Chapter 2: Acid, Base and Salt

Acid - A substance that produces hydrogen ions (H^+) in aqueous solutions.

For Example - Sulphuric Acid (H_2SO_4), Hydrochloric Acid (HCl).

General properties of acids:

- They have a sour taste.
- They turn blue litmus to red.
- They conduct electricity in solution form.
- They release H^+ ions in aqueous solution.

Reactions of Acids

(i) Reaction of Acid with Metal

Na (metal) + H_2SO_4 (acid) → H_2 (hydrogen gas) + $Na SO_4$ (salt)
(ii) Reaction of Acid with Carbonates

$Na_2 CO_3$ (s) + 2 HCl (aq) → 2NaCl (aq) + H_2O(l) + CO_2(g)
(iii) Reaction of Acid with Bicarbonates

$NaHCO_3$ (s) + HCl (aq) → NaCl(aq) + H_2O (l) + CO_2 (g)

Base - A substance that produces hydroxide ions (OH^-) in aqueous solutions.

For Example - Sodium Hydroxide (NaOH), Potassium hydroxide (KOH)

General properties of bases:

- They have a bitter taste.
- They are soapy to touch.
- They turn red litmus to blue.
- They conduct electricity in solution form.
- They release OH^- ions in aqueous solution

Reactions of Bases

(i) Reaction with Metals

2NaOH + Zn → Na_2ZnO_2 + H_2

(ii) Reaction with Non-metallic Oxides

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

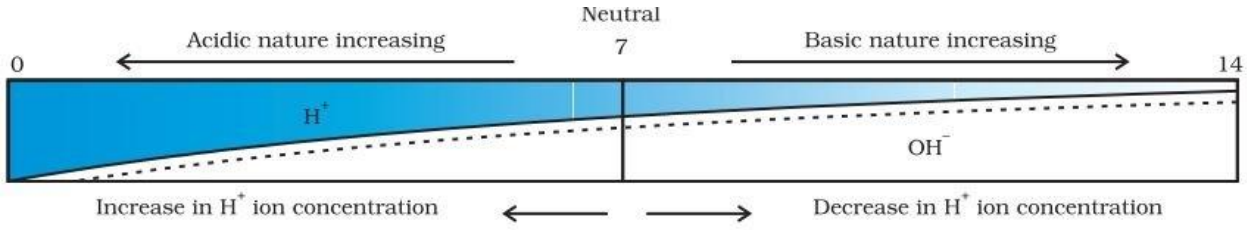
(iii) Reaction with Acids

$NaOH + HCl \rightarrow NaCl + H_2O$

Strong Acids An acid which completely dissociates into its ions in aqueous solution. For example: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)	**Strong Base** A base which completely dissociates into its ions in aqueous solution. For example: Sodium hydroxide (NaOH), Potassium hydroxide (KOH)
Weak Acids An acid which does not completely dissociate into its ions in aqueous solutions. For example: Acetic acid (CH_3COOH), Carbonic acid (H_2CO_3)	**Weak Base** A base which does not completely dissociate into its ions in aqueous solution. For example: Ammonium hydroxide (NH_4OH).

Concept of pH scale

Strength of an acid or base can be determined using a pH scale. It is a scale to measure the hydrogen ion concentration in a solution. The p stands for 'potenz', it is a German word which means power.



Variation of pH *with the change in concentration of* $H^+(aq)$ *and* $OH^-(aq)$ *ions*

For water or neutral solutions : pH = 7

For acidic solutions : pH < 7

For basic solution : pH > 7

Importance of pH in everyday life

(i) pH in our digestive system: Our stomach produces hydrochloric acid that helps in the digestion of food. During indigestion the stomach produces too much acid and this causes pain and irritation. To get rid of this pain, antacids like magnesium hydroxide [$Mg(OH)_2$] also known as milk of magnesia and sodium hydrogen carbonate (baking soda) are used to neutralize excess acid.

(ii) Tooth decay caused by acids: Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating. When the pH of acid formed in the mouth falls below 5.5, tooth-decaying starts. The best way to prevent this is to clean the mouth after eating food. Using toothpastes, which are generally basic, for cleaning the teeth can neutralise the excess acid and prevent tooth decay.

(iii) pH of soil and plant growth: Most of the plants require a specific pH range (close to 7) for their healthy growth. If the soil is too acidic or basic, the plants grow badly or do not grow at all. pH of the soil can be adjusted by using certain chemicals. For example, if the soil is too acidic then it is treated with materials like quicklime or slaked lime. On the other hand, if the soil is too alkaline then alkalinity can be reduced by adding decaying organic matter.

Preparation and uses of important compounds

Caustic Soda (Sodium Hydroxide, NaOH)

Preparation: In the process of electrolytic decomposition of brine (aqueous solution of sodium chloride), brine decomposes to form sodium hydroxide.
$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
In this process, chlorine is obtained at anode and hydrogen gas is obtained at cathode as by products. This whole process is known as Chlor – Alkali process.

Uses:
Sodium hydroxide is used for degreasing of metals, manufacturing of paper, soap, detergents, artificial fibres, etc.

Bleaching Powder (Calcium Oxychloride, $CaOCl_2$)

Preparation: 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:
Bleaching powder is used –

(i) for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;

(ii) as an oxidising agent in many chemical industries; and

(iii) to make drinking water free from germs

Baking Soda (Sodium Hydrogen Carbonate, $NaHCO_3$)

Preparation:
The chemical name of the compound is sodium hydrogen carbonate ($NaHCO_3$). It is produced by the reaction of brine with carbon dioxide and ammonia. This is known as Solvay process.

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow \underset{\text{Ammonium chloride}}{NH_4Cl} + \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3}$$

Uses:

(i) Baking soda is used in making of baking powder, which is used in cooking.

Baking powder is a mixture of baking soda (sodium hydrogen carbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place –

$$NaHCO_3 + \underset{\text{(From any acid)}}{H^+} \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

Carbon dioxide produced during the reaction can cause bread or cake to rise making them soft and spongy.

(ii) Baking soda (sodium hydrogen carbonate) is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.

(iii) It is also used in soda-acid fire extinguishers.

Washing Soda (Sodium Carbonate, $Na_2CO_3.10H_2O$)

Preparation:
Sodium carbonate is manufactured by the thermal decomposition of sodium hydrogen carbonate obtained by Solvay process.

$$NaCl + NH_3 + H_2O + CO_2 \rightarrow NaHCO_3 + NH_4Cl$$

$$NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

$$Na_2CO_3 + 10\ H_2O \rightarrow Na_2CO_3.10H_2O$$

Uses:
(i) Sodium carbonate (washing soda) is used in glass, soap and paper industries.

(ii) It is used in the manufacture of sodium compounds such as borax.

(iii) Sodium carbonate can be used as a cleaning agent for domestic purposes.

(iv) It is used for removing permanent hardness of water

Plaster of Paris (Calcium Sulphate Hemihydrate, $CaSO_4$. ½ H_2O)

Preparation:
On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate($CaSO_4$. ½H_2O) which is called Plaster of
Plaster of Paris is a white powder and on mixing with water, it changes to gypsum once again giving a hard solid mass.

$CaSO_4$. ½H_2O + 1½H_2O → CaSO4.2H_2O
(POP) (Gypsum)

Questions for self-assessment:
Why should curd and sour substances not be kept in brass and copper vessels?

Why does distilled water not conduct electricity, whereas rain water does?

Name the acid present in an ant sting and give its chemical formula. Also give the common method to get relief from the discomfort caused by the ant sting.

What happens when nitric acid is added to egg shell?

An aqueous solution of sodium chloride is neutral but an aqueous solution of sodium carbonate is basic. Why?