Chapter 2
Acids Bases and Salts

Acids

- Acids are substances that dissolve in water to release H+ ions.
- Have a pH value less than 7 and turn blue litmus red.
- They taste sour and can be corrosive.
- Some common examples of acids include hydrochloric acid (HCl) and sulfuric acid (H_2SO_4).
- Conduct electricity in solutions.

Strong Acids: Acids which completely ionise in water and produce (H+) ions are called strong acids.

Examples: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)

Weak Acids: Acids which partially ionise in water and produce a small amount of hydrogen ions (H+) are called weak acids.

Example: Acetic acid (CH_3COOH), Carbonic acid (H_2CO_3)

Types of acids on the basis of their occurrence

1. **Natural Acids:** Acids which are obtained from natural sources are called natural acids or organic Acids.
   Examples: Methanoic acid (HCOOH), Acetic acid (CH_3COOH), Oxalic acid ($C_2H_2O_4$) etc.

2. **Mineral Acids:** Acids that are derived from minerals are known as mineral acids Example; Inorganic acids, man-made acids or synthetic acid are also known as Mineral Acids.
   Example: Hydrochloric acid (HCl), Sulphuric acid (H2SO4), Nitric acid (HNO3), Carbonic acid (H2CO3), Phosphoric acid (H3PO4) etc.

Chemical properties of acids

- **Acids react with metal** to give salt and hydrogen gas.

  Metal + Acid → Salt + Hydrogen

  Example: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

- **Acids react with metal carbonates** to give salt, water and carbon dioxide gas.

  Metal carbonate + Acid → Salt + Carbon dioxide + Water

  Example: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

- **Acids react with metal hydrogen carbonates(bicarbonates)** to give salt, water and carbon dioxide gas.

  Metal hydrogen carbonate + Acid → Salt + Carbon dioxide + Water

  Example: $NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

- **Pop Sound Test:** If we bring a lighted candle near a gas which has evolved in a chemical reaction and it bums with a pop sound, then it confirms the evolution of hydrogen gas. Burning with pop sound is the characteristic test for hydrogen gas.

- **Lime Water Test:** Carbon dioxide turns lime water *milky* when passed through it. This is the characteristic test for carbon dioxide gas.

$$\underset{\text{(Lime water)}}{Ca(OH)_2} + CO_2 \rightarrow \underset{\text{(White precipitate)}}{CaCO_3} + H_2O$$

On passing **excess** carbon dioxide the milky colour disappears and the following reaction takes place:

$$CaCO_3 + H_2O + CO_2 \rightarrow \underset{\text{(Soluble in water)}}{Ca(HCO_3)_2}$$

- **Acids react with metal oxides** to give salt and water because metal oxides are *basic* in nature.

  Acid + Metal Oxide → Salt + Water

  Example: $2HCl + CaO \rightarrow CaCl_2 + H_2O$

Bases

- Bases are substances that give hydroxide ions (OH^-) in aqueous solution.
- Have a pH value greater than 7 and turn red litmus blue.
- They taste bitter and are usually slippery to the touch.
- Conducts electricity in solution.
- Some common examples of bases include sodium hydroxide (NaOH) and calcium hydroxide ($Ca(OH)_2$).
- Bases which are soluble in water are also known as alkali. For example : sodium hydroxide, magnesium hydroxide, calcium hydroxide, etc.
- **Strong bases** completely ionize in water and produce a large amount of hydroxide ions. For example: NaOH, KOH, etc.
- **Weak bases** partially ionize in water and produce a little amount of hydroxide ions. For example: NH_4OH, $Zn(OH)_2$, etc.

Chemical properties of Bases

- **Bases react with metal** to give salt and hydrogen gas.

  Metal + Base → Salt + Hydrogen

  Example: $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

  (Sodium zincate)

- **Bases react with non-metal oxides** to give salt and water because non-metal oxides are *acidic* in nature.

  Base + Non-metal oxide → Salt + Water

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

- **In neutralisation reaction** an acid and a base react to form salt and water. The reaction is often exothermic, meaning it releases heat.

  Acid + Base → Salt + Water

  Example: $HCl + NaOH \longrightarrow NaCl + H_2O$

Dilution of acid and base

Dilution is the process of adding more solvent (usually water) to a solution to reduce its concentration. Diluting an acid or a base involves adding water to the solution to decrease the concentration of the acid or base. The dilution process results in a solution with a lower concentration of the acid(H+ ions) or base(OH- ions).

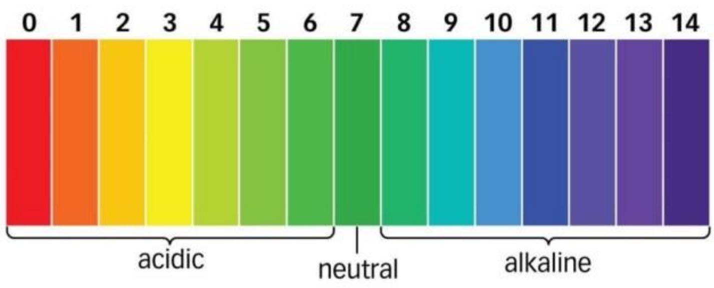
When diluting an acid, it is important to add the acid to the water slowly, stirring constantly, to avoid a sudden release of heat. Diluting a base can also release heat, so the same caution should be taken.

pH Scale

- The pH scale is used to measure the strength of acidic or basic substance.
- It ranges from 0 to 14, with 7 being neutral.
- Acids have pH less than 7, while bases have pH greater than 7.
- Increase in pH decreases the acidic strength and increases the basic strength.
- Decrease in pH increases the acidic strength and decreases the basic strength.

Importance of pH in everyday life

- In the human body, all the physiological reactions take place at the pH of 7-7.8.
- The pH of the soil is an important factor in the growth plants. The ideal pH for the growth of plants ranges from 5.5 to 7
- Our tooth starts decaying when the pH of the mouth falls below 5.5.
- Dilute hydrochloric acid helps in digestion of proteins in our stomach. Excess acid in stomach causes acidity. Antacids like magnesium hydroxide also known as milk of magnesia and sodium hydrogen carbonate (baking soda) are used to neutralize excess acid.



Salts

Salts are ionic compounds formed from the reaction between an acid and a base. Salts are electrically neutral. There are many salts but sodium chloride (NaCl) is the most common one. Sodium chloride is also known as table salt or common salt.

Types of salts:

- **Neutral Salt:** When a strong acid and a strong base react, they fully neutralize each other and form a neutral salt.
  For example: Sodium chloride, Sodium sulphate, etc.
  Strong Acid + Strong Base → Neutral Salt + Water

- **Acidic Salt:** When a strong acid and a weak base react, the base is unable to fully neutralize the acid and forms acidic salt.
  For example: Ammonium sulphate, Ammonium chloride, etc.
  Strong Acid + Weak Base → Acidic Salt + Water

- **Basic Salt:** When a weak acid and a strong base react, the acid is unable to fully neutralize the base and forms basic salt.
  For example: Sodium carbonate, Sodium acetate, etc.
  Weak Acid + Strong Base → Basic Salt + Water

The pH value of a neutral salt is almost equal to 7, the pH value of an acidic salt is less than 7 and the pH value of a basic salt is more than 7.

Chemicals from Common Salt

- **Sodium Hydroxide (NaOH):** Sodium hydroxide is obtained by the electrolytic decomposition of solution of sodium chloride (brine). In this process brine decomposes to form sodium hydroxide, chlorine gas (at anode) and hydrogen gas (at cathode). This process is also known as chlor – alkali process.

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

- **Bleaching Powder ($CaOCl_2$):** Calcium oxychloride (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 of Bleaching Powder

- Bleaching powder is used as disinfectant to clean water.
- It is used for bleaching of cotton in textile industry, bleaching of wood pulp in paper industry.
- It is used as oxidizing agent in many industries, such as textiles industry, paper industry, etc.

- **Baking Soda ($NaHCO_3$):** The chemical name of baking soda is sodium hydrogen carbonate or sodium bicarbonate and it is widely used in cooking activities. Baking soda is obtained by the reaction of brine with carbon dioxide and ammonia.

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

The following reaction takes place when baking soda is heated during cooking –

$$NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

Uses of Baking Soda

- Baking soda is used in making of baking powder, which is used in cooking as it produces carbon dioxide which makes the batter soft and spongy.
- It is used as an antacid. Being alkaline, it neutralises excess acid in the stomach and provides relief.
- Baking Soda is also used in soda-acid fire extinguishers.

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

$$NaHCO_3 + \text{Tartaric Acid} \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

- **Washing Soda ($Na_2CO_3.10H_2O$):** We have seen above that sodium carbonate can be obtained by heating baking soda; recrystallisation of sodium carbonate gives washing soda. It is also a basic salt.

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3.10H_2O$$

Uses of Washing Soda

- Washing soda is used in glass, soap and paper industries.
- Sodium carbonate can be used for washing clothes.
- It is used for removing permanent hardness of water.

Water of Crystallization

Water of crystallization is the fixed number of water molecules present in one formula unit of a salt.

For example: Five water molecules are present in one formula unit of copper sulphate. Chemical formula for hydrated copper sulphate is $CuSO_4.5H_2O$. It's blue in colour. When copper sulphate is heated, it loses water molecules and turns into white powder which is known as anhydrous copper sulphate. After adding water, anhydrous copper sulphate becomes blue again.

$$CuSO_4.5H_2O \text{ Heat} \rightleftharpoons CuSO_4 + 5H_2O$$

Plaster of Paris

Plaster of Paris is a white powder and on mixing with water, it changes to gypsum giving a hard solid mass.

$$\underset{\text{(Plaster of Paris)}}{CaSO_4.\frac{1}{2}H_2O} + 1\frac{1}{2}H_2O \rightarrow \underset{\text{(Gypsum)}}{CaSO_4.2H_2O}$$

Indicators

- Indicators are the substances that change the colour depending on the acidic or basic nature of the solution they are in.
- Indicators obtained from natural sources are called **natural indicators**. For example: litmus, turmeric, red cabbage, etc.
- Substances which change their smell when mixed with acid or base are known as **olfactory indicators**. For example: onion, vanilla extract, clove oil etc.
- Indicators that are synthesized in the laboratory are known as **synthetic indicators**. For example: Phenolphthalein, methyl orange, etc.