acetylene is ethyne where eth- is the hydrocarbon chain with two carbon atoms

dissolves in water.

Thus (d) is correct option.

- 31.** Organic Compounds containing closed ring of atoms are called

(a) Alicyclic Compounds
(b) Acyclic Compounds
(c) Aliphatic Compounds
(d) None of the above

Ans :

COMP 2018

Organic Compounds that have a closed ring of atoms are called cyclic or Alicyclic Compounds or ring Compounds

Thus (a) is correct option.

- 32.** Two neighbours of a homologous series differ by :

(a) CH (b) CH₃
(c) CH₂ (d) CH₄

Ans :

MAIN 2017

Two adjacent members of a homologous series differ by 14 atomic mass units (amu), or a molecular formula of CH₂, which is one carbon atom and two hydrogen atom

Thus (c) is correct option.

- 33.** Which of the following is an insecticide

(a) CNG (b) PVC
(c) DDT (d) TNT

Ans :

SQP 2011

DDT is used as insecticide. DDT is an organochlorine insecticide which is a colorless, crystalline solid, tasteless and almost odourless chemical Compound.

Thus (c) is correct option.

- 34.** Ethene is an hydrocarbon.

(a) cyclic (b) saturated
(c) unsaturated (d) aromatic

Ans :

COMP 2013

Ethene, also known as ethylene, is an unsaturated hydrocarbon. Unsaturated hydrocarbons are carbon Compounds that have at least one double or triple bond between carbon atoms.

Thus (c) is correct option.

- 35.** If the molecular formula of an organic Compound is C₁₀H₁₈, it is

(a) alkyne
(b) alkane
(c) alkene
(d) not a hydrocarbon

Ans :

MAIN 2015

A chemical formula that shows how many atoms of each element there are in each molecule of a substance.

The molecular formula for an alkyne is C_nH_{2n-2}

If we put n = 10

we get C₁₀H₁₈,

Thus (a) is correct option.

- 36.** General formula of alkenes is

(a) C_nH_{2n} (b) C_nH_{2n+2}
(c) C_nH_{2n-2} (d) C_nH_{2n+1}

Ans :

SQP 2019

The general formula of alkenes is C_nH_{2n}, where n is the no. of carbon atoms.

Thus (a) is correct option.

- 37.** Ethene and ethyne are Compounds.

(a) aromatic (b) saturated
(c) aliphatic (d) unsaturated

Ans :

COMP 2020

Ethene and ethyne are unsaturated hydrocarbons. Unsaturated hydrocarbons are carbon Compounds that have at least one double or triple bond between the carbon atoms.

Thus (c) is correct option.

- 38.** Molecular formula of butane is

(a) C₄H₁₀ (b) C₅H₁₀
(c) C₄H₈ (d) C₄H₁₂

Ans :

MAIN 2022

The formula of butane is C₄H₁₀ since the chemical Compound is a combination of two hydrocarbons or alkanes where it is further Composed of four carbon atoms which are all linked in a straight chain.

Thus (a) is correct option.

- 39.** Which of the following Compound has highest boiling point ?

(a) 2-methylbutane
(b) n-pentane
(c) n-hexane
(d) 2,2-dimethyl propane

Ans :

SQP 2023

A straight chain alkane will have a boiling point higher than a branched chain alkane hence, n-hexane has highest boiling point.

Thus (c) is correct option.

21. The reaction of alcohol with acetic acid in the presence of concentrated sulphuric acid is known as
 (a) Distillation (b) Esterification
 (c) Saponification (d) Condensation

Ans :

MAIN 2021

The reaction of alcohol with acetic acid in the presence of concentrated sulfuric acid (H_2SO_4) is called an esterification reaction.

Thus (b) is correct option.

22. Methyl alcohol reacts with in the presence of conc. H_2SO_4 to give an ester.
 (a) Phenol (b) Benzoic acid
 (c) Ethanoic acid (d) Benzene

Ans :

COMP 2023

Methyl alcohol reacts with ethanoic acid in the presence of conc. H_2SO_4 to give an ester.

Thus (c) is correct option.

23. Aqueous KOH brings reactions, whereas alcoholic KOH brings reactions.
 (a) Addition; substitution
 (b) Elimination; addition
 (c) Substitution; elimination
 (d) Elimination; substitution

Ans :

SQP 2007

Aqueous KOH causes substitution reactions that produce alcohols, while alcoholic KOH causes elimination reactions that produce alkenes.

Thus (c) is correct option.

24. is formed when acetic acid and ethyl alcohol reacts in the presence of conc. H_2SO_4 .
 (a) Alcohol (b) Ester
 (c) Ether (d) Ketones

Ans :

COMP 2010

Ester is formed when acetic acid and ethyl alcohol reacts in the presence of conc. H_2SO_4

Thus (b) is correct option.

25. An acid contains functional group.
 (a) CN (b) —OH
 (c) —NH_2 (d) —COOH

Ans :

MAIN 2015

Organic acids, such as acetic acid, contain a functional group called a carboxyl group, which is often written as —COOH

Thus (d) is correct option.

26. Organic Compounds are conductors of electricity.
 (a) bad (b) good
 (c) partial (d) none of the above

Ans :

SQP 2019

Organic Compounds are generally poor conductors of electricity, or good insulators. This is because of their molecular structure, which consists of covalent and hydrogen bonds that don't allow electrons or charged particles to flow. This results in a lack of free electrons and mobile ions, which prevents organic Compounds from conducting electrical currents.

Thus (a) is correct option.

A carbon atom linked with two carbon atoms is known as carbon.

- (a) primary (b) tertiary
 (c) secondary (d) chiral

Ans :

MAIN 2013

A carbon atom linked with two carbon atoms is known as secondary carbon.

Thus (c) is correct option.

28. An aldehyde contains functional group.
 (a) —COOH (b) —CHO
 (c) —OH (d) —NH_2

Ans :

COMP 2011

Aldehydes are organic Compounds that contain a functional group with the structure R—CH=O .

Thus (b) is correct option.

29. Heptane contains carbon atoms in chain
 (a) Seven (b) Six
 (c) Eight (d) Nine

Ans :

MAIN 2010

Heptane is a straight-chain alkane with seven carbon atoms.

Thus (a) is correct option.

30. Which of the following is an organic Compound
 (a) Bleaching powder (b) Washing soda
 (c) Baking powder (d) Urea

Ans :

SQP 2015

Urea is an organic Compound with the chemical formula $\text{CO(NH}_2)_2$. It's made up of two amino groups (—NH_2) joined by a carbonyl functional group (—C=O—). Urea is also known as carbamide because it's a diamide of carbonic acid. It's a colorless, non-toxic, odorless substance that

3-dimethyl butane.

Thus (a) is correct option.

50. Acetylene polymerises into benzene by joining :

- (a) 6 molecules (b) 2 molecules
(c) 4 molecules (d) 3 molecules

Ans :

COMP 2016

Acetylene polymerises into benzene by joining 3 molecules

Thus (d) is correct option.

51. Pentane has the molecular formula, C_5H_{12} , It has

- (a) 16 covalent bonds
(b) 12 covalent bonds
(c) 5 covalent bonds
(d) 17 covalent bonds

Ans :

MAIN 2012

Pentane (C_5H_{12}) has 4 C – C single bond and 12 C – H single bond. So it has 16 covalent bonds.

Thus (a) is correct option.

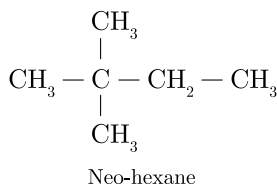
52. The common name of $(CH_3)_3CC_2H_5$ is

- (a) Neo-hexane (b) Iso-hexane
(c) Trimethylpropane (d) None is correct

Ans :

COMP 2014

IUPAC name of $(CH_3)_3CC_2H_5$ is Neo-hexane.



Thus (a) is correct option.

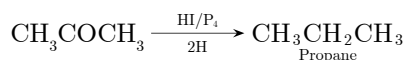
53. Which of the following reactions will not produce ethane ?

- (a) Reduction of CH_3COCH_3 with HI/P_4 .
(b) Reduction of CH_3COOH with HI/P_4 .
(c) Sodamine decarboxylation of sodium propionate.
(d) Hydrogenation of ethane in the presence of Ni.

Ans :

MAIN 2016

Reduction of CH_3COCH_3 with HI/P_4 does not produce ethane. It produce propane with HI/P_4 .



Thus (a) is correct option.

54. Compound X has the molecular formula, C_2H_6O .

X can be made by a fermentation process.

X can be oxidised to Y.

X can react with Y to form Z and water.

To which homologous series do X, Y and Z belong?

	X	Y	Z
(a)	Alcohols	Carboxylic acids	Esters
(b)	Alcohols	Esters	Carboxylic acids
(c)	Carboxylic acids	Alcohols	Esters
(d)	Carboxylic acids	Esters	Alcohols

Ans :

COMP 2017

X may be alcohol because, it can be made by a fermentation process. X (alcohol) can be oxidised to Y (acid). X can react with Y (acid) to form Z (ester) and water hence X is alcohol and Y and Z are carboxylic acid and ester respectively.

Thus (a) is correct option.

55. Wine (alcoholic beverage) Mainly contains.

- (a) C_2H_5OH (b) C_6H_6
(c) CH_3OH (d) CH_3COOH

Ans :

MAIN 2000

Wine Mainly contains ethanol (C_2H_5OH).

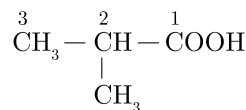
Thus (a) is correct option.

56. The IUPAC name of $(CH_3)_2CHCOOH$ is

- (a) propan-2-oic acid
(b) iso-butanoic acid
(c) 2-methyl butanoic acid
(d) 2-methyl propanoic acid

Ans :

SQP 2005



IUPAC name : 2-methyl propanoic acid

Thus (d) is correct option.

57. Acetic acid reacts with PCl_5 to form

- (a) carbon monoxide and hydrogen chloride
(b) methyl chloride
(c) acetyl chloride
(d) None of these

Ans :

SQP 2010



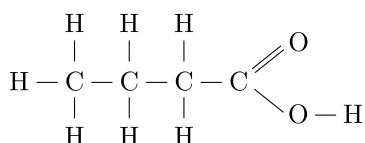
Thus (c) is correct option.

58. Which structure shows a Compound that reacts with ethanol to give a sweet smelling liquid ?

- (a) $\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$
- (b) $\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & \\ & | & & | & & | & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{C} \\ & | & & | & & | & \\ & \text{H} & & \text{H} & & \text{H} & \end{array} \begin{array}{c} \text{O} \\ // \\ \text{O} - \text{H} \end{array}$
- (c) $\begin{array}{ccccccc} & \text{H} & & & & \text{H} & & \text{H} \\ & | & & & & | & & | \\ \text{H} & - \text{C} & - & \text{C} & & \text{O} & - & \text{C} & - & \text{C} & - & \text{H} \\ & | & & & & // & & | & & | \\ & \text{H} & & & & \text{O} & & \text{H} & & \text{H} \end{array}$
- (d) $\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & & \text{H} \\ & | & & | & & | & & | \\ \text{H} & - \text{O} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{H} \\ & & & | & & | & & | \\ & & & \text{H} & & \text{H} & & \text{H} \end{array}$

Ans :

COMP 2007



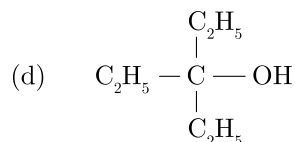
Compound (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ (acid) react with ethanol to forms ester (sweet smelling liquid)



Thus (b) is correct option.

59. Neo-heptyl alcohol is correctly represented as

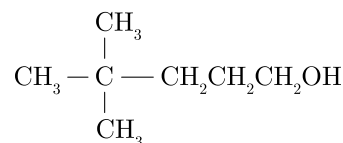
- (a) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CHCH}_2\text{CH}_3 \\ | \quad | \\ \text{CH}_3 \quad \text{OH} \end{array}$
- (b) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \\ | \\ \text{OH} \end{array}$
- (c) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$



Ans :

MAIN 2008

Neo-heptyl alcohol is correctly represented by the following formula.



Thus (c) is correct option.

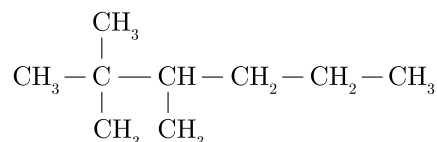
60. Which of the following structure represents 2, 2, 3- trimethylhexane ?

- (a) $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$
- (b) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- (c) $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}_3$
- (d) $\text{CH}_3\text{C}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$

Ans :

SQP 2010

$\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$ represent 2,2,3- trimethylhexane



Thus (d) is correct option.

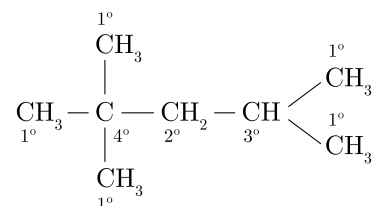
61. Which of the following alkane contains pri, sec, tert as well as quaternary C-atoms ?

- (a) $(\text{CH}_3)_3\text{CH}_2\text{CH}(\text{CH}_3)_2$
- (b) $(\text{C}_2\text{H}_5)_3\text{CH}$
- (c) $(\text{CH}_3)_3\text{CH}$
- (d) $(\text{CH}_3)_4\text{C}$

Ans :

MAIN 2012

$(\text{CH}_3)_3\text{CCH}_2\text{CH}(\text{CH}_3)_2$ alkane contains primary, secondary, tertiary as well as quaternary C-atoms.



Thus (a) is correct option.

62. The correct order of decreasing boiling point of following alcohols is

- I. pentan-1-ol
 II. 2-methyl butan-2-ol
 III. 3-methyl butan-2-ol
 (a) $\text{III} > \text{II} > \text{I}$ (b) $\text{II} > \text{III} > \text{I}$
 (c) $\text{I} > \text{II} > \text{III}$ (d) $\text{I} > \text{III} > \text{II}$

Ans :

COMP 2013

Amongst isomeric alcohols, the boiling points decrease with branching due to corresponding decrease in surface area, i.e. boiling point decreases in order :



Thus (d) is correct option.

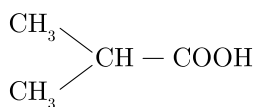
63. How many acids are possible for the compound with molecular formula, $\text{C}_4\text{H}_8\text{O}_2$?

- (a) Two acids (b) One acid
 (c) Three acids (d) Four acids

Ans :

COMP 2011

Two acids are possible for the Compound with molecular formula $\text{C}_4\text{H}_8\text{O}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ n-butanoic acid



2-methyl propanoic acid

Thus (a) is correct option.

64. Fermentation is an
 (a) endothermic reaction
 (b) exothermic reaction
 (c) reversible reaction
 (d) None of these

Ans :

MAIN 2015

Fermentation is an exothermic reaction, it releases heat to surroundings.

Thus (b) is correct option.

65. Among the following, which alkane is expected to have lowest boiling point.
 (a) Hexane
 (b) 2,2-dimethyl butane
 (c) 3-methylpentane
 (d) 2-methylpentane

Ans :

SQP 2008

A straight chain alkane will have a boiling point higher than a branched chain alkane, due to the greater surface area in contact, thus the greater

van der waals forces between adjacent molecules. Hence, 2, 2-dimethyl butane have lowest boiling point.

Thus (b) is correct option.

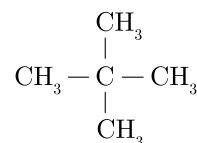
66. Which of the following will give only one monochloro derivative on halogenation ?

- (a) Neopentane (b) Isopentane
 (c) Isohexane (d) Isoheptane

Ans :

COMP 2005

Neo-pentane will give only one monochloro derivative on halogenation.



Neo-pentane

Thus (a) is correct option.

67. The unsaturated hydrocarbons undergo:

- (a) a substitution reaction
 (b) an oxidation reaction
 (c) an addition reaction
 (d) none of the above

Ans :

MAIN 2009

Unsaturated hydrocarbons undergoes the addition reaction easily because the double or triple bond will convert into a single bond. For example, Ethene on reaction with Hydrogen will convert into Ethane ($\text{CH}_3 - \text{CH}_3$)

Thus (c) is correct option.

68. Which of the following statements is wrong about alkanes?

- (a) They are all saturated hydrocarbons.
 (b) They can undergo addition as well as substitution reaction.
 (c) On complete combustion give out carbon dioxide and water.
 (d) They are almost non polar in nature.

Ans :

COMP 2010

The non availability of electrons in the single covalent bond makes them less reactive and therefore they undergo characteristic substitution reactions only.

Thus (b) is correct option.

69. An example of alicyclic Compound is

- (a) cyclohexane (b) hexane
 (c) benzene (d) furan

Aliphatic carboxylic acids are known as fatty acids.

Thus (a) is correct option.

85. The functional group present in acetic acid is:

- (a) Ketonic >C=O
- (b) Carboxyl $-\text{COOH}$
- (c) Aldehydic $-\text{CHO}$
- (d) Hydroxyl $-\text{OH}$

Ans :

SQP 2015

Organic acids such as acetic acid all contain a functional group called a carboxyl group $-\text{COOH}$. Thus (b) is correct option.

86. Compounds of carbon and hydrogen are known as

- (a) Hydrocarbons
- (b) Organic Compounds
- (c) Catenated Compounds
- (d) None of above

Ans :

COMP 2017

Compounds made up of carbon and hydrogen are called hydrocarbon.

Thus (a) is correct option.

87. Which of the following statements is wrong about alkanes ?

- (a) They are all saturated hydrocarbon.
- (b) On Complete combustion give out carbon dioxide and water.
- (c) They are almost non polar in nature.
- (d) They can undergo addition as well as substitution reaction.

Ans :

SQP 2019

They can undergo addition as well as substitution reactions.

Thus (d) is correct option.

88. Polythene, PVC, bakelite are

- (a) molecular Compounds
- (b) inorganic Compounds
- (c) ionic Compounds
- (d) organic Compounds

Ans :

MAIN 2005

PVC, bakelite and polythene are plastics.

Thus (d) is correct option.

89. Amines owes its properties due to the functional group

- (a) NO_2
- (b) NH_2
- (c) HNO_3
- (d) N_2

Ans :

MAIN 2017

Amines are organic compounds having a functional group $-\text{NH}_2$ in which a nitrogen atom consists a lone pair of electrons." They are the derivatives of ammonia where one or more hydrogen atoms can be replaced by substituent groups such as alkyl or aryl.

Thus (d) is correct option.

90. The organic Compound mixed with alcohol to make it spurious is :

- (a) Methanoic acid
- (b) Methanol
- (c) Methanal
- (d) Ethanoic acid

Ans :

COMP 2010

The organic compound mixed with ethanol to make it spurious is Methanol.

Thus (b) is correct option.

91. is used as a coagulating agent in rubber industry.

- (a) Nitric acid
- (b) Acetic acid
- (c) Formic acid
- (d) Hydrochloric acid

Ans :

SQP 2020

Formic is the acid used as a coagulating agent for coagulating latex and getting a high – quality natural rubber product. Formic acid satisfies all the requirements for a good coagulating agent.

Thus (b) is correct option.

92. The organic Compound obtained as the end product of the fermentation of sugar solution is :

- (a) Ethanol
- (b) Methanol
- (c) Ethane
- (d) Methanoic acid

Ans :

SQP 2007

Ethanol is the organic compound obtained as the end product of the fermentation of sugar solution.

Thus (a) is correct option.

93. In which of the following Compounds $-\text{OH}$ is the functional group ?

- (a) Butanol
- (b) Butanone
- (c) Butanoic acid
- (d) Butanal

Ans :

MAIN 2009

The $-\text{OH}$ functional group is used for the compounds belonging to the family of alcohols.

Thus (a) is correct option.

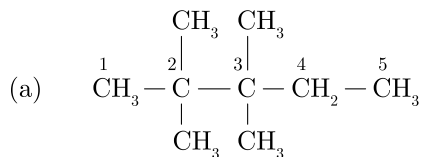
94. The organic Compound which undergoes substitution reaction is.

- (a) C_2H_6
- (b) C_2H_4
- (c) $\text{C}_{10}\text{H}_{18}$
- (d) C_2H_2

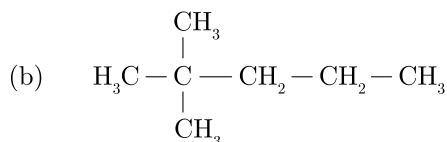
77. The Compound which has one isopropyl group is
 (a) 2, 2, 3, 3-tetramethylpentane
 (b) 2, 2-dimethylpentane
 (c) 2, 2, 3-trimethylpentane
 (d) None of these

Ans :

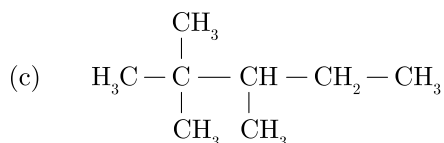
MAIN 2021



2, 2, 3, 3-tetramethyl pentane



2, 2-dimethyl pentane



2, 2, 3-trimethyl pentane

From the above example, none of the Compound have isopropyl group.

Thus (d) is correct option.

78. Which statement about ethanoic acid is correct ?
 (a) It reacts with ethanol to form a sweet smelling Compound.
 (b) It contains three carbon atom per molecule.
 (c) It is insoluble in water.
 (d) It contains five hydrogen atoms per molecule.

Ans :

COMP 2023

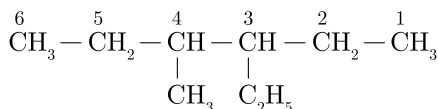
Ethanoic acid reacts with ethanol to form a sweet smelling Compound (ester).

Thus (a) is correct option.

79. The correct IUPAC name of $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{C}_2\text{H}_5)_2$ is
 (a) 4-ethyl-3-methylhexane
 (b) 3-methyl-4-ethylhexane
 (c) 3-ethyl-4-methylhexane
 (d) 2-isopentylbutane

Ans :

SQP 2021



IUPAC name : 3-ethyl-4-methyl hexane

Thus (c) is correct option.

80. Identify the statement that is incorrect about alkanes :

- (a) They are hydrocarbons.
 (b) There is a single covalent bond between carbon and hydrogen.
 (c) They can undergo both substitution as well as addition reactions.
 (d) On Complete combustion they produce carbon dioxide and water.

Ans :

COMP 2013

They can undergo both substitution as well as addition reactions Alkanes are made of C and H only so they are called hydrocarbons and due to presence of single bonds they only gives substitution reaction. On combustion they give carbon dioxide and water.

Thus (c) is correct option.

81. The alkanes in which carbon atoms are not a continuous chain are called

- (a) structured (b) branched
 (c) unsymmetric (d) symmetric

Ans :

SQP 2010

The alkanes in which carbon atoms are not a continuous chain are called as Branched-Chain Alkanes.

Thus (b) is correct option.

82. An organic weak acid is :
 (a) Sulphuric acid (b) Formic acid
 (c) Nitric acid (d) Hydrochloric acid

Ans :

MAIN 2011

An organic weak acid is an organic compound that is capable of donating protons (hydrogen ions) to a solvent, resulting in a solution with a pH less than 7.

Thus (b) is correct option.

83. Heating sodium acetate with soda lime produces :
 (a) Ethane (b) Methane
 (c) Ethene (d) Ethyne

Ans :

COMP 2010

When sodium acetate on heating with soda lime, methane is produced.

Thus (b) is correct option.

84. Aliphatic carboxylic acids are known as acids.

- (a) fatty (b) aromatic
 (c) aliphatic (d) carboxylic

Ans :

SQP 2011

- 104.** Organic compounds have melting and boiling points.
 (a) Constant
 (b) High
 (c) Low
 (d) Non-uniformly decreasing

Ans :

COMP 2017

Organic compounds are made from weak covalent bonds which are easy to break as compared to the inorganic compounds which are made from strong bonds like ionic bonds, hydrogen bonds, etc.

Thus, organic compounds need less amount of energy to break the bonds and hence, they have low melting and boiling points.

Thus (c) is correct option.

- 105.** The organic compound mixed with ethanol to make it spurious is
 (a) ethanoic acid (b) methanoic acid
 (c) methanal (d) methanol

Ans :

SQP 2019

The organic compound mixed with ethanol to make it spurious is Methanol.

Thus (d) is correct option.

- 106.** The formation of 1, 2-dibromoethane from ethene and bromine is an example of
 (a) Substitution
 (b) Dehydration
 (c) Addition
 (d) Dehydrohalogenation

Ans :

MAIN 2011

Ethene is an unsaturated hydrocarbon that contains a set of double bonded carbon atoms. When the addition of bromine takes place across the double bond, it results in the formation of 1, 2-dibromoethane. Therefore, the formation of 1, 2-dibromoethane from ethene and bromine is an example of an addition reaction.

Thus (c) is correct option.

- 107.** Organic Compounds are generally whereas inorganic Compounds are non-inflammable.
 (a) highly inflammable
 (b) inflammable
 (c) partially inflammable
 (d) partially flammable

Ans :

COMP 2017

Most of these compounds have a higher melting point. Some of the organic compounds are highly flammable. Most inorganic compounds are less

flammable as compared to organic compounds. They have relatively low density.

Thus (b) is correct option.

- 108.** The name of alkene and alkyne structure depends upon the presence of a
 (a) Single or double bond
 (b) Single or ionic
 (c) Single or triple bond
 (d) Double or triple bond

Ans :

MAIN 2014

The name of alkene and alkyne structure depends upon the presence of a double or triple bond.

Thus (d) is correct option.

- 109.** Which of the following is an aromatic hydrocarbon?
 (a) Cyclopropane (b) Benzene
 (c) Cyclobutane (d) None of above

Ans :

COMP 2015

Aromatic hydrocarbons including benzene, toluene, ethyl benzene, xylene (BTEX) are retrieved during fossil fuel extraction and used as solvents in consumer and industrial products, as gasoline additives and as intermediates in the synthesis of organic compounds for many consumer products.

Thus (b) is correct option.

- 110.** Halogenation of alkane can be carried out in :
 (a) Diffused sunlight (b) Bright light
 (c) UV light (d) Dark

Ans :

MAIN 2019

Halogenation reactions may be conducted in either the gaseous or liquid phase. In gas phase chlorinations the presence of oxygen (a radical trap) inhibits the reaction. In liquid phase halogenations radical initiators such as peroxides facilitate the reaction.

Thus (a) is correct option.

- 111.** Category of Compounds containing –OH group are known as
 (a) Alkanes (b) Alkanols
 (c) Alkenes (d) Aldehydes

Ans :

COMP 2000

Organic compounds containing (–OH) functional group are known as Alcohols. The hydroxyl derivatives of alkanes are called alcohols.

Thus (b) is correct option.

Ans :

COMP 2010

C_2H_6 - ethane is saturated hydrocarbon which undergoes substitution reaction.

Thus (a) is correct option.

95. Isomerism shown by pent-1-yne and 3-methylbut-1-yne is

- (a) functional isomerism
(b) position isomerism
(c) chain isomerism
(d) stereo isomerism

Ans :

MAIN 2004

Chain isomerism is shown by pent-1-yne and 3-methylbut-1-yne.

Thus (c) is correct option.

96. Triple bond is present in

- (a) Alkanes (b) Alkenes
(c) Alkyls (d) Alkynes

Ans :

SQP 2015

Alkynes are hydrocarbons with carbon-to-carbon triple bonds and properties much like those of alkenes.

Thus (d) is correct option.

97. $CH_3CH_2OH \xrightarrow[\text{Heat}]{\text{Alkaline } KMnO_4} CH_3COOH$

In the above reaction, alkaline $KMnO_4$ acts as

- (a) Oxidising agent
(b) Reducing agent
(c) Catalyst
(d) Dehydrating agent

Ans :

COMP 2017

In the given reaction, alkaline $KMnO_4$ acts as the oxidising agent. It adds oxygen alcohol (ethanol) and oxidises it to an acid (ethanoic acid).

Thus (a) is correct option.

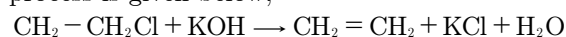
98. Dehydrogenation of X with alcoholic KOH produces ethene. X is :

- (a) Ethylene dichloride
(b) Methyl chloride
(c) Ethyl chloride
(d) None

Ans :

MAIN 2019

Here X is the Ethyl chloride. The reaction of this process is given below,



Thus (c) is correct option.

99. When acetic acid is heated with phosphorus pentoxide is formed.

- (a) acetic anhydride
(b) aliphatic Compound
(c) cellulose acetate
(d) methanoic acid

Ans :

SQP 2022

When Acetic acid is heated in the presence of Phosphorous pentoxide, it results in the removal of water and forms Acetic anhydride.

Thus (a) is correct option.

100. Ester is formed by

- (a) Two carboxylic acid
(b) One carboxylic acid and one alcohol
(c) Two alcohol
(d) None of the above

Ans :

MAIN 2011

Thus (b) is correct option.

101. An odd compound in the following is :

- (a) Ethene (b) Ethane
(c) Methane (d) Propane

Ans :

SQP 2012

An esterification is a reaction between a carboxylic acid and an alcohol. It is used to synthesise ester. The reaction proceeds in the presence of dilute sulphuric acid.

Thus (a) is correct option.

102. An organic compound undergoes addition reactions and gives a red colour precipitate with ammoniacal cuprous chloride. Therefore, the organic compound could be :

- (a) Ethyne (b) Ethene
(c) Ethane (d) Ethanol

Ans :

MAIN 2014

The compound which reacts with ammoniacal cuprous chloride and produces a red precipitate is ethyne. Ethyne is treated with ammoniacal cuprous chloride gives acetylide. This acetylide is red in color.

Thus (a) is correct option.

103. are sweet smelling compounds used in perfumes and flavoured drinks.

- (a) Esters (b) Aldehydes
(c) Ketones (d) Ethers

Ans :

MAIN 2019

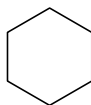
Esters are sweet smelling substance and are used in making perfumes.

Thus (a) is correct option.

Ans :

MAIN 2014

Cyclohexane is an example of alicyclic Compound. An alicyclic Compound is an organic Compound that is both aliphatic and cyclic.



Cyclohexane

Thus (a) is correct option.

70. The functional group present in acetic acid is:

- (a) Ketonic >C=O
 (b) Hydroxyl — OH
 (c) Aldehydic — CHO
 (d) Carboxyl — COOH

Ans :

COMP 2010

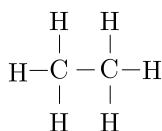
The functional group present in acetic acid is a carboxyl group, represented as — COOH. Thus (d) is correct option.

71. The number of C—H bonds in ethane molecule are
 (a) Four (b) Six
 (c) Eight (d) Ten

Ans :

SQP 2012

Number of C—H bonds in ethane means number of single bonds present in C_2H_6



Hence, the number of C-H bonds (Single bonds) in ethane is 6.

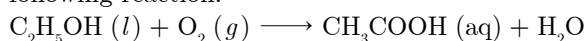
Thus (b) is correct option.

72. Vinegar is a solution of ethanoic acid made by the reaction ethanol with air. Which gas in air takes part in this reaction
 (a) Carbon dioxide (b) Nitrogen
 (c) Water vapour (d) Oxygen

Ans :

MAIN 2014

Ethanoic acid is formed when ethanol is oxidised. Ethanol reacts with the oxygen in air. In the following reaction.



Thus (d) is correct option.

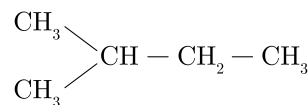
73. Which isomer of C_5H_{12} gives four isomers of monoiodopentane?

- (a) Neo-pentane (b) iso-pentane
 (c) n-pentane (d) None of these

Ans :

COMP 2017

Iso-pentane isomer of C_5H_{12} gives four isomers of monoiodopentane.



Iso-pentane

Thus (b) is correct option.

74. Absolute alcohol can be obtained from rectified spirit by
 (a) azeotropic distillation
 (b) fractional distillation
 (c) vacuum distillation
 (d) steam distillation

Ans :

MAIN 2015

Absolute alcohol is named to 100% concentrated ethanol with chemical formula $\text{C}_2\text{H}_5\text{OH}$. To obtain absolute alcohol from rectified spirit (95% ethanol + 5% water) azeotropic distillation is used.

Thus (a) is correct option.

75. Oxidation of but-1-ene with hot KMnO_4 solution produces
 (a) $\text{CH}_3\text{CH}_2\text{COOH} + \text{CO}_2$
 (b) $\text{CH}_3\text{CH}_2\text{COOH} + \text{HCOOH}$
 (c) $\text{CH}_3\text{COOH} + \text{CO}_2$
 (d) $(\text{CH}_3)_2\text{C} = \text{O} + \text{CO}_2$

Ans :

SQP 2019

Oxidation of but- 1-ene with hot KMnO_4 solution produces propanoic acid and CO_2 .



Thus (a) is correct option.

76. The unsaturated hydrocarbons undergo
 (a) a substitution reaction
 (b) an addition reaction
 (c) an oxidation reaction
 (d) None of these

Ans :

COMP 2008

The unsaturated hydrocarbons undergo an addition reaction.

Thus (b) is correct option.

ASSERTION AND REASON

- 112. Assertion :** Organic compounds generally have low melting and boiling points.

Reason : Organic compounds are covalent in nature.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : SQP 2004

Organic compounds are covalent, leading to weaker intermolecular forces, which result in lower melting and boiling points.

Thus (a) is correct option.

- 113. Assertion :** Methane is a saturated hydrocarbon.

Reason : Methane contains a carbon-carbon double bond.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : MAIN 2010

Methane is a saturated hydrocarbon because it only contains single bonds, not double bonds.

Thus (c) is correct option.

- 114. Assertion :** Ethene undergoes addition reactions.

Reason : Ethene is an unsaturated hydrocarbon.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : COMP 2015

Ethene is unsaturated due to its double bond, which makes it reactive in addition reactions.

Thus (a) is correct option.

- 115. Assertion :** Alkanes are more reactive than alkenes.

Reason : Alkanes contain single covalent bonds, which are more reactive than double bonds.

- (a) Both assertion and reason are true and reason

is the correct explanation of assertion.

- (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : SQP 2008

Alkanes are less reactive than alkenes because single bonds are less reactive than double bonds.

Thus (d) is correct option.

- 116. Assertion :** Ethanol can be dehydrated to form ethene.

Reason : Dehydration of ethanol involves the removal of a water molecule.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : MAIN 2018

Ethanol undergoes dehydration to form ethene by losing a water molecule.

Thus (a) is correct option.

- 117. Assertion :** Methanoic acid is the first member of the carboxylic acid series.

Reason : Methanoic acid contains only one carbon atom.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : COMP 2014

Methanoic acid, with only one carbon atom, is indeed the first member of the carboxylic acid series.

Thus (a) is correct option.

- 118. Assertion :** Propanol and propanone are isomers.

Reason : Isomers have the same molecular formula but different structural formulas.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans : SQP 2007

Propanol and propanone are structural isomers because they have the same molecular formula but different structures.

Thus (a) is correct option.

- 119. Assertion :** Methane is a good conductor of electricity.

Reason : Methane is a non-polar molecule.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

COMP 2012

Methane is a non-polar molecule, but it is not a good conductor of electricity.

Thus (d) is correct option.

- 120. Assertion :** Ethanoic acid is a stronger acid than ethanol.

Reason : Ethanoic acid can donate a proton more easily than ethanol.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

MAIN 2006

Ethanoic acid is a stronger acid because it can more easily donate a proton compared to ethanol. Thus (a) is correct option.

- 121. Assertion :** Butane and 2-methylpropane are examples of chain isomers.

Reason : Chain isomers have the same molecular formula but different branching of the carbon chain.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
 (c) Assertion is true, but reason is false.
 (d) Assertion is false, but reason is true.

Ans :

SQP 2010

Butane and 2-methylpropane are chain isomers because they have the same molecular formula with different carbon chain arrangements.

Thus (a) is correct option.

ONE MARK QUESTIONS

DIRECTION : Name the following :

- 122.** Process by which ethane is obtained from ethene

Ans :

COMP 2015

Hydrogenation

- 123.** A hydrocarbon which contributes towards the greenhouse effect.

Ans :

MAIN 2010

Methane

- 124.** Distinctive reaction that takes place when ethanol is treated with acetic acid.

Ans :

SQP 2013

Esterification reaction

- 125.** The property of elements by virtue of which atoms of the element can link to each other in the form of a long chain or ring structure.

Ans :

MAIN 2010

Catenation

- 126.** Reaction when an alkyl halide is treated with alcoholic potassium hydroxide.

Ans :

COMP 2015

Elimination reaction

- 127.** The flame used for the welding and cutting of metals.

Ans :

MAIN 2017

Oxyacetylene flame

- 128.** Process by which Ethene is obtained from Ethanol.

Ans :

COMP 2019

Dehydration

- 129.** The hydrocarbon which contributes towards greenhouse effect.

Ans :

SQP 2000

Methane

- 130.** The catalyst used during hydrogenation of alkene.

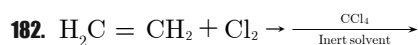
Ans :

MAIN 2001

Nickel

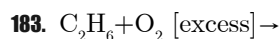
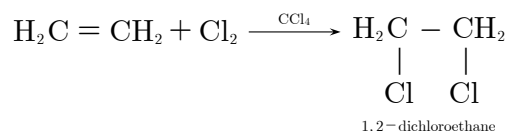
- 131.** The property of Carbon by which it can link to each other in the form of long chain or ring structure.
Ans : COMP 2005
 Catenation
- 132.** The type of reactions alkanes undergo.
Ans : MAIN 2007
 Substitution reactions
- 133.** The type of reactions alkenes undergo.
Ans : SQP 2009
 Addition reactions
- 134.** A simplest hydrocarbon.
Ans : COMP 2010
 Methane
- 135.** The gas commonly called as marsh gas.
Ans : MAIN 2015
 Methane
- 136.** The solution which detects the presence of unsaturation in the given hydrocarbon.
Ans : SQP 2017
 Bromine water in Carbon tetrachloride or Alkaline Potassium permanganate solution
- 137.** Process by which ethane is obtained from ethene.
Ans : MAIN 2019
 Hydrogenation
- 138.** A hydrocarbon which contributes towards the green house effect.
Ans : COMP 2011
 Methane
- 139.** Distinctive reaction that takes place when ethanol is treated with acetic acid.
Ans : SQP 2013
 Esterification
- 140.** The property of elements by virtue of which atoms of the element can link to each other in the form of a long chain or ring structure.
Ans : MAIN 2014
 Catenation
- 141.** Reaction when an alkyl halide is treated with alcoholic potassium hydroxide.
Ans : COMP 2016
 Dehydrohalogenation reaction.
- 142.** The Compound with 3 carbon atoms whose functional group is a carboxyl.
Ans : SQP 2017
 propanone
- 143.** The first homologue whose general formula is C_nH_{2n} .
Ans : MAIN 2018
 ethene
- 144.** The Compound that reacts with acetic acid to form ethyl ethanoate.
Ans : COMP 2010
 ethanol
- 145.** Name the hydrocarbon which causes global warming.
Ans : SQP 2005
 Methane.
- 146.** Name the scientist who gave 'vital force theory'.
Ans : COMP 2016
 Friedrich Wohler.
- 147.** Name the product of the reaction between ethene and chlorine.
Ans : SQP 2002
 1, 2 - Dichloroethane
- 148.** Name a Compound which will give acetylene gas when treated with water.
Ans : MAIN 2010
 Calcium carbide, CaC_2
- 149.** Name a gas (organic) present as an intestinal gas.
Ans : MAIN 2010
 Methane.
- 150.** The Compound formed by Complete chlorination of ethyne.
Ans : SQP 2019
 1, 1, 2, 2 tetrachloro ethane

DIRECTION : Complete and balance the following equations.



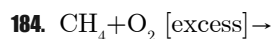
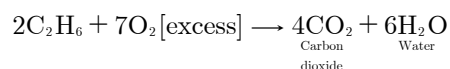
Ans :

SQP 2015



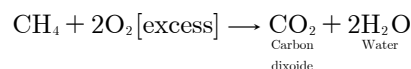
Ans :

MAIN 2008



Ans :

COMP 2022

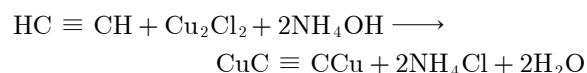


DIRECTION : Write balanced chemical equations for the following:

185. Ethyne is passed through Fehling's solution.

Ans :

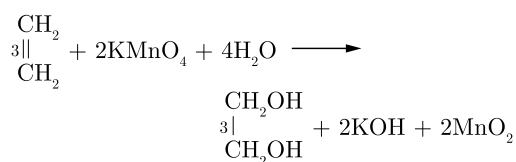
COMP 2017



186. Ethene is passed through alkaline Potassium permanganate solution.

Ans :

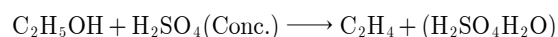
MAIN 2015



187. Ethyl alcohol is dehydrated.

Ans :

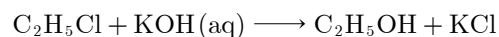
SQP 2019



188. Ethyl chloride reacts with aqueous Potassium hydroxide.

Ans :

MAIN 2010

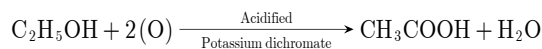


189. Ethanol is oxidised with acidified Potassium

dichromate.

Ans :

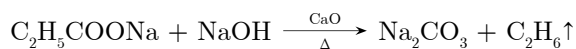
COMP 2015



190. Preparation of ethane from sodium propionate.

Ans :

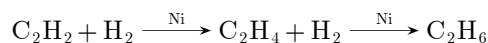
MAIN 2014



191. Addition of Hydrogen to Ethyne.

Ans :

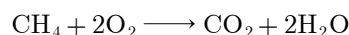
COMP 2017



192. Burning of Methane in sufficient supply of air.

Ans :

MAIN 2019



193. Burning of Ethane in sufficient supply of air.

Ans :

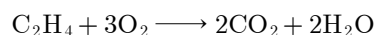
SQP 2011



194. Burning of Ethene in sufficient supply of air or Oxygen.

Ans :

COMP 2010



195. Burning of Ethyne in sufficient supply of air or Oxygen.

Ans :

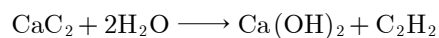
MAIN 2017



196. Calcium carbide is reacted with water.

Ans :

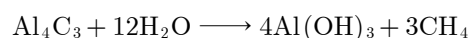
COMP 2011



197. Aluminium carbide is hydrolysed.

Ans :

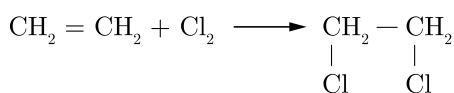
SQP 2017



198. Chlorine is added to Ethene.

Ans :

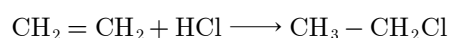
MAIN 2011



199. Hydrogen chloride is reacted with Ethene.

Ans :

COMP 2013



The conversion of ethene to ethane is an example of hydrogenation.

- 170.** The catalyst used in the conversion of ethene to ethane is commonly _____. (iron, nickel, cobalt).

Ans : COMP 2015

The catalyst used in the conversion of ethene to ethane is commonly nickel.

- 171.** Choosing only words from the following list, write down the appropriate words to fill in the blanks from (i) to (v) given below.

Addition, carbohydrates, C_nH_{2n-2} , C_nH_{2n} , C_nH_{2n+2} electrochemical, homologous, hydrocarbons, saturated, substitution, unsaturated.

The alkanes form a (i) _____ series with the general formula (ii) _____. The alkenes _____ are (iii) _____ (iv) _____ which generally undergo (v) _____ reactions.

Ans : MAIN 2017

The alkanes form a (i) homologous series with the general formula (ii) C_nH_{2n+2} . The alkenes are (iii) unsaturated (iv) hydrocarbons which generally undergo (v) addition reactions.

- 172.** Organic Compounds of carbon and hydrogen containing a double covalent bond between the carbon atoms are called _____.

Ans : SQP 2003

Alkenes

- 173.** Organic Compounds of carbon and hydrogen containing one triple covalent bond between the carbon atoms are called _____.

Ans : MAIN 2010

Alkynes

- 174.** Organic Compound of carbon and hydrogen containing single bonds between the carbon atoms are called _____.

Ans : COMP 2015

Alkanes

- 175.** The catalyst used for conversion of ethene to ethane is commonly _____. (nickel/iron/cobalt).

Ans : SQP 2019

Nickel

- 176.** When acetaldehyde is oxidized with acidified potassium dichromate, it forms _____ (ester/ethanol/acetic acid)

Ans : COMP 2017

Acetic acid

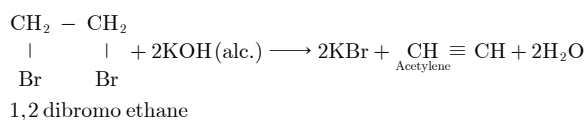
- 177.** Ethanoic acid reacts with ethanol in presence of concentrated H_2SO_4 , so as to form a Compound and water. The chemical reaction which takes place is called _____. (dehydration/hydrogenation/esterification).

Ans : MAIN 2019

Esterification

- 178.** Write the equation for the reaction taking place between 1,2-dibromoethane and alcoholic potassium hydroxide.

Ans : COMP 2010



- 179.** The product formed when ethene gas reacts with water in the presence of sulphuric acid is _____ (ethanol/ethanal/ethanoic acid).

Ans : SQP 2012

Ethanol

- 180.** The Compound formed when ethene reacts with Hydrogen is _____. (CH_4 , C_2H_6 , C_3H_8)

Ans : MAIN 2015

C_2H_6

- 181.** Complete the following table which relates to the homologous series of hydrocarbons.

General formula	IUPAC name of the homologous series	Characteristic bond type	IUPAC name of the first member of the series
C_nH_{2n-2}	(A) _____	(B) _____	(C) _____
C_nH_{2n+2}	(D) _____	(E) _____	(F) _____

Ans : COMP 2018

- (A) Alkynes
(B) Triple bond
(C) Ethyne
(D) Alkane
(E) Single bond
(F) Methane

- 256.** What type of Compound is formed by the reaction between acetic acid and an alcohol?

Ans : MAIN 2016
Ester.

- 257.** Give a chemical test to distinguish between the following pairs of Compounds:
Ethene gas and ethane gas.

Ans : MAIN 2013
Add a few drops of bromine solution in carbon tetrachloride to the given hydrocarbons.
Ethene gas-the reddish brown colour of bromine solution gets decolourized. Ethane gas-no change in colour.

- 258.** Give suitable chemical terms for the following:
A reaction in which hydrogen of an alkane is replaced by a halogen.

Ans : MAIN 2013
Halogenation

- 259.** Some word/words are missing in the following statements. You are required to rewrite the statements in the correct form using the appropriate word/words:
Ethyl alcohol is dehydrated by sulphuric acid at a temperature of about 170 °C.

Ans : SQP 2013
Ethyl alcohol is dehydrated by concentrated sulphuric acid at a temperature of about 170°C.

- 260.** Choose from the following list of substances as to what matches the description given below :
[Acetylene gas, aqua fortis, coke, brass, barium chloride, bronze, platinum]
A gaseous hydrocarbon commonly used for welding purposes.

Ans : COMP 2011
Acetylene gas.

- 261.** Some word/words are missing in the following statement. You are required to rewrite the statement in the correct form using the appropriate word/words:
Ethyl alcohol is dehydrated by sulphuric acid at a temperature of about 170°C.

Ans : SQP 2012
Ethyl alcohol is dehydrated by concentrated sulphuric acid at a temperature of about 170°C.

- 262.** Distinguish between the following pair of Compounds using test given within brackets :
Ethane and ethene (using alkaline potassium permanganate solution)

Ans : MAIN 2014
Ethane : The pink colour of KMnO_4 remains the same.
Ethene : The pink colour of KMnO_4 is discharged.

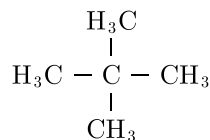
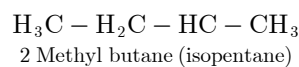
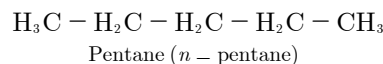
- 263.** Distinguish between the following pairs of Compounds using the test given within brackets:
Ethane and ethene (using alkaline potassium permanganate solution)

Ans : MAIN 2014
Ethene: Decolourises the solution.
Ethane: No change.

- 264.** Draw the structures of isomers of pentane.

Ans : SQP 2020

Isomers of pentane (C_5H_{12})



2, 2 dimethyl propane (neo pentane)

- 265.** Find the odd one out and explain your choice (note : valency is not a criterion)
 C_3H_8 , C_5H_{10} , C_2H_6 , CH_4

Ans : COMP 2023
 C_5H_{10} [All others are alkane, this is an alkene]

- 266.** What do you understand by the term 'unsaturated hydrocarbon' ?

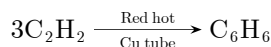
Ans : MAIN 2020
Hydrocarbons like alkenes and alkynes which possess (=) and ($\equiv$) bond are known as unsaturated hydrocarbons.

- 267.** Give the condensed formula of alkane with 6 carbon atoms ?

Ans : SQP 2000
 C_6H_{14} (Hexane)
 $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$

200. Acetylene is passed through red hot Copper tube.

Ans : MAIN 2016



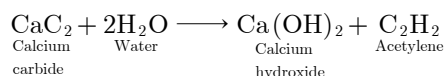
201. Preparation of methane from iodo-methane.

Ans : SQP 2014



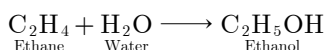
202. Calcium carbide and water

Ans : COMP 2008



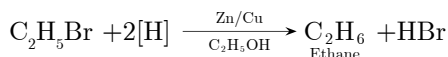
203. Ethene and water (steam)

Ans : MAIN 2008



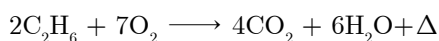
204. Producing ethane from bromo ethane using Zn/Cu couple in alcohol.

Ans : SQP 2020



205. Complete combustion of ethane.

Ans : COMP 2020



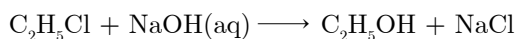
206. Preparation of ethane from sodium propionate.

Ans : COMP 2014



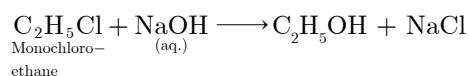
207. Preparation of ethanol from Ethyl Chloride.

Ans : MAIN 2016



208. Preparation of ethanol from monochloro-ethane and aq. sodium hydroxide.

Ans : COMP 2014



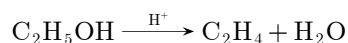
209. A saturated hydrocarbon from iodomethane.

Ans : SQP 2012



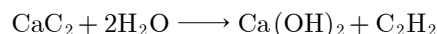
210. An unsaturated hydrocarbon from an alcohol.

Ans : SQP 2018



211. An unsaturated hydrocarbon from calcium carbide.

Ans : MAIN 2007



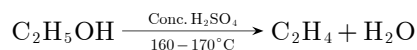
212. An alcohol from ethyl bromide.

Ans : COMP 2013



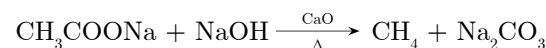
213. Write the equation for the preparation of ethylene from ethyl alcohol.

Ans : SQP 2007



214. Write chemical equation of decarboxylation of ethanoic acid.

Ans : COMP 2019



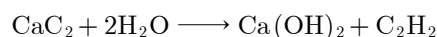
215. Ethanoic acid to ethyl ethanoate.

Ans : MAIN 2011



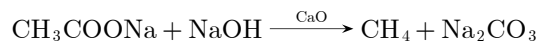
216. Calcium carbide to ethyne.

Ans : SQP 2009



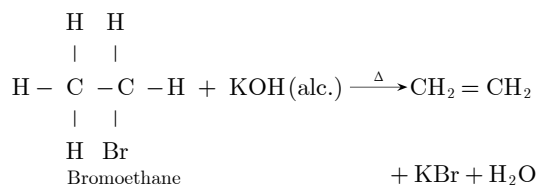
217. Sodium ethanoate to methane.

Ans : COMP 2015



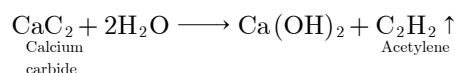
218. Ethene from bromoethane

Ans : MAIN 2004



219. Ethyne using calcium carbide

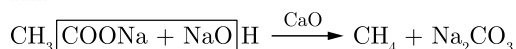
Ans : SQP 2002



220. Methane from sodium acetate.

Ans :

SQP 2019



Sodium acetate

221. Burning of ethane in plentiful supply of air.

Ans :

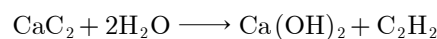
MAIN 2009



222. Action of water on Calcium carbide.

Ans :

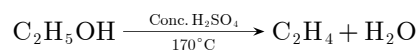
MAIN 2007



223. Heating of Ethanol at 170°C in the presence of conc. Sulphuric acid.

Ans :

COMP 2016



DIRECTION : Name the organic compound prepared by each of the following reactions:

224. $\text{C}_2\text{H}_5\text{COONa} + \text{NaOH} \longrightarrow$

Ans :

MAIN 2021

Ethane

225. $\text{CH}_3\text{I} + 2[\text{H}] \longrightarrow$

Ans :

COMP 2020

Methane

226. $\text{C}_2\text{H}_5\text{Br} + \text{KOH}$ (alcoholic solution) $\longrightarrow$

Ans :

SQP 2000

Ethene

227. $\text{CO} + 2\text{H}_2 \xrightarrow{\text{ZnO}}$

Ans :

COMP 2001

Methanol

228. $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow$

Ans :

SQP 2005

Ethyne

DIRECTION : Write the formula of the following :

229. Methane

Ans :

MAIN 2009

Methane, CH_4

230. Ethane

Ans :

COMP 2000

Ethane, C_2H_6

231. Methyl alcohol

Ans :

SQP 2010

Methyl alcohol, $\text{CH}_3 - \text{OH}$

232. Ethyl alcohol

Ans :

MAIN 2013

Ethyl alcohol, $\text{CH}_3 - \text{CH}_2 - \text{OH}$

233. Methyl chloride

Ans :

COMP 2015

Methyl chloride, $\text{CH}_3 - \text{Cl}$

234. Ethyl chloride

Ans :

SQP 2019

Ethyl chloride, $\text{CH}_3 - \text{CH}_2 - \text{Cl}$

DIRECTION : State which of the following characteristics are true or false for organic Compounds:

235. are non-volatile and non-inflammable.

Ans :

MAIN 2018

False

236. are essentially ionic.

Ans :

COMP 2013

False

237. show molecular reaction not proceeding to Completion.

Ans :

SQP 2000

True

238. do not exhibit isomerism

Ans :

MAIN 2005

False

239. are soluble in organic solvents

Ans :

COMP 2010

True

240. do not conduct electricity

Ans :

SQP 2017

True

DIRECTION : Identify the substance underlined, in the following case :

- 241.** An organic Compound containing —COOH functional group.

Ans : COMP 2019
Carboxylic acid

DIRECTION : Identify the term/substance in each of the following :

- 242.** The catalyst used in the conversion of ethyne to ethane.

Ans : SQP 2016
Nickel or platinum or palladium

- 243.** The type of reactions alkenes undergo.

Ans : MAIN 2016
Addition reactions

- 244.** Liquid (E) can be dehydrated to produce ethene.

Ans : MAIN 2017
Ethanol.

- 245.** Hydrocarbons containing a $\begin{array}{c} \text{O} \\ || \\ \text{—C—} \end{array}$ functional group.

Ans : COMP 2010
Ketone

- 246.** When sodium propionate is heated with soda lime.

Ans : SQP 2013
Ethane

DIRECTION : State one relevant observation for each of the following reactions :

- 247.** A piece of sodium metal is put into ethanol at room temperature.

Ans : SQP 2020



Brisk effervescence due to liberation of hydrogen gas are observed.

- 248.** When the gaseous product obtained by dehydration of ethyl alcohol is passed through

bromine water.

Ans : COMP 2015
Reddish brown solution decolourises.

- 249.** Bromine vapours are passed into a solution of ethyne in carbon tetrachloride.

Ans : SQP 2012
The reddish brown coloured gas (Br_2) gets decolourised.

DIRECTION : Select the correct answer from the choice in brackets.

- 250.** The functional group in ethanoic acid. [aldehydic/carboxyl/hydroxyl]

Ans : MAIN 2002
Carboxyl

- 251.** The vapour density of the fifth member of the homologous series of alkanes. [22/36/29]

Ans : COMP 2010
36

- 252.** The isomer of pentane which has one carbon atom attached to four other C-atom. [*n*—/iso—/neo-pentane]

Ans : SQP 2016
Neo-Pentane

- 253.** The IUPAC name of methyl acetylene. [1- Butyne/Propyne/Ethyne]

Ans : MAIN 2005
Propyne

- 254.** The IUPAC name of the product of the reaction of ethylene with hydrogen bromide. [ethyl bromide/bromoethane/dibromoethane]

Ans : SQP 2017
Bromoethane

DIRECTION : Answer the following :

- 255.** Why pure acetic acid is known as glacial acetic acid?

Ans : COMP 2018
It solidifies to give ice like crystals.

- 151.** The Compounds having same molecular formula but different structural formula.

Ans : COMP 2012
Isomer

- 152.** The chemist who prepared Urea.

Ans : MAIN 2008
Wohler

- 153.** First organic Compound synthesized.

Ans : SQP 2007
Urea

- 154.** Mixture of Sodium hydroxide and Calcium oxide.

Ans : COMP 2012
Soda lime

- 155.** The series in which members are arranged in the increasing order of their molecular masses.

Ans : MAIN 2019
Homologous series

- 156.** Name the gas evolved in the following case :
Ethene undergoes hydrogenation reaction.

Ans : MAIN 2019
Ethane

- 157.** A gas which forms explosive mixture with air.

Ans : SQP 2008
Acetylene

- 158.** Solution used for storing biological specimens.

Ans : COMP 2015
Formalin

- 159.** A gas used as anaesthetic under the name narcyless.

Ans : MAIN 2000
Acetylene

DIRECTION : Fill in the blank with the choices given in bracket.

- 160.** Alkynes undergo _____ [addition/substitution] reactions.

Ans : SQP 2025
addition

- 161.** Conversion of ethene to ethane is an example of _____ (hydration/hydrogenation).

Ans : COMP 2016
Hydrogenation

- 162.** Conversion of ethanol to ethene by the action of concentrated sulphuric acid is an example of _____ (dehydration/dehydrogenation/dehydrohalogenation).

Ans : COMP 2019
dehydration

- 163.** Substitution reactions are characteristic reactions of _____ (alkynes/alkenes/alkanes)

Ans : MAIN 2019
alkanes

- 164.** For alkane the general formula is _____ ($C_nH_{2n}/C_nH_{2n-2}/C_nH_{2n+2}$)

Ans : SQP 2000
 C_nH_{2n+2}

- 165.** For alkynes the general formula is _____ ($C_nH_{2n}/C_nH_{2n-2}/C_nH_{2n+2}$)

Ans : COMP 2001
 C_nH_{2n-2}

- 166.** The Compound formed when ethanol reacts with sodium is _____ (sodium ethanoate, sodium ethoxide, sodium propanoate).

Ans : MAIN 2005
Sodium ethoxide

- 167.** The conversion of ethanol to ethene is an example of _____ (dehydration, dehydro-genation).

Ans : COMP 2007
The conversion of ethanol to ethene is an example of dehydration.

- 168.** Converting ethanol to ethene requires the use of _____ (conc. HCl, conc. HNO_3 , conc. H_2SO_4).

Ans : SQP 2009
Converting ethanol to ethene requires the use of conc. H_2SO_4 .

- 169.** The conversion of ethene to ethane is an example of _____ (hydration, hydrogenation).

Ans : MAIN 2010

- 268.** Name the type of chemical reaction by which C_2Br_6 can be prepared from ethane.

Ans :

MAIN 2005

Substitution reaction.

- 269.** Define catenation.

Ans :

COMP 2006

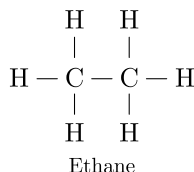
The unique property on the part of carbon atom to link with each other so as to form long chain or ring structure is called as catenation.

- 270.** Which of the following C_2H_6 , C_2H_5OH , CH_3COOH is a hydrocarbon ?

Ans :

MAIN 2010

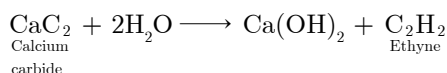
C_2H_6 , this is because it is made-up of only carbon and hydrogen atoms linked together by covalent bonds.



- 271.** Write down the equation for the preparation of ethyne from calcium carbide.

Ans :

COMP 2011



- 272.** Give some important natural sources of organic Compound.

Ans :

SQP 2016

These are plants, animals, coal and petroleum.

- 273.** State which of the following are aliphatic organic Compounds :

methane, benzene, ethene, ethyl alcohol, lead acetate.

Ans :

MAIN 2019

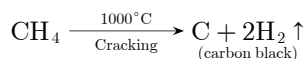
Methane, ethene, ethyl alcohol.

- 274.** How is carbon black prepared from methane ? Give its use.

Ans :

COMP 2010

By cracking



It is used for making printers ink, paints, shoe polishes and as filler in tyres.

- 275.** Write the molecular, electronic and structural formula of ethene.

Ans :

MAIN 2015

Molecular formula C_2H_4

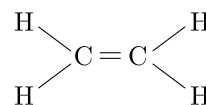
Electronic formula $\begin{array}{c} \text{H} \quad \text{H} \\ \cdot\cdot \quad \cdot\cdot \\ \text{H} : \text{C} :: \text{C} : \text{H} \end{array}$

Structural formula $\text{H} - \text{C} = \text{C} - \text{H}$

- 276.** Draw the structure of ethene.

Ans :

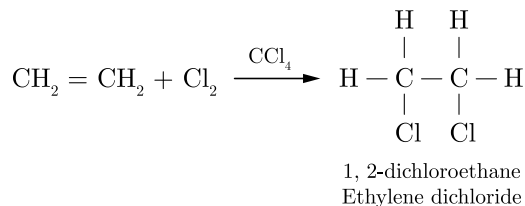
SQP 2016



- 277.** Alkenes undergo addition reaction. Explain this property with the help of a suitable example.

Ans :

MAIN 2000

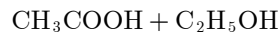


- 278.** Write a fully balanced equation for each of the following cases :

Acetic acid is warmed with ethanol in the presence of concentrated sulphuric acid.

Ans :

COMP 2009



- 279.** What is the term defined below?

A reaction in which the hydrogen of an alkane is replaced by another element like chlorine.

Ans :

MAIN 2010

Substitution reaction.

- 280.** What are hydrocarbons ?

Ans :

COMP 2004

The covalent Compounds of carbon and hydrogen are called hydrocarbons.

281. Name two alkanes that exist as

- (i) Gases
(ii) Liquids

Ans :

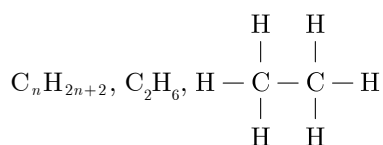
SQP 2011

- (i) Methane, Ethane
(ii) Heptane, Octane

282. Write the general formula for a saturated hydrocarbon and give one example of saturated hydrocarbon with its structural formula.

Ans :

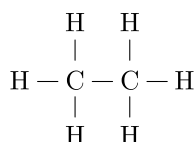
SQP 2001



283. State the structural formula of ethane.

Ans :

MAIN 2019



284. What type of reaction has taken place between ethane and chlorine ?

Ans :

COMP 2007

Substitution reaction

285. What type of reaction between ethene and chlorine ?

Ans :

SQP 2003

Addition reaction

286. What feature of the ethene structure makes such a reaction possible ?

Ans :

COMP 2010

Double bond or unsaturation

287. Write the equation of the Complete combustion of ethane.

Ans :

MAIN 2016



288. Burning acetylene (ethyne) in oxygen produces a very hot flame. What is this hot flame used for ?

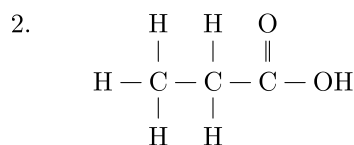
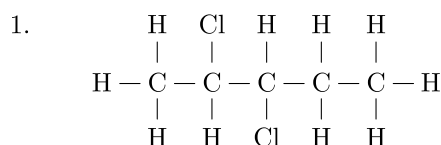
Ans :

COMP 2019

For welding purposes.

TWO MARKS QUESTIONS

289. Give the IUPAC names of the organic compounds represented by the structural formulae given below:



Ans :

MAIN 2024

1. 2, 3-dichloropentane
2. Propanoic acid

290. Match the options A to B with the statements (i) to (ii) :

A. alkynes (i) C_nH_{2n+2}

B. alkane (ii) C_nH_{2n-2}

Ans :

SQP 2014

A. alkynes – (i) C_nH_{2n-2}

B. alkane – (ii) C_nH_{2n+2}

291. State the conditions required for the following reactions to take place :

- (i) Catalytic hydrogenation of ethyne.
(ii) Preparation of ethyne from ethylene dibromide.

Ans :

MAIN 2014

- (i) Nickel at 200°C
(ii) Alcoholic KOH (KOH alc.)

292. Arrange the following according to the instructions given in brackets :

Ethane, methane, ethene, ethyne. (In the increasing order of the molecular weight)

[H = 1, C = 12]

Ans :

COMP 2014

Ethane	Methane	Ethene	Ethyne
(C_2H_6)	CH_4	C_2H_4	C_2H_2
30	16	28	26

- 293.** State one relevant reason for the following:
Soda lime is preferred to sodium hydroxide in the laboratory preparation of methane.

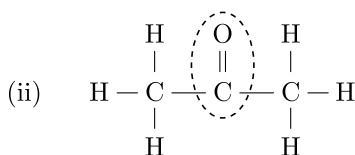
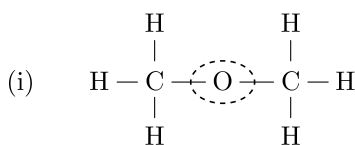
Ans : SQP 2020

Soda lime is a mixture of sodium hydroxide and calcium oxide. This sodium hydroxide brings about the reaction and calcium oxide removes the water, thus preventing the reversible reaction.

- 294.** Using their structural formulae, identify the functional group by circling them:

- (i) Dimethyl ether.
(ii) Propanone.

Ans : MAIN 2015



- 295.** Select from the list the gas that matches the description given in each case :

[ammonia, ethane, hydrogen chloride, hydrogen sulphide, ethyne]

- (i) This gas is used for welding purposes.
(ii) This gas is also a saturated hydrocarbon.

Ans : MAIN 2015

- (i) Ethyne
(ii) Ethane

- 296.** Match the options A to E with the statements (i) to (v):

A	alkynes	(i)	No. of molecules in 22.4 dm ³ of carbon dioxide at S.T.P
B	alkane	(ii)	An element with electronic configuration 2,8,8,3
C	iron	(iii)	C_nH_{2n+2}
D	6.023×10^{23}	(iv)	C_nH_{2n-2}
E	metal	(v)	The metal that forms two types of ions

Ans : SQP 2014

A : (iv), B : (iii), C : (v), D : (i), E : (ii).

- 297.** Give the general formula of paraffins, olefins and alkynes.

Ans : COMP 2015

General formula of :

- (i) Paraffins is C_nH_{2n+2} ; $n = 1, 2, 3, \dots$
(ii) Olefins is C_nH_{2n} ; $n = 2, 3, 4, \dots$
(iii) Alkynes is C_nH_{2n-2} ; $n = 2, 3, 4, \dots$

- 298.** Write the molecular formulae of the third and fifth members of homologous series of carbon Compounds represented by the generally formula C_nH_{2n-2} .

Ans : COMP 2018

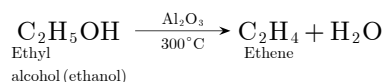
General formula = C_nH_{2n-2} , $n = 2, 3, 4, \dots$

Third member = C_4H_6

Fifth member = C_6H_{10}

- 299.** How is ethanol converted to ethene using a solid as dehydrating agent and not concentrated H_2SO_4 ? Give only balanced equation.

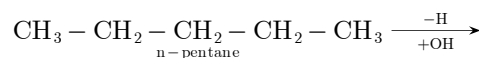
Ans : SQP 2002



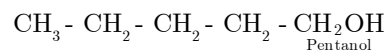
Dehydrating agent used is alumina Al_2O_3 .

- 300.** What is the molecular formula of alcohol, which is derived from pentane ?

Ans : COMP 2006



(Molecular formula = C_5H_{12})



(Molecular formula = $C_5H_{11}OH$)

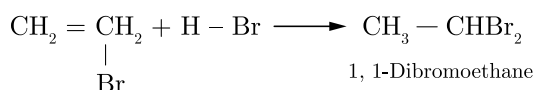
Thus, molecular formula of alcohol which is derived from pentane is $\rightarrow C_5H_{11}OH$. It is called pentanol.

- 301.** Give reasons as to why

- (i) almost 90% of all known Compounds are organic in nature.
(ii) it is dangerous to burn methane in an insufficient supply of air.

Ans : MAIN 2010

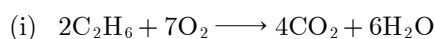
- (i) Organic Compounds contain carbon atom which is tetravalent and has the unique property of catenation, isomerism and presence of multiple bonds.



- 316.** (i) Write equation for the Complete combustion of ethane.
 (ii) Using appropriate catalysts, ethane can be oxidized to an alcohol, an aldehyde and an acid.
 Name the alcohol, aldehyde and acid formed when ethane is oxidized.

Ans :

MAIN 2017

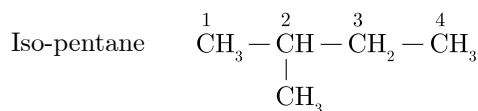


(ii) Ethanol, Ethanal and Ethanoic acid

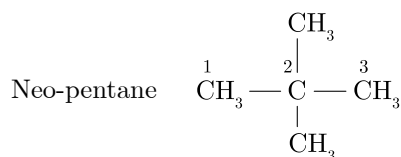
- 317.** Write the structural formula of isomers of pentane other than *n*-pentane.

Ans :

SQP 2010



2-Methylbutane

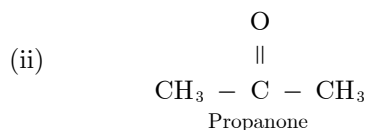


2, 2-Dimethyl-propane

- 318.** Using their structural formulae identify the functional group by circling them :
 (i) Dimethyl ether.
 (ii) Propanone.

Ans :

MAIN 2015

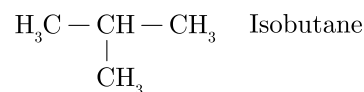
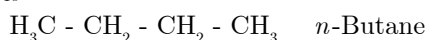


- 319.** Define isomerism. How many isomers are possible for a alkane having molecular formula C_4H_{10} ?

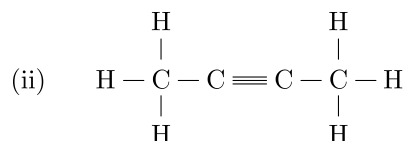
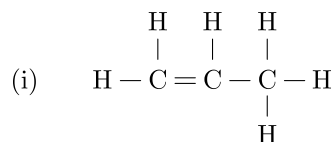
Ans :

MAIN 2019

Two or more compounds having same molecular formula but different properties are called isomers and this phenomenon is known as isomerism.
 e.g., C_4H_{10} represents two chain isomers.



- 320.** Write the IUPAC names of each of the following:



Ans :

SQP 2016

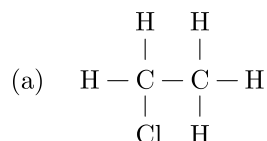
- (i) Propene
 (ii) But-2-yne

- 321.** Ethane and chlorine react together to form monochloroethane (ethyl chloride).

- (a) Write down the structural formula of monochloroethane.
 (b) What type of reaction has taken place between ethane and chlorine ?

Ans :

MAIN 2011



- (b) Substitution reaction.

THREE MARKS QUESTIONS

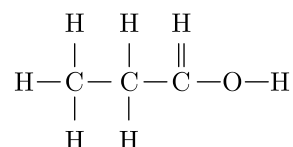
- 322.** Draw the structural diagram for the following compounds:

- (a) propanoic acid
 (b) pentan-2-ol
 (c) 2, 2 dibromo butane

Ans :

SQP 2025

- (a)



- (b)

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309. State two Main groups of aliphatic hydrocarbons with examples.

Ans :

MAIN 2022

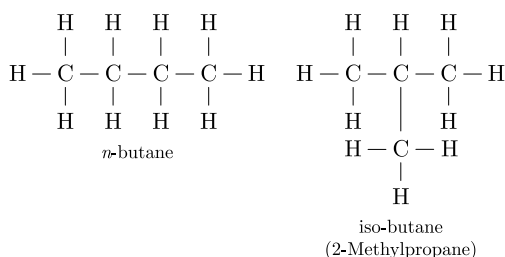
Aliphatic hydrocarbons are mainly of two types.

1. Saturated aliphatic hydrocarbons
e.g., Methane, CH_4 , Ethane, C_2H_6
2. Unsaturated aliphatic hydrocarbons
e.g., Ethene, C_2H_4 , Ethyne, C_2H_2

310. Draw the structural formulae of the two isomers of butane. Give the correct IUPAC name of each isomer.

Ans :

COMP 2023



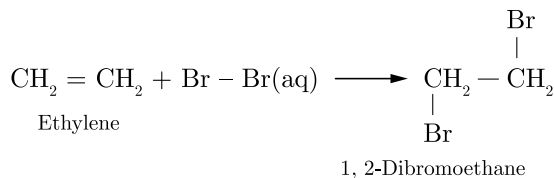
311. How would you convert :

- (i) Ethylene to 1, 2-dibromoethane ?
- (ii) Ethylene to ethyl bromide ?

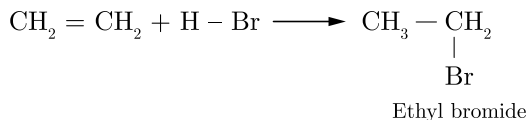
Ans :

SQP 2011

- (i) Ethylene to 1, 2 - dibromoethane :



- (ii) Ethylene to ethyl bromide

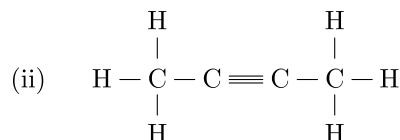
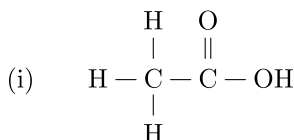


312. Draw the structural formula for each of the following:

- (i) Ethanoic acid
- (ii) But-2-yne

Ans :

COMP 2017



313. Write the following properties of ethylene :

- (i) Physical state
- (ii) Odour

Ans :

MAIN 2018

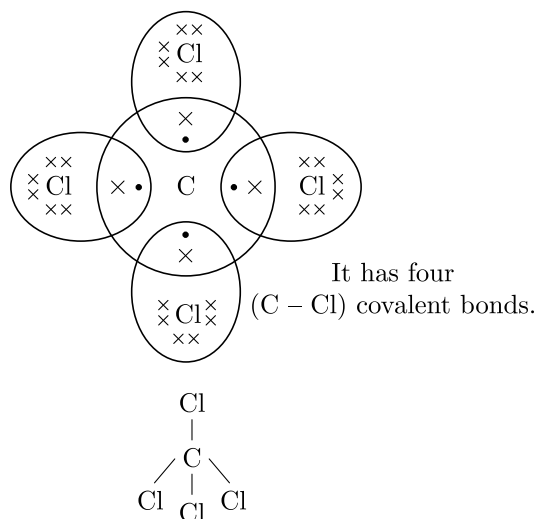
Physical properties of ethylene are as follows :

- (i) Physical state : It is colourless gas.
- (ii) Odour : It has a peculiar odour (first sweetish smell).

314. Methane is the first member of alkane, when it is treated with excess of chlorine in the presence of diffused sunlight forms carbon tetrachloride. Draw the appropriate structural formula of carbon tetrachloride and state the type of bond present in it.

Ans :

SQP 2015

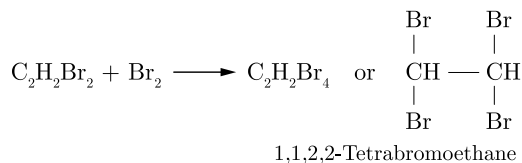
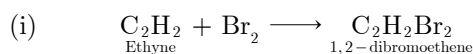


315. Write equations to show what happens when acetylene gas (Ethyne gas) reacts with

- (i) bromine water
- (ii) excess of hydrobromic acid ?

Ans :

COMP 2012

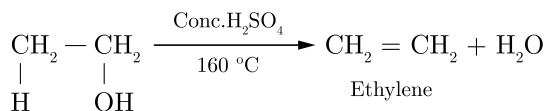


- (ii) On burning methane in insufficient supply of air, it will produce carbon monoxide which is highly poisonous.

302. Give the balanced equation for lab preparation of ethylene. How is the gas collected and dried ?

Ans :

SQP 2017



Ethylene is collected over water by the downward displacement of water.

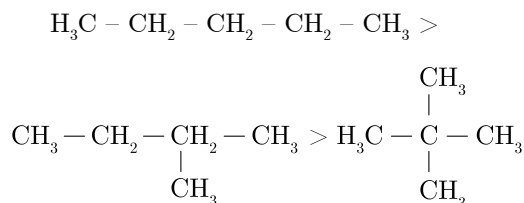
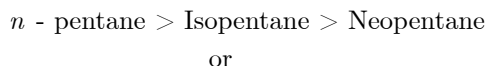
Ethylene is dried by passing it through conc. sulphuric acid.

303. Arrange *n*-pentane, isopentane and neopentane in the decreasing order of boiling points and justify.

Ans :

MAIN 2019

The decreasing order of boiling points is

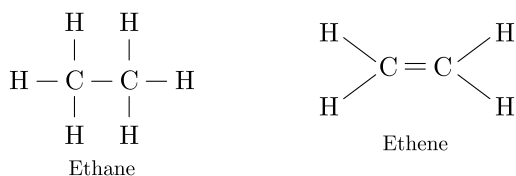


This is because with the increase in branching, the surface area decreases. As a result of it the magnitude of vander-waals forces of attraction decreases, therefore, boiling point goes on decreasing.

304. Distinguish between the saturated hydrocarbon ethane and the unsaturated hydrocarbon ethene by drawing their structural formulae.

Ans :

SQP 2020



305. List three characteristics of isomers.

Ans :

COMP 2020

Three characteristics of isomers are as follows:

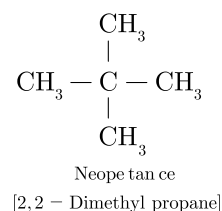
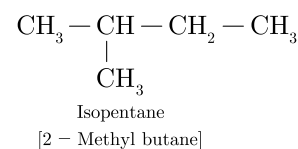
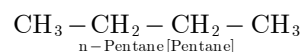
- (i) They have same molecular formula.
- (ii) They have different physical and chemical properties.
- (iii) They have same molecular mass.

306. Define isomers. Write the various isomers of pentane. Write both molecular as well as structural formula [Common and IUPAC names both].

Ans :

COMP 2011

Isomers are the organic compounds having different structural formula but same molecular formula.

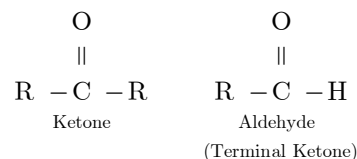


307. "Ketonic group is never terminal". Comment.

Ans :

MAIN 2015

Ketonic group is never terminal, because if it is terminal, it will start behaving as an aldehyde.

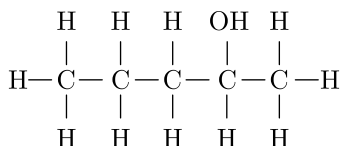


308. Give the names of the following functional groups : CHO, CO, -OH, -COOH.

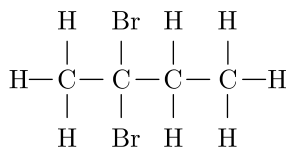
Ans :

SQP 2019

S.No.	Formula of the functional group	Name of the functional group
(i)	-CHO	Aldehydic
(ii)	$\diagup \text{C} = \text{O} \diagdown$	Ketonic
(iii)	-OH	Alcoholic
(iv)	-COOH	Carboxyl



(c)



323. Choose the organic compound from the list given below to answer the following question:

Ethene Ethanoic acid Ethanol Methanal

- The compound which does not have double bond in its structure.
- The compound which in its pure form turns into an ice like solid on cooling.
- The compound which is used for artificial ripening of fruits.

Ans :

MAIN 2024

- Ethanol ($\text{C}_2\text{H}_5\text{OH}$)
- Ethanoic acid
- Ethene

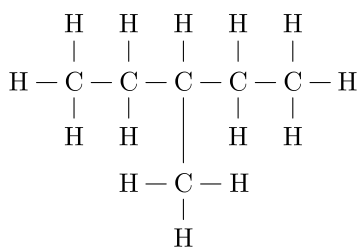
324. Draw the structural diagram for the following organic compounds:

- 3-methyl pentane
- propyne
- methanal

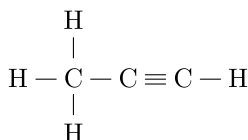
Ans :

MAIN 2024

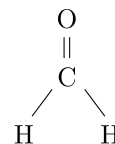
- 3-methylpentane



- Propyne



- Methanal



325. Ethane, Ethene, Ethanoic acid, Ethyne, Ethanol

From the box given above, name :

- The Compounds with $-\text{OH}$ as a part of its structure.
- The Compounds with $-\text{COOH}$ as a part of its structure.
- Homologues and Homologous series with general formula, C_nH_{2n} .

Ans :

MAIN 2005

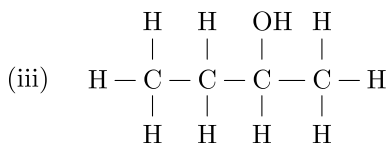
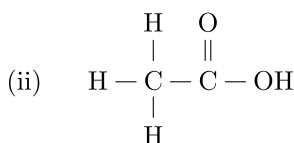
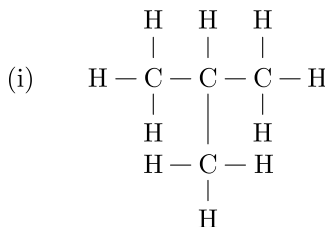
- Ethanol
- Ethanoic acid
- Ethene

326. Give the structural formulae of each of the following:

- 2-methyl propane
- Ethanoic acid
- Butan-2-ol

Ans :

MAIN 2016



327. (i) What is the general formula of a saturated hydrocarbon ?

Give an example of such a hydrocarbon along with its structural formula.

- A white solid on treating with water liberates acetylene gas. Name the solid.
- Write an equation for the preparation of ethylene gas from ethyl alcohol.

FOUR MARKS QUESTIONS

347. State the terms for the following:

- The group obtained by removing one hydrogen atom from the parent alkane.
- Two metal plates or wires through which the current enters and leaves the electrolytic cell.
- The amount of substance which contains the same number of units as the number of atoms in carbon-12.
- The tendency of an atom to pull a shared pair of electrons towards itself in a compound.
- The formula which represents the simplest ratio between the atoms of elements present in a compound.

Ans :

MAIN 2024

- Alkyl group
- Electrodes (cathode and anode)
- Mole
- Electronegativity
- Empirical formula

348. Compound A is bubbled through bromine dissolved in carbon tetrachloride and the product is $\text{CH}_2\text{Br} - \text{CH}_2\text{Br}$.



- Draw the structural formula of A.
- What type of reaction has A undergone?
- What is your observation?
- Name (not formula) the Compound formed when steam reacts with A in the presence of phosphoric acid.
- What is the procedure for converting the product of (iv) back to A?

Ans :

MAIN 2010

- $$\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H} - \text{C} = \text{C} - \text{H} \end{array}$$
- Addition reaction
- Reddish brown bromine solution decolourises
- Ethanol
- Dehydration of ethanol by conc. H_2SO_4

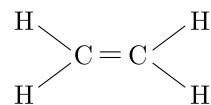
- 349.**
- What is the type of reaction taking place between ethane and chlorine to form monochloroethane ?
 - The reaction between ethene and chlorine forms only one product. Name the type of this reaction.
 - (a) Draw the structural formula of ethene.

- What is the feature of the ethene structure which allows ethene to react with chlorine in the way it does ?

Ans :

MAIN 2019

- Substitution reaction
- Addition reaction
- (a) Structural formula of ethene is



- Carbon-Carbon double bond ($>\text{C}=\text{C}<$)

350. What are the final products when acetylene (ethyne) adds to

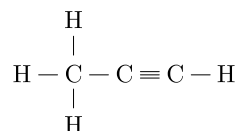
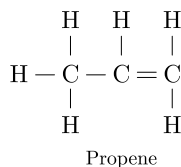
- Iodine
- Chlorine
- Bromine (liquid)
- Hydrogen ?

Ans :

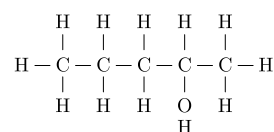
MAIN 2021

- 1, 2-diiodoethene.
- 1, 1, 2, 2-tetrachloroethane $\text{C}_2\text{H}_2\text{Cl}_4$
- 1, 1, 2, 2-tetrabromoethane $\text{C}_2\text{H}_2\text{Br}_4$
- Ethane, C_2H_6

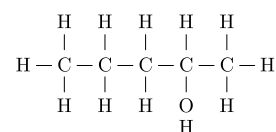
351. Give the IUPAC names of the following Compounds numbered (i) to (v). The IUPAC names of the Compounds of the left are to guide you into giving the correct IUPAC names of the Compounds on the right.



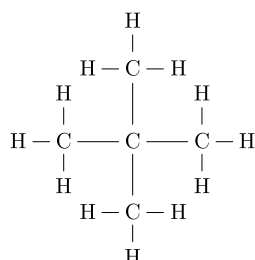
(i) _____



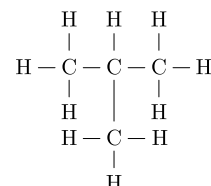
Pentan - 2 - ol



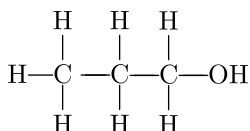
(ii) _____



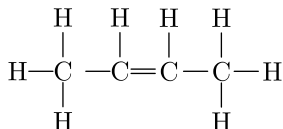
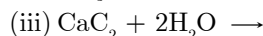
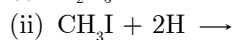
2,2 dimethyl propane



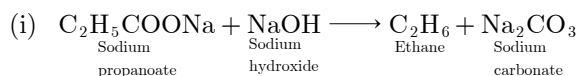
(iii) _____



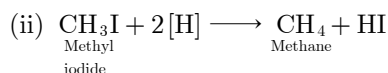
(iii) 2-butane :

**332.** Name the organic Compound prepared by each of the following reactions.**Ans :**

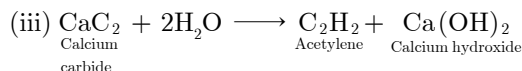
MAIN 2021



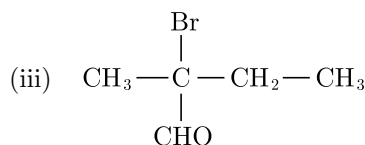
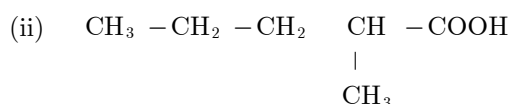
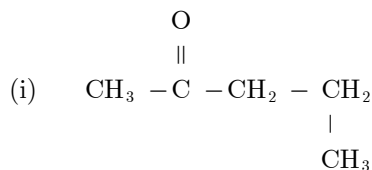
Organic Compound formed is ethane.



Organic Compound formed is methane.



Organic Compound formed is acetylene.

333. Write IUPAC names for following**Ans :**

COMP 2017

- (i) Pentan-2-one
 (ii) 2-Methyl pentanoic acid
 (iii) 2-Bromo, 2-Methyl butanal

334. Give three uses of ethylene.**Ans :**

COMP 2021

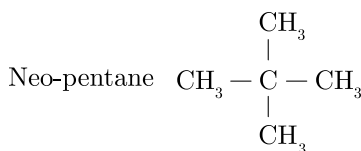
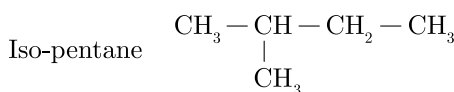
Uses of ethylene :

1. It is used in the manufacture of polyethylene which is a valuable plastic.
2. It is used for the artificial ripening of fruits.
3. It is used for producing oxyethane (used in the manufacture of detergents).

335. What is the Main difference in the structural formula of the Compounds *n*-pentane, iso-pentane and neo-pentane ?

Ans :

MAIN 2021



The difference in the three isomers is that they have different lengths of chain of C-atoms.

336. State the molecular formula and structural formula of ethane, ethene and ethyne.**Ans :**

COMP 2005

Compound	Molecular formula	Structural formula
Ethane	C_2H_6	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} - \text{C} - \text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $
Ethene	C_2H_4	$ \begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \end{array} $
Ethyne	C_2H_2	$\text{H} - \text{C} \equiv \text{C} - \text{H}$

containing $\text{C} = \text{C}$ or $-\text{C} \equiv \text{C}-$ in their molecules.

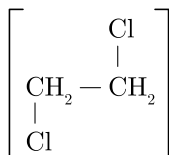
337. The type of reaction between ethane and chlorine is different from that between ethene and chlorine.

- What is the type of reaction that has taken place between ethene and chlorine ?
- What feature of the ethene structure makes such a reaction possible ?
- Name the product of the reaction between ethene and chlorine.

Ans :

SQP 2005

- (i) Addition reaction.
 (ii) Presence of $\text{C}=\text{C}$ double bond
 (iii) Ethylene dichloride IUPAC (1, 2 dichloro ethane)

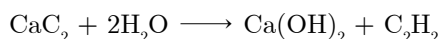


338. How is acetylene prepared in the laboratory ?

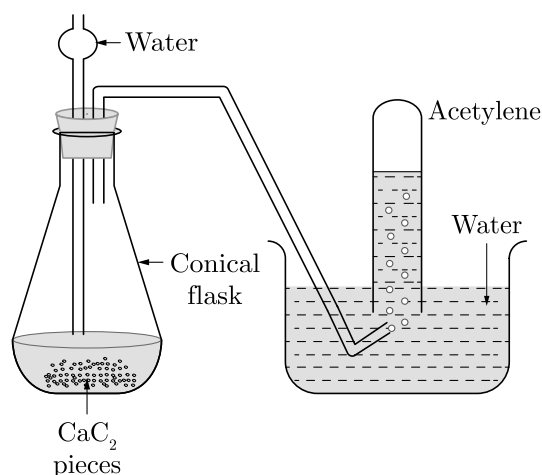
Ans :

MAIN 2005

Acetylene is prepared in the laboratory by the action of water on calcium carbide.



Method : Fit up the apparatus as given below :



Take a few pieces of calcium carbide in a conical flask. Add a few drops of water through the thistle funnel. Acetylene gas is produced which is collected over water by the downward displacement of water.

339. Compare methane, ethylene and acetylene.

Ans :

SQP 2011

The Comparison between methane, ethylene and acetylene are as follows:

	Property	Methane	Ethylene	Acetylene
1.	Molecular formula	CH_4	C_2H_4	C_2H_2
2.	Structural formula	$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} = \text{C} - \text{H} \end{array}$	$\text{H} - \text{C} \equiv \text{C} - \text{H}$

3.	Physical state	Gas	Gas	Gas
4.	Colour	Colourless	Colourless	Colourless
5.	Smell	Odourless	Sweetish smell	Fast pleasant smell
6.	Melting point	-182°C	-169°C	-81°C
7.	Boiling point	-162°C	-105°C	-84°C
8.	Combustibility	Burns with a blue flame	Burns with a luminous flame	Burns with a luminous and smoky flame
9.	Reaction with Cl_2	Substitution reaction	Addition reaction	Addition reaction

340. Write the equation for the following reactions.

- (i) Calcium carbide and water
 (ii) Ethene and water (steam)
 (iii) Bromoethane and an aqueous solution of sodium hydroxide.

Ans :

MAIN 2016

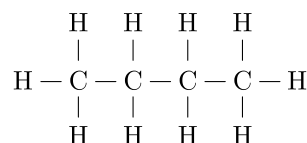
- (i) $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + \text{C}_2\text{H}_2$
 (ii) $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \longrightarrow \text{C}_2\text{H}_5\text{OH}$
 (iii) $\text{C}_2\text{H}_5\text{Br} + \text{NaOH} \longrightarrow \text{C}_2\text{H}_5\text{OH} + \text{NaBr}$

341. Give the molecular formula, structural formula, electronic formula and condensed formula of butane.

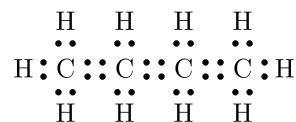
Ans :

SQP 2019

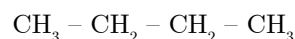
- (i) Molecular formula C_4H_{10}
 (ii) Structural formula



- (iii) Electronic formula



- (iv) Condensed formula



342. Identify the term or substance based on the descriptions given below :

- (i) Hydrocarbon containing a triple bond used for welding purposes.

- (ii) The property by virtue of which the Compound has the same molecular formula but different structural formulae.
- (iii) The Compound formed where two alkyl groups are linked by $\begin{array}{c} \text{O} \\ || \\ -\text{C}- \end{array}$ group.

Ans :

MAIN 2011

- (i) Acetylene
(ii) Isomers
(iii) Ketone

343. Copy and Complete the following table which relates to three homologous series of hydrocarbons:

General Formula	C_nH_{2n}	C_nH_{2n-2}	C_nH_{2n+2}
IUPAC name of the homologous series			
Characteristic bond type			Single bond
IUPAC name of the first member of the series			
Type of reaction with chlorine.		Addition	

Ans :

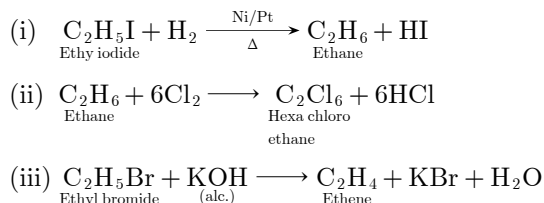
COMP 2018

General Formula	C_nH_{2n}	C_nH_{2n-2}	C_nH_{2n+2}
IUPAC name of the homologous series	Alkene	Alkyne	Alkane
Characteristic bond type	Double bond	Triple bond	Single bond
IUPAC name of the first member of the series	Ethene	Ethyne	Methane
Type of reaction with chlorine.	Addition	Addition	Substitution

- 344.** Name the product formed (give equations)
- (i) When ethyl iodide is reduced Completely.
- (ii) Chlorinated product of ethane with camphor like smell.
- (iii) When ethyl bromide is treated with alc. KOH

Ans :

COMP 2021

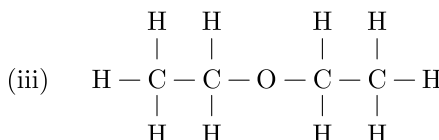
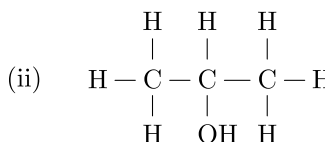
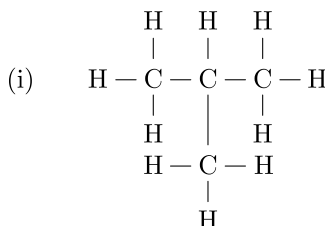


345. Give the structural formulae for the following:

- (i) An isomer of n-butane.
(ii) 2-propanol.
(iii) Diethyl ether.

Ans :

MAIN 2000



346. Name a substance used for

- (i) Illuminating country houses
(ii) making a household plastic material
(iii) Ripening of fruits
(iv) Is poisonous
(v) Consumed as a drink
(vi) Made from water gas.

Ans :

COMP 2016

- (i) Acetylene
(ii) Ethylene
(iii) Ethylene
(iv) Methyl alcohol
(v) Ethyl alcohol
(vi) Methyl alcohol.

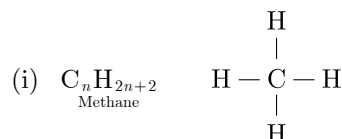
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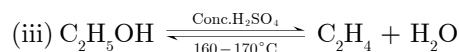
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Ans :

MAIN 2004



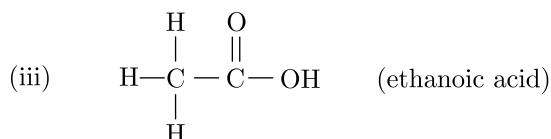
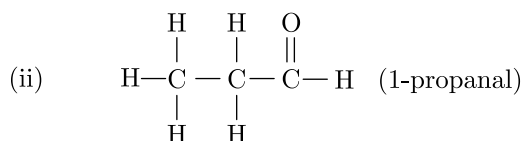
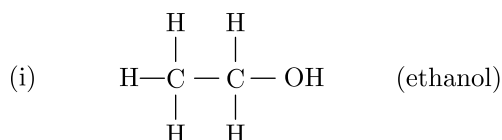
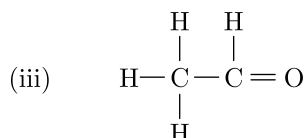
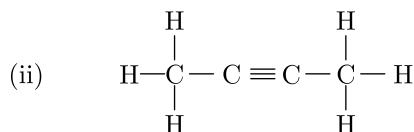
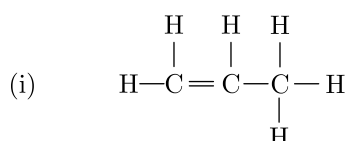
(ii) Calcium carbide

**328.** Give the structural formula of the following :

- (i) ethanol
(ii) 1-propanal
(iii) ethanoic acid

Ans :

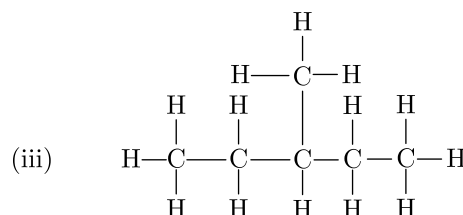
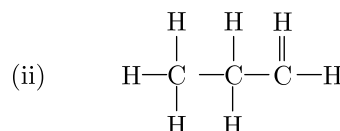
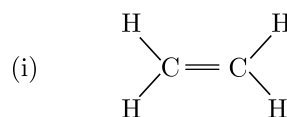
MAIN 2014

**329.** Write the IUPAC names of each of the following :

Ans :

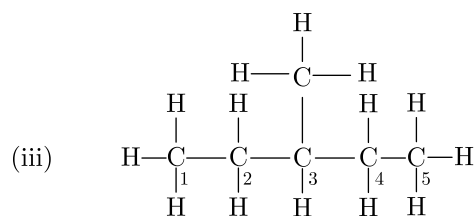
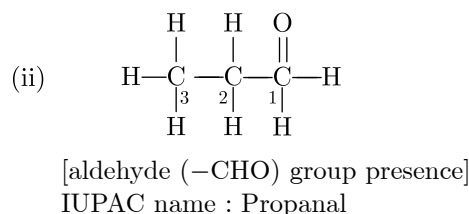
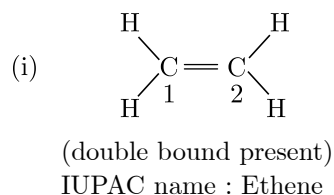
COMP 2016

- (i) prop -1 - ene,
(ii) but -2 - yne
(iii) ethanal

330. Give the IUPAC name for the following:

Ans :

SQP 2022



IUPAC name : 3-methylpentane

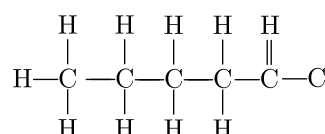
331. Draw the structural diagram of

- (i) pentanal
(ii) propanol
(iii) 2-butene

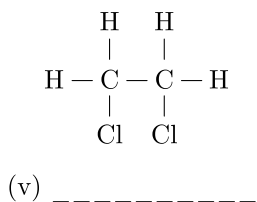
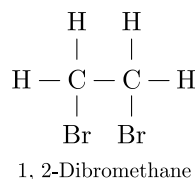
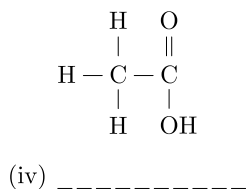
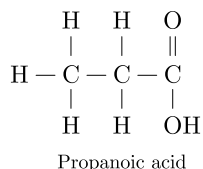
Ans :

MAIN 2022

(i) Structural diagram of pentanal :



(ii) Structural diagram of propanol :



Ans :

SQP 2007

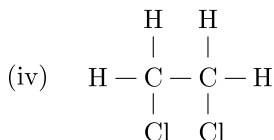
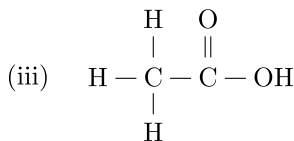
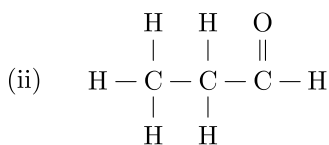
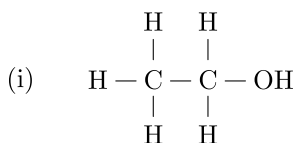
- (i) Propyne
- (ii) Pentan-3-ol
- (iii) 2-methyl propane
- (iv) ethanoic acid
- (v) 1, 2-dichloroethane

352. Give the structural formula of the following:

- (i) ethanol.
- (ii) 1-propanal.
- (iii) ethanoic acid.
- (iv) 1, 2, dichloroethane.

Ans :

MAIN 2014

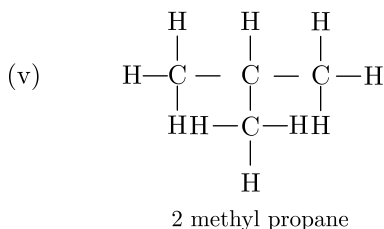
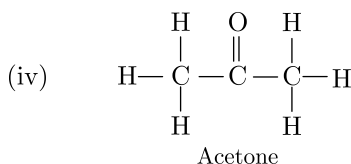
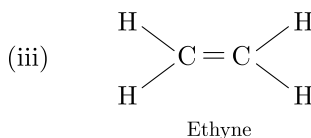
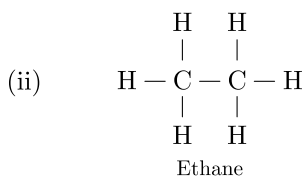
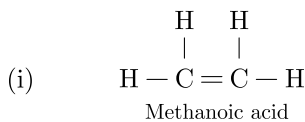
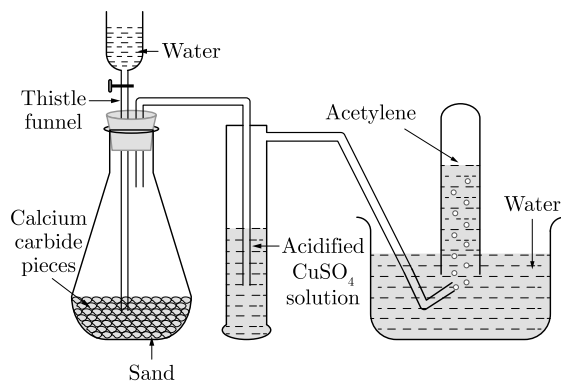
**353.** Give the structural formula for the following :

- (i) Methanoic acid
- (ii) Ethanal
- (iii) Ethyne
- (iv) Acetone

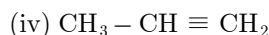
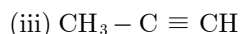
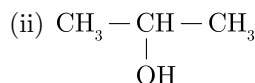
(v) 2-methyl propane.

Ans :

SQP 2012

**354.**

- (i) What is the reaction which is taking place ?
- (ii) Give the function of acidified copper sulphate solution.
- (iii) Give a reaction in which acetylene gas is prepared by synthesis reaction.
- (iv) Compare the reaction of acetylene with bromine water and liquid bromine.
- (v) What happens when acetylene is heated in copper tube at 600°C ?



Ans :

- (i) Propanol
(ii) Propan-2-ol
(iii) Propyne
(iv) Propene

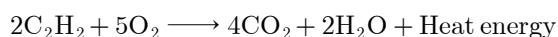
364. Give balanced equations for the reactions of acetylene with each of the following:

- (i) Oxygen
(ii) Chlorine
(iii) Bromine water
(iv) Liquid bromine

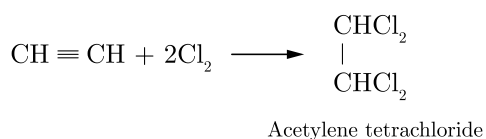
Ans :

Reactions of acetylene with

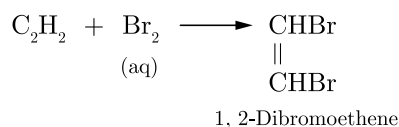
- (i) Oxygen



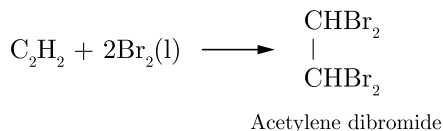
- (ii) Chlorine



- (iii) Bromine water



- (iv) Liquid bromine



365. (a) Give the general formula of alkanes. Write the name, structural formula and physical state of the Compound containing :

- (i) 3-carbon atoms
(ii) 8- carbon atoms.

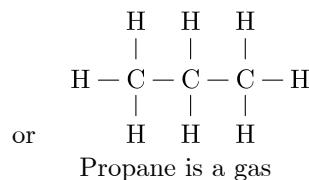
- (b) Which of the Compounds named in (a) would show: (i) Isomerism (ii) Higher melting point (iii) Higher density (iv) Lower boiling point ?

Ans :

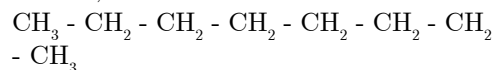
COMP 2021

- (a) General formula of alkanes = $\text{C}_n\text{H}_{2n+2}$ $n = 1, 2, 3, \dots$

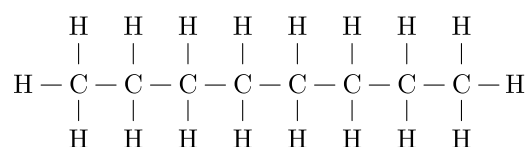
- (i) Propane, $\text{CH}_3 - \text{CH}_2 - \text{CH}_3$



- (ii) Octane,



or



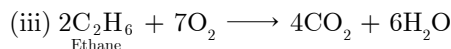
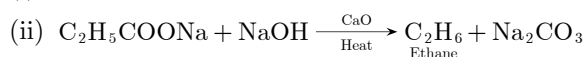
- (b) (i) Octane shows isomerism.
(ii) Octane has higher melting point.
(iii) Octane has higher density.
(iv) Propane has lower boiling point.

- 366.** (i) Which Compound should be heated with soda lime to obtain ethane gas in the laboratory ?
(ii) Write the equation for the reaction in (i) above.
(iii) Write balanced equation for the Complete combustion of ethane.
(iv) Name a solid which can be used instead of concentrated sulphuric acid to prepare ethylene by the dehydration of ethanol.
(v) Name a reagent which can be used to distinguish between ethane and ethene.
(vi) Ethylene forms an addition product with chlorine. Name this addition product and write its structural formula.

Ans :

COMP 2011

- (i) Sodium propionate

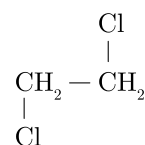


- (iv) Alumina or Aluminium oxide, Al_2O_3

- (v) Alkaline potassium permanganate solution.

- (vi) Ethylene dichloride ($\text{C}_2\text{H}_4\text{Cl}_2$)

Structural formula of ethylene dichloride is :



- (i) Ethene decolourises Bromine solution.
- (ii) A red precipitate is formed.
- (iii) A white precipitate is formed.
- (iv) A colourless, odourless gas which burns with popping sound.
- (v) The purple colour of Potassium permanganate gets decolourised.

359. Give any four uses of ethanoic acid.

Ans :

MAIN 2017

- (i) Ethanoic acid is used in making synthetic vinegar.
- (ii) Ethanoic acid is used as a reagent in chemistry laboratory.
- (iii) Ethanoic acid is used for making white lead $[2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2]$.
- (iv) Ethanoic acid is used for coagulating rubber from latex and casein from milk.

360. Give the formula of the next higher homologue of:

(a) Methanol	(b) Ethane
(c) Ethene	(d) Ethyne
(e) Propyl	(f) Methanoic acid
(g) Propane	(h) Butene
(i) Pentane	(j) Methanal

Ans :

COMP 2014

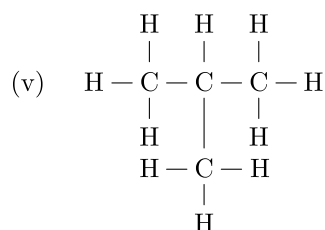
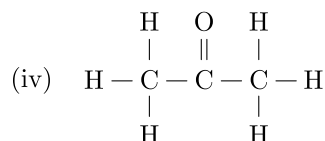
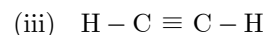
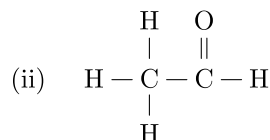
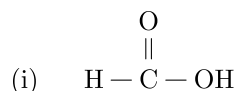
(a) Ethanol	$\text{C}_2\text{H}_5\text{OH}$
(b) Propane	C_3H_8
(c) Propene	C_3H_6
(d) Propyne	C_3H_4
(e) Butyl	C_4H_9
(f) Ethanoic acid	CH_3COOH
(g) Butane	C_4H_{10}
(h) Pentene	C_5H_{10}
(i) Hexane	C_6H_{14}
(j) Ethanal	CH_3CHO

361. Give the structural formula for the following:

- (i) Methanoic acid
- (ii) Ethanal
- (iii) Ethyne
- (iv) Acetone
- (v) 2-methyl propane.

Ans :

MAIN 2012

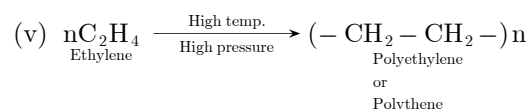
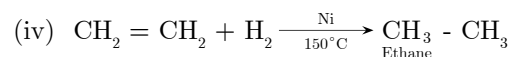
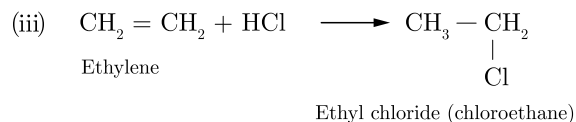
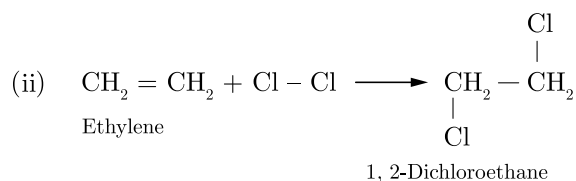
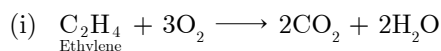


362. What happens when (give balanced equations) :

- (i) Ethylene is burnt in an excess of oxygen.
- (ii) Ethylene reacts with chlorine.
- (iii) Ethylene combines with hydrogen chloride.
- (iv) A mixture of ethylene and hydrogen is passed over nickel at 150°C .
- (v) Ethylene is heated at 400°C under very high pressure in the presence of traces of O_2 .

Ans :

COMP 2014



363. Give IUPAC names of the following:



to study its physical and chemical properties and explore its applications in industry, particularly in welding and cutting metals.

- What gas is produced when calcium carbide reacts with water and how is it collected?
- What is the by-product formed in this reaction and what is its use?
- Describe the type of bond present between the carbon atoms in ethyne and its significance.
- What is one common industrial application of ethyne?

Ans :

- Ethyne (acetylene) gas, collected over water.
- Calcium hydroxide, used in construction as a lime.
- A triple bond, which makes ethyne highly reactive.
- It is used in oxy-acetylene welding.

377. During an organic chemistry experiment, a student adds bromine water to an unknown hydrocarbon sample and observes that the reddish-brown solution becomes colorless. The student is tasked with identifying the type of hydrocarbon, explaining the significance of this observation and predicting the product of the reaction. Additionally, they must discuss how this test can be used to differentiate between alkanes and alkenes.

- What does the decolorization of bromine water indicate about the hydrocarbon?
- Which type of hydrocarbon reacts with bromine water in this manner and what is the mechanism?
- Predict the product formed when ethene reacts with bromine and its significance.
- How can this bromine water test be used to differentiate between alkanes and alkenes?

Ans :

- It is an unsaturated hydrocarbon.
- Alkenes ; through an addition reaction.
- 1, 2-Dibromoethane, indicating a successful test for unsaturation.
- Alkenes decolorize bromine water, while alkanes do not.

378. A chemical engineer is working on the catalytic hydrogenation of propene to produce propane. The engineer must choose the appropriate catalyst, understand the reaction mechanism and optimize the process to ensure high yield and purity. The engineer also needs to consider the

industrial significance of this process, particularly in the food industry for hydrogenating vegetable oils.

- What catalyst is commonly used in the hydrogenation of alkenes and why?
- What type of reaction is hydrogenation and what are its characteristics?
- What is the product formed when propene is hydrogenated and what is its use?
- Why is hydrogenation important in the food industry?

Ans :

- Nickel (Ni), because it facilitates the addition of hydrogen.
- Addition reaction; it converts unsaturated compounds to saturated ones.
- Propane ; used as a fuel and refrigerant.
- It is used to solidify vegetable oils, producing margarine and shortening.

379. A laboratory technician is performing an experiment to test for the presence of aldehydes using Tollen's reagent. The technician must identify the chemical basis of the test, observe the result and explain why aldehydes give a positive result while ketones do not. The technician is also required to discuss the practical applications of this test in distinguishing between different types of carbonyl compounds.

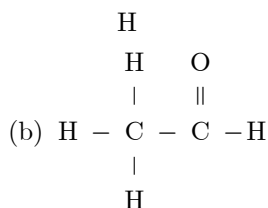
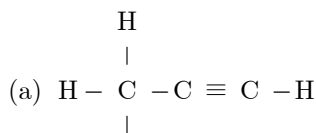
- What is the visual result of a positive Tollens test for aldehydes and what causes it?
- What is the functional group present in aldehydes that makes them reactive in the Tollen's test?
- Why does Tollen's reagent give a positive result with aldehydes but not with ketones?
- What is a practical application of the Tollen's test in organic chemistry?

Ans :

- Formation of a silver mirror, caused by the reduction of silver ions to metallic silver.
- The $-CHO$ group.
- Aldehydes are easily oxidized to carboxylic acids, unlike ketones.
- It is used to differentiate between aldehydes and ketones in a mixture.

380. In an organic chemistry lab, a student is tasked with converting ethanoic acid to ethyl ethanoate using an esterification reaction. The student must identify the reagents, describe the reaction conditions and purify the ester product. The

- 367.** (i) Give the IUPAC name of the following organic Compounds :



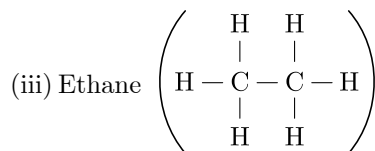
- (ii) What is the special feature of the structure of ethyne ?
 (iii) Name the saturated hydrocarbon containing two carbon atoms.
 (iv) Give the structural formula of Acetic acid.

Ans :

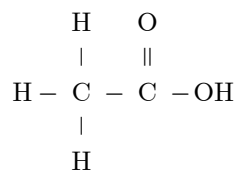
COMP 2019

- (i) (a) Prop -1- yne or propyne
 (b) Ethanal
 (ii) $\text{H} - \text{C} \equiv \text{C} - \text{H}$

Special feature of the structure of ethyne is the presence of triple bond.



- (iv) Acetic acid (CH_3COOH)



- 368.** State the common and IUPAC names of the following Compounds. Also indicate the functional group, if any in each case :

- (a) $\text{CH}_3 - \text{CH}_3$ (b) $\text{CH}_2 = \text{CH}_2$
 (c) $\text{CH} \equiv \text{CH}$ (d) CH_4
 (e) $\text{C}_2\text{H}_5 - \text{Cl}$

Ans :

MAIN 2011

	Compound	Common name	IUPAC Name	Functional group
(a)	$\text{CH}_3 - \text{CH}_3$	Ethane	Ethane	
(b)	$\text{CH}_2 = \text{CH}_2$	Ethylene	Ethene	$\diagup \text{C} = \text{C} \diagdown$, Double bond
(c)	$\text{CH} \equiv \text{CH}$	Acetylene	Ethyne	$-\text{C} \equiv \text{C}-$, Triple bond
(d)	CH_4	Methane	Methane	-----
(e)	$\text{C}_2\text{H}_5 - \text{Cl}$	Ethylchloride	Chloroethane	-----

- 369.** State the common and IUPAC names of the following Compounds. Also indicate the functional group, if any in each case :

- (i) $\text{CH}_3 - \text{CH} = \text{CH}_2$ (ii) $\text{CH}_3 - \text{C} \equiv \text{CH}$
 (iii) $\text{H} - \text{COOH}$ (iv) $\text{CH}_3 - \text{COOH}$
 (v) $\text{H} - \text{CHO}$

Ans :

MAIN 2011

	Compound	Common name	IUPAC Name	Functional group
(i)	$\text{CH}_3 - \text{CH} = \text{CH}_2$	Propylene	Propene	$\diagup \text{C} = \text{C} \diagdown$, Double bond
(ii)	$\text{CH}_3 - \text{C} \equiv \text{CH}$	Methylacetylene	Propyne	$-\text{C} \equiv \text{C}-$, Triple bond
(iii)	$\text{H} - \text{COOH}$	Formic acid	Methanoic acid	$-\text{COOH}$, Carboxyl group
(iv)	$\text{CH}_3 - \text{COOH}$	Acetic acid	Ethanoic acid	$-\text{COOH}$, Carboxyl group
(v)	$\text{H} - \text{CHO}$	Formaldehyde	Methanal	$-\text{CHO}$, Aldehydic group

370. State the common and IUPAC names of the following Compounds. Also indicate the functional group, if any in each case :

- (a) $\text{CH}_3 - \text{CHO}$ (b) $\text{CH}_3 - \text{OH}$
 (c) $\text{C}_2\text{H}_5 - \text{OH}$ (d) C_2H_6

Ans :

MAIN 2011

	Compound	Common name	IUPAC Name	Functional group
(a)	$\text{CH}_3 - \text{CHO}$	Acetaldehyde	Ethanal	— CHO, Aldehydic group
(b)	$\text{CH}_3 - \text{OH}$	Methyl alcohol	Methanol	— OH, Hydroxyl group
(c)	$\text{C}_2\text{H}_5 - \text{OH}$	Ethyl alcohol	Ethanol	— OH,
(d)	C_2H_6	Ethane	Ethane	-----

371. State one important use of each :

- (i) Ethanol
 (ii) Acetylene
 (iii) Chloroform
 (iv) Carbon tetrachloride.

Ans :

SQP 2019

Uses of :

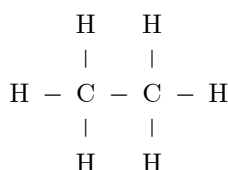
- (i) Ethanol : It is used as a solvent for gums and resins.
 (ii) Acetylene : It is used in the production of oxyacetylene flame which is used for welding and cutting of metals.
 (iii) Chloroform : It is used as a solvent for rubber and waxes.
 (iv) Carbon tetrachloride : It is used as a solvent and a fire extinguisher.

372. Draw the relevant structural formula of :

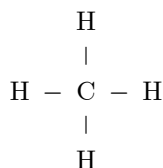
- (i) Ethane
 (ii) Marsh gas
 (iii) Ethene
 (iv) Acetylene
 (v) 2-Butyne

Ans :

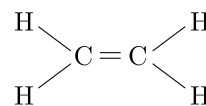
COMP 2017



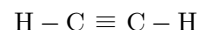
(ii) Marsh gas (Methane)



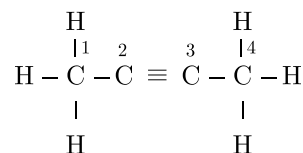
(iii) Ethene



(iv) Acetylene

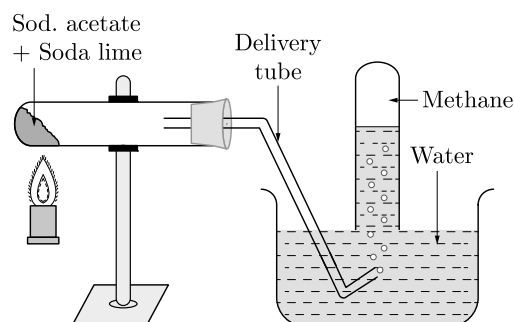


(v) 2-Butyne



373. The diagram given below shows the preparation of methane. Answer the questions based on the above fact.

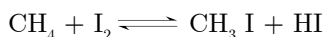
- (i) What is the Composition of soda lime ?
 (ii) Give the reaction among the given reactants.
 (iii) Can you prepare methane from aluminium carbide ? If so, give equation.
 (iv) What do you know about the solubility of methane in water ?
 (v) Why direct iodination of methane is not carried ? Then how is it carried ?



Ans :

SQP 2013

- (i) NaOH and CaO
 (ii) $\text{CH}_3\text{COONa} + \text{NaOH} \xrightarrow{\text{CaO}} \text{CH}_4\uparrow + \text{Na}_2\text{CO}_3$
 (iii) $\text{Al}_4\text{C}_3 + 12\text{H}_2\text{O} \longrightarrow 4\text{Al}(\text{OH})_3 + 3\text{CH}_4\uparrow$
 (iv) Methane is insoluble in water.
 (v) Direct iodination is not carried out because it is reversible. Hence, it is carried out in the presence of oxidising agents like conc. nitric acid and iodic acid which oxidises hydroiodic acid to iodine.



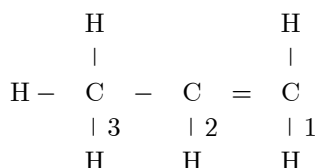
374. Draw the relevant structural formula of :

- (i) propylene
 (ii) 1-Butyne
 (iii) 1-Butene
 (iv) Propane
 (v) n-Butane

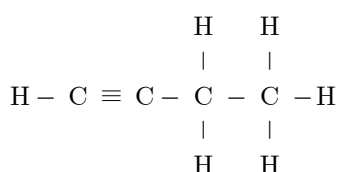
Ans :

COMP 2018

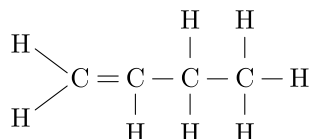
- (i) Propylene



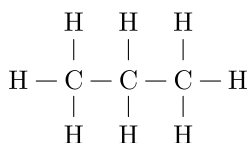
- (ii) 1-Butyne



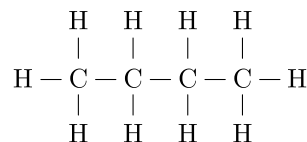
- (iii) 1-Butene



- (iv) Propane



- (v) n-Butane



375. Differentiate between organic and inorganic Compounds.

Ans :

MAIN 2015

The differentiate between organic and inorganic Compounds are as follows :

	Organic Compounds	Inorganic Compounds
1.	These are made-up of only a few elements C, H, O, N, S, P, X (Cl, Br, I).	These are made-up of all the known elements.
2.	These involve covalent bonds.	These involve ionic bonds.
3.	These are generally gases or liquids.	These are generally solids.
4.	They have low melting and boiling points.	They have high melting and boiling points.
5.	They are combustible.	They are non-combustible.
6.	They show molecular reactions.	They show ionic reactions.
7.	These are non-conductors of electricity.	These are generally good conductors of electricity.
8.	They show isomerism.	They do not show isomerism.
9.	These are generally insoluble in water but soluble in organic solvents.	These are generally soluble in water but insoluble in organic solvents

NODIA

CASE BASED QUESTION

376. A student is synthesizing ethyne (acetylene) in the laboratory by reacting calcium carbide with water. They must carefully observe the reaction, identify the products formed and analyze their properties. After collecting the gas, the student is required

student should also explore the applications of esters in the fragrance and flavor industries.

- What alcohol is required to esterify ethanoic acid to form ethyl ethanoate and why?
- Which acid is used as a catalyst in the esterification reaction and what is its role?
- What is the type of reaction called where an acid and an alcohol form an ester and what is its significance?
- What is one common use of ethyl ethanoate in industry?

Ans :

- Ethanol, because it reacts with ethanoic acid to form the ester.
- Concentrated sulfuric acid (H_2SO_4) ; it acts as a dehydrating agent and catalyst.
- Esterification ; it forms esters with pleasant smells used in perfumes.
- As a solvent in paints and coatings.

381. A chemist is tasked with synthesizing 1-bromopropane by reacting propane with bromine under specific conditions. The chemist must understand the reaction mechanism, optimize the conditions to favor the formation of 1-bromopropane over other possible isomers and discuss the industrial relevance of halogenated hydrocarbons.

- What type of reaction is used to add bromine to propane and what is the general mechanism?
- Under what conditions does propane react with bromine to form 1-bromopropane?
- What is the primary product formed when propane reacts with bromine and why is it preferred?
- What is a significant industrial application of halogenated hydrocarbons like 1-bromopropane?

Ans :

- Free radical substitution, where bromine radicals replace hydrogen atoms in propane.
- In the presence of UV light which initiates the radical formation.
- 1-Bromopropane: it is more stable due to the formation of a primary radical.
- They are used as solvents and intermediates in organic synthesis.

382. A student is investigating the complete and incomplete combustion of methane in a controlled environment. They must measure the products

formed under different oxygen conditions, understand the environmental implications of incomplete combustion and explore the role of methane as a fuel in various applications.

- What are the main products of the complete combustion of methane and why are they significant?
- What type of reaction is combustion and what energy change is associated with it?
- What is the balanced chemical equation for the complete combustion of methane?
- What are the environmental concerns associated with the incomplete combustion of methane?

Ans :

- Carbon dioxide and water; they indicate complete oxidation of methane.
- Exothermic oxidation reaction; it releases energy as heat.
- $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- It produces carbon monoxide, a toxic pollutant.

383. A chemist is studying the polymerization of ethene to produce polyethylene. They must understand the conditions required for the reaction, the properties of the resulting polymer and the significance of polyethylene in the manufacturing industry. The chemist should also consider the environmental impact of widespread polyethylene use and disposal.

- What is the monomer unit used to produce polyethylene and what is its structure?
- What type of reaction is involved in the formation of polyethylene and what are its conditions?
- What are the key properties of polyethylene that make it valuable in industry?
- What is a major environmental concern related to the use of polyethylene?

Ans :

- Ethene (C_2H_4) ; it consists of a double bond between two carbon atoms.
- Addition polymerization: requires high temperature, pressure and a catalyst.
- It is lightweight, durable and resistant to chemicals.
- It contributes to plastic pollution due to its non-biodegradability.

384. A researcher is investigating the nitration of benzene to form nitrobenzene. The researcher must select the appropriate reagents, understand the reaction mechanism and ensure that the reaction is carried out safely. The researcher also needs to explore the industrial applications of nitrobenzene and its derivatives.

- (i) What are the reagents required for the nitration of benzene and what do they produce?
- (ii) What type of reaction is nitration and what is its mechanism?
- (iii) What is the main product of benzene nitration and what are its uses?
- (iv) Why is sulfuric acid used in the nitration of benzene and what is its role?

Ans :

- (i) Concentrated nitric acid and sulfuric acid; they produce the nitronium ion (NO_2^+).
- (ii) Electrophilic substitution; the nitronium ion attacks the benzene ring.
- (iii) Nitrobenzene; used in the manufacture of dyes and explosives.
- (iv) It acts as a catalyst to generate the nitronium ion and absorb water formed during the reaction.

385. A chemical engineer is exploring the industrial synthesis of chloroform (trithloromethane) from methane. The engineer must understand the stepwise chlorination of methane, optimize the reaction conditions to maximize chloroform production and consider the environmental and health implications of using and handling chloroform.

- (i) Which halogen is used in the chlorination of methane to produce chloroform and why is it chosen?
- (ii) What are the intermediate products formed before chloroform in the stepwise chlorination of methane?
- (iii) What type of reaction mechanism is involved in the production of chloroform and how does it proceed?
- (iv) What is one significant use of chloroform in industry and what are the associated risks?

Ans :

- (i) Chlorine, it reacts readily with methane to form chlorinated products.
- (ii) Methyl chloride (CH_3Cl) and dichloromethane (CH_2Cl_2).
- (iii) Free radical substitution; chlorine radicals

replace hydrogen atoms in methane.

- (iv) It is used as a solvent in laboratories; however, it is a potential carcinogen and must be handled with care.

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