CH 2- ACID BASES & SALTS

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Ionisable and non-ionisable compounds

An ionisable compound when dissolved in water or in its molten state, dissociates into ions almost entirely.

Example: NaCl, HCl, KOH, etc.

A non-ionisable compound does not dissociate into ions when dissolved in water or in its molten state.

Example: glucose, acetone, etc.

Physical test

Given are two possible physical tests to identify an acid or a base.

a. Taste

An acid tastes sour whereas a base tastes bitter.

The method of taste is not advised as an acid or a base could be contaminated or corrosive.

b. Effect on indicators by acids and bases

An indicator is a chemical substance which shows a change in its physical properties, mainly colour or odour when brought in contact with an acid or a base.

Below mentioned are commonly used indicators and the different colours they exhibit:

a) Litmus

In a neutral solution – **purple**

An **acid** turns a moist blue litmus paper to **red.**

A **base** turns a moist red litmus paper to **blue.**

Litmus is also available as strips of paper in two variants – red litmus and blue litmus.

b) Methyl orange

In a neutral solution – **orange**

In acidic solution – **red**

In basic solution – **yellow**

c) Phenolphthalein

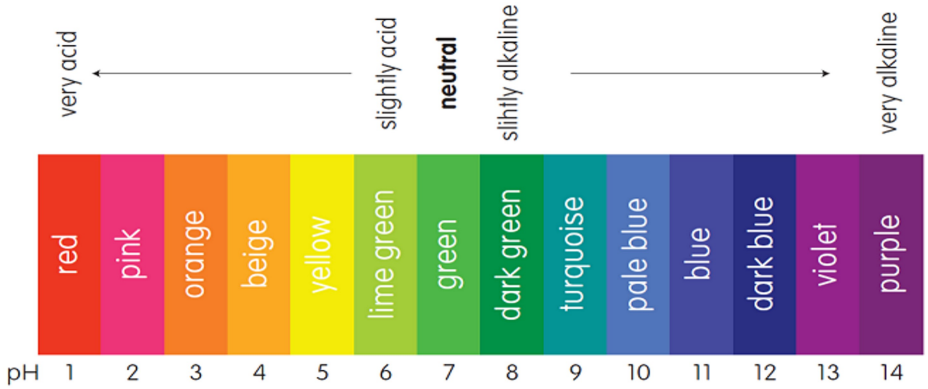
In a neutral solution – colourless

In acidic solution – remains colourless

In basic solution – **pink**

d)Universal Indicator :

A universal indicator is a pH indicator made of a solution of several compounds that exhibits several smooth colour from **red** **to** **purple** which changes over a wide range pH values to indicate the acidity or alkalinity of solutions.



Reactions of acids and bases

a) Reaction of acids and bases with metals

Acid + active metal → salt + **hydrogen** + heat

Example : $2HCl+Mg \rightarrow MgCl_2+\mathbf{H_2}$

Base + metal → salt + **hydrogen** + heat

Example : $2NaOH + Zn \rightarrow Na_2ZnO_2+\mathbf{H_2}$

A more reactive metal displaces the less reactive metal from its base.

Example : $2Na + Mg(OH)_2 \rightarrow 2NaOH + Mg$

b) Reaction of acids with metal carbonates and bicarbonates

Acid + **metal carbonate or bicarbonate** → salt + water + **carbon dioxide.**

Example : $2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + \mathbf{CO_2}$

$H_2SO_4 + Mg(HCO_3)_2 \rightarrow MgSO_4 + 2H_2O + 2\mathbf{CO_2}$

Effervescence indicates liberation of CO_2 gas.

c) Neutralisation reaction

ACID + BASE ⟶ SALT + WATER + HEAT

Reaction of metal oxides and hydroxides with acids

Metal oxides or metal hydroxides are basic in nature.

Acid + **Metal Oxide** → salt + water + heat

Example : $H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$

$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$

Reaction of non-metal oxides with bases

Non-metal oxides are acidic in nature

Base + **Non-metal oxide** → salt + water + heat

Example : $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

Acids and bases in water

When added to water, acids and bases dissociate into their respective ions and help in conducting electricity.

Difference between a base and an alkali

Base-

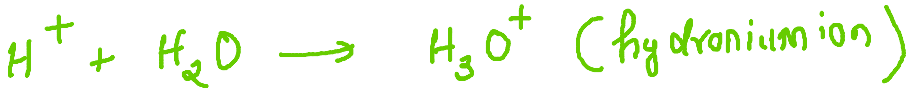
- **Bases undergo neutralisation reaction with acids.**
- They are comprised of metal oxides, metal hydroxides, metal carbonates and metal bicarbonates.
- Most of them are **insoluble in water.**

Alkali –

- **An alkali is an aqueous solution of a base, (mainly metallic hydroxides).**
- It dissolves in water and dissociates to give **OH- ion.**
- **All alkalis are bases, but not all bases are alkalis.**

Hydronium ion

Hydronium ion is formed when a hydrogen ion combine with oxygen atom of a water molecule. Hydronium ions concentration results in acidity.



Hydroxyl ion

When an alkaki is dissolved in water it splits to its ionic form containing OH^- ions. Its concentration results in the alkaline nature of the solution.

Dilution

Dilution is the process of reducing the concentration of a solution by adding more solvent (usually water) to it.

It is a highly exothermic process.

To dilute acid, the acid must be added to water and not the other way round

pH

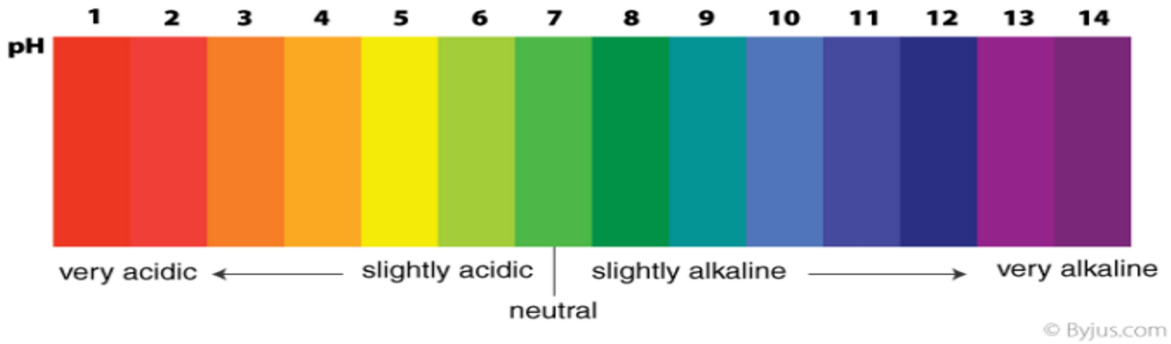
pH= –log10[H+]

In pure water, $[H^+]=[OH^-]=10^{-7}$ mol/L. Hence ,***–log10[***10^{-7}***]*** = 7.

The pH scale ranges from 0 to 14.

If pH < 7 – acidic solution

If pH > 7- basic solution



Importance of pH in everyday life

1. pH sensitivity of plants and animals

Plants and animals are sensitive to pH. Crucial life processes such as digestion of food, functions of enzymes and hormones happen at a certain pH value.

Usually the human body maintains the pH of blood close to 7.40.

2. pH of a soil

The pH of a soil optimal for the growth of plants or crops is 6.5 to 7.0.

3. pH in the digestive system

The process of digestion happens at a specific pH in our stomach which is 1.5 – 4.

The pH of the interaction of enzymes, while food is being digested, is influenced by HCl in our stomach.

4. pH in tooth decay

Tooth decay happens when the teeth are exposed to an acidic environment of pH 5.5 and below.

5. pH of self-defence by animals and plants

Acidic substances are used by animals and plants as a self-defence mechanism. For example, bee and plants like nettle secrete a highly acidic substance for self-defence.

pH of salts

A salt of a strong acid and a strong base will be neutral in nature. pH = 7 (approx.).

A salt of a weak acid and a strong base will be basic in nature. pH > 7.

A salt of a strong acid and a weak base will be acidic in nature. pH < 7.

The pH of a salt of a weak acid and a weak base is determined by conducting a pH test.

Common salt

Chemical name – Sodium Chloride

Chemical formula – NaCl

The common salt thus obtained is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder and many more.

Sodium hydroxide (CHLOR- ALKALI PROCESS)

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide solution, chlorine gas and hydrogen gas .

$$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

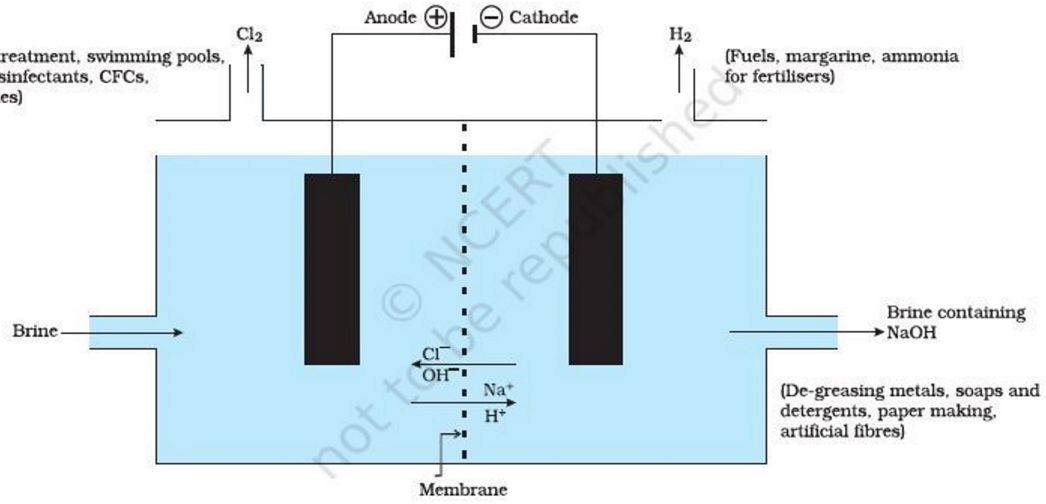


Figure 2.8 *Important products from the chlor-alkali process*

Chlorine gas is given off at the anode, and hydrogen gas at the cathode. Sodium hydroxide solution is formed near the cathode. The three products produced in this process are all useful.
Figure above shows the different uses of these products.

Bleaching powder

Chemical name – calcium oxychloride

Chemical formula – CaOCl2

- Chlorine is produced during the electrolysis of aqueous sodium chloride (brine).
- Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$].

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

Uses:

- for bleaching agent in textile industry, paper factories and in laundry;
- as an oxidising agent in many chemical industries
- to make drinking water free from germs.

Baking soda

Chemical name – Sodium hydrogen carbonate

Chemical formula – $NaHCO_3$

Preparation (Solvay process) –

- Limestone is heated: $CaCO_3 \rightarrow CaO + CO_2$
- CO_2 is passed through a concentrated solution of sodium chloride and ammonia:

$$NaCl(aq) + NH_3(g) + CO_2(g) + H_2O(l) \rightarrow NaHCO_3(aq) + NH_4Cl(aq)$$

Uses:

- For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid.
  When baking powder is heated or mixed in water, the following reaction takes place –
  $NaHCO_3 + H^+ \rightarrow CO_2 + H_2O$ + Sodium salt of acid
  (From any acid)
- An ingredient in antacids.
- used in soda-acid fire extinguishers.

Washing soda

Chemical name – Sodium carbonate decahydrate

Chemical formula – $Na_2CO_3.10H_2O$

- Sodium carbonate can be obtained by heating baking soda;
- Recrystallisation of sodium carbonate gives washing soda. It is also a basic salt.

$$Na_2CO_3 + 10\ H_2O \rightarrow Na_2\ CO_3.10\ H_2\ O$$

Uses

- Used in glass, soap and paper industries
- Removing permanent hardness of water.
- Domestic cleaning agent.

Crystals of salts

Certain salts form crystals by combining with a definite proportion of water. The water molecules that combines with the salt is called water of crystallisation.

$CuSO_4.5H_2O \rightarrow CuSO_4$

(Deep Blue crystals) **(white powder)**

Plaster of paris & gypsum

Gypsum, on heating at 100°C (373K) gives plaster of paris. $CaSO_4.\ ½\ H_2O$ plaster of paris. and $\frac{3}{2}\ H_2O$

$CaSO_4.2H_2O$ (s) $\xrightarrow{373\ K}$ $CaSO_4.\ ½\ H_2O + \frac{3}{2}\ H_2O$

Gypsum Plaster of Paris.

$CaSO_4.\ ½\ H_2O$ means two formula units of $CaSO_4$ share one molecule of water.

Uses –

- Gypsum cast is used as support for healing fractures.
- Plaster of Paris is used for making toys, materials for decoration and in construction field.