

CHAPTER 3

METALS AND NON-METALS

Syllabus

Properties of metals and non-metals; Reactivity series; Formation and properties of ionic compounds; Basic metallurgical processes; Corrosion and its prevention.

Trend Analysis

List of Concept names	2018	2019		2020	
	OD/D	OD	D	OD	D
Properties of metals and Non-metals; Reactivity series, amphoteric oxides	2	1 Q (2 M) 1 Q (3 M)	1 Q (5 M)	1 Q (5 M)	1 Q (5 M)
Formation and properties of ionic compounds; Basic metallurgical processes; Corrosion and its prevention	1 Q (5 M)	Or 1 Q (2 M)			

TOPIC - 1 Properties of Metals and Non-Metals

Revision Notes

Introduction

Metals are mostly solids, possessing high density. They have high melting and boiling points. They are lustrous and sonorous. They are good conductors of heat and electricity.

Most of the metals are hard. However, some of the metals like sodium, potassium are soft metals and can be easily cut with knife.

All metals are solids except Mercury, Caesium, Francium, Germanium and Gallium which are solids with low melting point. Gallium becomes liquid if kept on palm but Gallium has very high boiling point which makes it useful for high temperature thermometers.

conductors?
metal \rightarrow e^- (as)
Free e^- = \downarrow

ionic
A - Mean G3
R - Mean G3
Asesent:

TOPIC - 1

Properties of Metals and Non-Metals
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TOPIC - 2

Ionic compounds, Metallurgy and Corrosion
Page No. 48

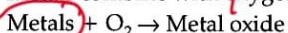
Physical Properties:

Property	Metals	Non-Metals
1. Lustre	Metals have shining surface.	They do not have shining surface. • Except Iodine.
2. Hardness	They are generally hard. • Except Sodium, Lithium and Potassium which are soft and can be easily cut with knife.	Generally soft. • Except Diamond, a form of carbon which is the hardest natural substance.
3. State	Exist as solids. • Except Mercury that exists in liquid.	Exist as solids or gases • Except Bromine that exists in liquid.
4. Malleability	Metals can be beaten into thin sheets. • Gold, Silver and Aluminium are the most malleable metals.	Non-metals are non-malleable. • They are brittle.
5. Ductility	Metals can be drawn into thin wires.	They are non-ductile.
6. Conductor of heat & electricity	Metals are good conductors of heat and electricity. <i>Free e⁻</i>	Non-metals are poor conductors of heat and electricity. • Except Graphite.
7. Density and Melting point	Generally metals have high density and high melting point. • Except Sodium and Potassium	Non-metals have low density and low melting point.
8. Sonorous	Metals produce a sound on striking a hard surface.	They are not sonorous.
9. Oxides	Metallic oxides are basic in nature.	Non-metallic oxides are acidic in nature.

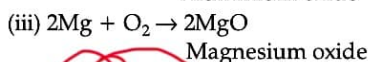
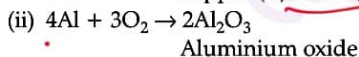
Chemical Properties:

(A) Reaction with Air:

Metals combine with oxygen to form metal oxide.



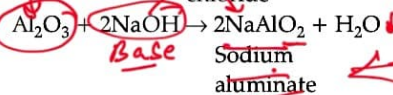
Examples:



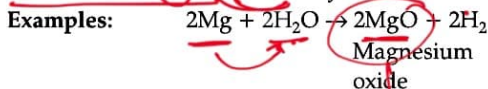
Different metals show different reactivity towards O₂.

- Na and K react so vigorously with oxygen that they catch fire if kept in open. So they are kept immersed in kerosene.
- Surfaces of Mg, Al, Zn and Pb are covered with a thin layer of oxide which prevent them from further oxidation.
- Fe does not burn on heating but iron filings burn vigorously.
- Cu does not burn but is coated with black copper (II) oxide.
- Au and Ag do not react with oxygen.

Amphoteric Oxides: Metal oxides which react with both acids as well as bases to produce salt and water are called amphoteric oxides.



(B) Reaction of Metals with Water:



Na Numb
(11) (2, 8)
(7) e acceptors
Tom
More
MP
BP
right

[Hg Ca]
low - Tml

Acceptors
e⁻ va

Substance
Group

Mg ribbon

minim

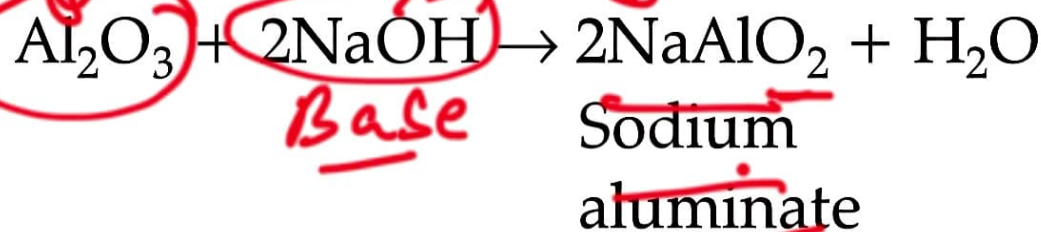
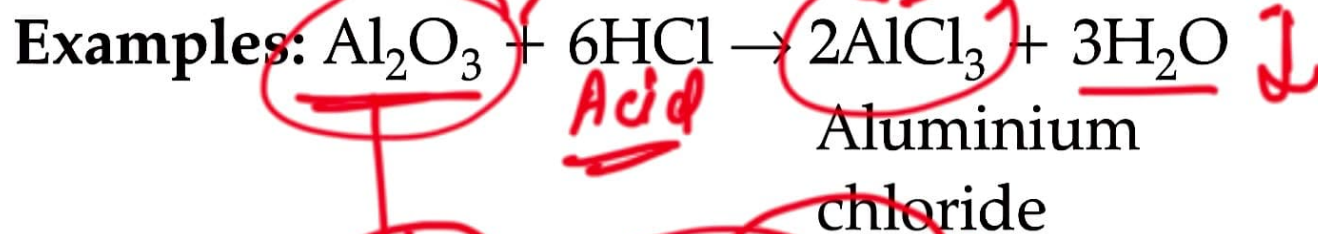




KEROSENE.

- Surfaces of Mg, Al, Zn and Pb are covered with a thin layer of oxide which is protective.
- Fe does not burn on heating but iron fillings burn vigorously.
- Cu does not burn but is coated with black copper (II) oxide.
- Au and Ag do not react with oxygen.

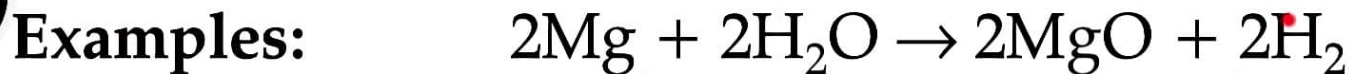
Amphoteric Oxides: Metal oxides which react with both acids as well as bases are called amphoteric oxides.



(B) Reaction of Metals with Water:

Metal + Water → Metal oxide + Hydrogen

Metal oxide + Water → Metal hydroxide





reaction of two acids.

- **Alloys** are homogeneous mixtures of two or more metals. One of them can be non-metal also, *e.g.*, Brass is an alloy of copper and zinc. When a metal is alloyed with mercury, it is called an **amalgam**.
- Metals in reactivity series, if placed above hydrogen, can displace hydrogen from dilute acids (HCl and H₂SO₄).



Mnemonics

Concept: Activity series of metals

Mnemonics:

Popular Scientists Can Make A Zoo In The Low Humid Country More Satisfactorily

Interpretation:

P - Potassium

C - Calcium

A - Aluminium

I - Iron

L - Lead

C - Copper

S - Silver

S - Sodium

M - Magnesium

Z - Zinc

T - Tin

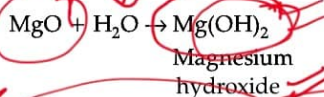
H - Hydrogen

M - Mercury

@Join SAP

Objective Type Questions

1 mark each



(C) Reaction of Metals with Solutions of other Metal Salts:



Reactive metals can displace less reactive metals from their compounds in solution form.



All the metals do not react with the same rate. Some react very fast, some react moderately whereas others react very slowly. The series of metals in decreasing order of reactivity is called **reactivity or activity series of metals**. The metals at the top (K at the top most) are most reactive whereas metals at the bottom (Pt at the extreme bottom) least reactive.



Metals react with dilute acids to form salt and hydrogen gas. The metal replaces hydrogen of the acid to form salt. **Aqua Regia** is a mixture of conc. HCl and conc. HNO₃ in the ratio of 3:1. It can dissolve gold and platinum. Aqua Regia is a strong oxidizing agent due to the formation of NOCl (Nitrosyl chloride) and chlorine produced by reaction of two acids.

Alloys are homogeneous mixtures of two or more metals. One of them can be non-metal also, e.g., Brass is an alloy of copper and zinc. When a metal is alloyed with mercury, it is called an **amalgam**.

Metals in reactivity series, if placed above hydrogen, can displace hydrogen from dilute acids (HCl and H₂SO₄).

Nitric Acid HNO₃
 Hydrochloric Acid.
 3 ml HCl
 1 ml HNO₃

Mnemonics

Concept: Activity series of metals

Mnemonics:

Popular Scientists Can Make A Zoo In The Low Humid Country More Satisfactorily

Interpretation:

- P - Potassium
- C - Calcium
- A - Aluminium
- I - Iron
- L - Lead
- C - Copper
- S - Silver

- S - Sodium
- M - Magnesium
- Z - Zinc
- T - Tin
- H - Hydrogen
- M - Mercury

Zinc Alloy is an alloy of Zn + Ag
 Zn + Sn
 Zn + Pb

Objective Type Questions

1 mark each

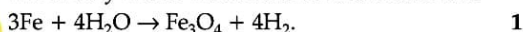
A Multiple Choice Questions

Q. 1. Which one of the following metals does not react with cold as well as hot water?

- (a) Na
- (b) Ca
- (c) Mg
- (d) Fe [NCERT Exemp.]

Ans. Correct option : (d)

Explanation: Metals like aluminium, zinc, iron do not react with hot/cold water. They react with water only when water is in the form of steam.



Q. 2. What happens when calcium is treated with water?

- (i) It does not react with water.
- (ii) It reacts violently with water.
- (iii) It reacts less violently with water.

Ca

(iv) Bubbles of hydrogen gas formed stick to the surface of calcium.

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

[NCERT Exemp.]

Ans. Correct option : (d)

Explanation: Calcium reacts slowly with water. The reaction forms calcium hydroxide, Ca(OH)₂ and hydrogen gas (H₂). The calcium metal sinks in water and after an hour or so bubbles of hydrogen are observed, stuck to the surface of the metal. 1

Q. 3. Generally, non-metals are not lustrous. Which of the following non-metal is lustrous?

- (a) Sulphur
- (b) Oxygen
- (c) Nitrogen
- (d) Iodine

[NCERT Exemp.]

Ans. Correct option : (d)

Explanation: Iodine is a non-metal but it is lustrous. 1

Q. 4. An element A is soft and can be cut with a knife. This is very reactive to air and cannot be kept open in air. It reacts vigorously with water. Identify the element from the following:

- (a) Mg (b) Na
(c) P (d) Ca [NCERT Exemp.]

Ans. Correct option : (b)

Explanation: Sodium is so soft that can be cut using a knife. It reacts with oxygen or moisture present in air readily and reacts with water vigorously. Because of this sodium is stored in kerosene oil to prevent any reaction or accident. 1

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

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

Q. 1. Assertion (A): When a piece of copper metal is added to dilute sulphuric acid, the solution turns blue.

Reason (R): Copper reacts with dilute sulphuric acid to form blue copper (II) sulphate solution.

Ans. Correct option : (a)

Explanation: When a piece of copper metal is added to dilute sulphuric acid, the solution turns blue. It is because, copper reacts with dilute sulphuric acid to form blue copper (II) sulphate solution. 1

Q. 2. Assertion (A): Metals are sonorous.

Reason (R): They are generally brittle in the solid state; they break into pieces when hammered.

Ans. Correct option : (c)

Explanation: Metals are sonorous, malleable and ductile while non-metals are brittle. 1

Q. 3. Assertion (A): Gas bubbles are observed when sodium carbonate is added to dilute hydrochloric acid.

Reason (R): Carbon dioxide is given off in the reaction.

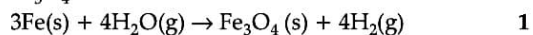
Ans. Correct option : (a)

Explanation: Gas bubbles are observed when sodium carbonate is added to dilute hydrochloric acid as CO_2 gas is released. 1

C Very Short Answer Type Questions

Q. 1. The compound obtained on reaction of iron with steam is/are: [R] [CBSE Delhi 2020]

Ans. Fe_3O_4



Q. 2. An element 'X' reacts with O_2 to give a compound with a high melting point. This compound is also soluble in water. The element 'X' is likely to be:

[U] [Delhi 2020]

Ans. Calcium reacts with oxygen and form CaO which has high melting point and is water soluble. 1

Q. 3. Name a non-metal which is lustrous and a metal which is non-lustrous. [AE] [DDE 2017]

Ans. Non-metal (lustrous) = Iodine (I)

Metal (non-lustrous) = Sodium (Na) $\frac{1}{2} + \frac{1}{2}$

Q. 4. Why is gold a preferred metal for making jewellery? (Any two reasons) [R]

Ans. Due to the property of malleability, ductility and it is lustrous (Any two) $\frac{1}{2} + \frac{1}{2}$

Q. 5. Which of the two, metal or non metal will form an oxide which is basic in nature? [U]

Ans. Metal, because metal oxides are basic in nature. 1

[AI] Q. 6. How are oxides of metal different from oxides of non metals in terms of their nature? [U]

Ans. Metallic oxides are basic, few are amphoteric.

Non-metallic oxides are acidic, few are neutral.

$\frac{1}{2} + \frac{1}{2}$

Short Answer Type Questions-I

2 marks each

Q. 1. The following observations were made by a student on treating four metals P, Q, R and S with the given salt solutions: [C] [CBSE 2020]

Sample	MgSO_4 (aq)	$\text{Zn}(\text{NO}_3)_2$ (aq)	CaSO_4 (aq)	Na_2SO_4 (aq)
P	No reaction	Reaction occurs	Reaction occurs	No reaction
Q	Reaction occurs	Reaction occurs	Reaction occurs	Reaction occurs

R	No reaction	Reaction occurs	No reaction	No reaction
S	No reaction	No reaction	No reaction	No reaction

Based on the above observations:

- (a) Arrange the given samples in the increasing order of reactivity
(b) Write the chemical formulae of products formed when Q reacts with CuSO_4 solution.

Ans. (a) $\text{S} > \text{R} > \text{P} > \text{Q}$

(b) Cu and QSO_4

2

Q. 2. Give reasons:

- (a) Platinum, gold and silver are used to make jewellery.
 (b) Metals like sodium and potassium are stored under oil. [AE] [CBSE Outside delhi 2019]

Ans. (a) Lustre, ductile, malleable, least reactive
 (Any two) $\frac{1}{2} + \frac{1}{2}$
 (b) Na & K are highly reactive (in air & moisture).
 [CBSE Marking Scheme, 2019] 2

Q. 3. Silver articles become black when kept in open for some time, whereas copper vessels lose their shiny brown surfaces and gain a green coat when kept in open. Name the substances present in air with which these metals react and write the name of the products formed. [A] [Outside Delhi 2019]

Ans.

Silver	Sulphur in air	Silver sulphide $\frac{1}{2} + \frac{1}{2}$
Copper	Moisture and carbon dioxide	Copper carbonate $\frac{1}{2} \times 4\frac{1}{2} = 2$

[CBSE Marking Scheme, 2019] 2

Q. 4. Give reasons:

- (a) Carbonate and sulphide ores are usually converted into oxides during the process of extraction.
 (b) Aluminium is a highly reactive metal; still it is widely used in making cooking utensils. [U] [Outside Delhi 2019]

Ans. (a) It is easier to obtain a metal from its oxide as compared to sulphide and carbonate ore.
 (b) Aluminium forms a thicker protective oxide layer.
 [CBSE Marking Scheme, 2019] 2

Q. 5. Give reasons for the following:

- (i) Most metals conduct electricity well.
 (ii) The reaction of iron (III) oxide [Fe_2O_3] with heated aluminium is used to join cracked machine parts. [AE] [CBSE Delhi 2019]

Ans. (i) Metals have loosely bound electrons / Loose electrons easily / free electrons.
 (ii) Molten iron produced during reaction joins the cracked machine parts.
 [CBSE Marking Scheme, 2019] 2



Short Answer Type Questions-II

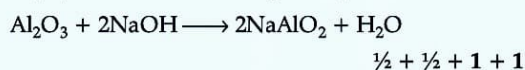
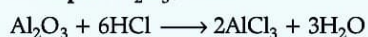
3 marks each

[AI] Q. 1. What are amphoteric oxides? Give an example. Write balanced chemical equations to justify your answer.

[R] [CBSE Board Outside Delhi, Set-I, 2019]

Ans. Amphoteric oxides: Metal oxides showing both acidic and basic nature.

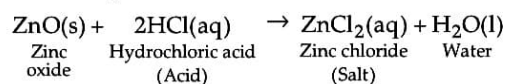
Example: $\text{Al}_2\text{O}_3 / \text{ZnO}$ (or any other)



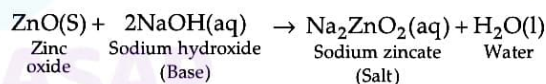
[CBSE Marking Scheme, 2019]

Detailed Answer:

Oxides of metals which have both acidic as well as basic behaviour are known as amphoteric oxides. Examples are aluminium oxide and zinc oxide. Amphoteric oxides react with acids as well as base to form salt and water. ZnO reacts with hydrochloric acid (acid) to form zinc chloride (salt) and water thus acting as basic oxide.



ZnO reacts with sodium hydroxide (base) to form sodium zincate (salt) and water thus, acting as acidic oxide.



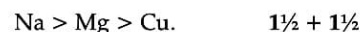
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Q. 2. You are given samples of three metals: Sodium, magnesium and copper. Suggest any two activities to arrange them in order to their decreasing reactivity. [U] [Board Term-I, 2016]

Ans. Different metals react with oxygen at different rates. e.g., Sodium (Na) and potassium (K) catch fire, if left in open. Hence, these are the most reactive metals. To prevent accidental fires, these metals are kept immersed in kerosene oil. Magnesium burns in air only by heating. So, it is less reactive than sodium and potassium. Copper (Cu) does not burn on heating but blister copper burns. Hence the order of reactivity of these metals with oxygen is:



Metals react with water to produce a metal oxide and hydrogen gas. Sodium (Na) and potassium (K) react violently with cold water. So the reaction is violent and exothermic. Magnesium (Mg) does not react with cold water. It reacts with hot water. Metals like lead, copper, silver do not react with water at all. The reactivity series of metals towards water is:



COMMONLY MADE ERROR

- Students usually get confused with the order of reactivity of metals.

ANSWERING TIP

- Understand the concept of reactivity of metals and how to arrange them in increasing or decreasing order.

AI Q. 3. State reason for the following:

✓ Long Answer Type Questions**5 marks each**

Q. 1. A metal 'M' is stored under kerosene. It vigorously catches fire, if a small piece of this metal is kept open in air. Dissolution of this metal in water releases great amount of energy and the metal catches fire. The solution so formed turns red litmus blue. **[CBSE Outside Delhi 2020]**

- Name the metal 'M'.
- Write formula of the compound formed when this metal is exposed to air.
- Why is metal 'M' stored under kerosene?
- If oxide of this metal is treated with hydrochloric acid, what would be the products?
- Write balanced equations for:
 - Reaction of 'M' with air.
 - Reaction of 'M' with water.
 - Reaction of metal oxide with hydrochloric acid.

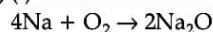
Ans. (a) Metal M is sodium (Na).

(b) Formula of the compound formed is Na_2O .

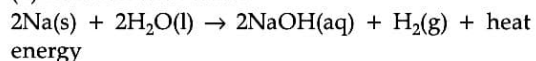
(c) Metals like sodium and potassium react with oxygen so fast that they can catch fire if kept open. Since, they are most reactive metals; they are always kept immersed in kerosene oil to prevent accidental fire.

(d) Sodium oxide reacts with hydrochloric acid to produce sodium chloride and water.

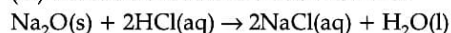
(e) (i) Reaction with air:



(ii) Reaction with water:



(iii) Reaction of sodium oxide with HCl:



1 × 5 = 5

Q. 2. (a) List in tabular form any three chemical properties on the basis of which metals and non-metals are differentiated.

- Non-metals cannot displace hydrogen from the acids.
- Hydrogen is not a metal, yet it is placed in the activity series of metals.
- Aluminium is more reactive than iron, yet its corrosion is less than that of iron.

[Board Term-I, 2015]

Ans. (i) Non-metals are electron acceptors, they cannot supply electrons so as to convert H^+ ion to $\text{H}_2(g)$.

(ii) Like metals, hydrogen can lose an electron to form positive H^+ ion.

(iii) Aluminium reacts with oxygen in atmosphere and forms a strong protective layer of oxide which protects the metal from further corrosion. 1+1 + 1

(b) State two ways to prevent the rusting of iron.

[R+U [Compartment Set 1, 2,3, 2018]

Ans. (a)

S. No.	Metals	Non-Metals
1.	Lose electrons to form positive ions/ are electropositive in nature.	Gain electrons to form negative ions/ are electronegative in nature.
2.	React with dilute acids to liberate hydrogen gas.	Do not react with dilute acids.
3.	Generally metal oxides are basic in nature.	Generally non-metal oxides are acidic in nature.

(b) (i) Painting

(ii) Oiling

(iii) Galvanization

(vi) Alloying

(or any other)

[CBSE Marking Scheme, 2018] 5

COMMONLY MADE ERROR

- Students get confused and interchange the properties of metals and non metals.

ANSWERING TIP

- Don't get confused between acceptor and gainer of electron concept.
- Learn and understand the properties of both metals and non metals with examples.