Acids, Bases and Salts

Acids

Acids furnish H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replaceable H atoms.

Arrhenius Concept of Acids

Acid is capable of producing hydrogen ion H^+ by dissociating in aqueous solution. This reaction can be represented by

$$HA\,(aq) \longrightarrow H^+(aq)\,A^-(aq)$$

For example: Hydrochloric Acid (HCl)

$$HCl\,(aq) \longrightarrow H^+(aq)\,Cl^-(aq)$$

The proton or hydrogen ion binds itself to a water molecule to form a **hydronium ion** (H_3O^+)

$$\underset{\text{Hydrogen Ion}}{H^+} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Hydronium Ion}}{H_3O^+}$$

The **hydronium ion** is also known as **oxonium ion** or **hydroxonium ion**.

Note:
- H^+ ions are protons.
- Metals usually are **basic** in nature whereas Non metals usually are **acidic** in nature.

Properties of Acids

- Acids generally have sour taste.
- Acids change Blue litmus Red.
- They are colorless with **phenolphthalein** and pink with **methyl orange**.
- Acids show acidic nature in their aqueous form.

Classification of Acids

- **Based on Source:**

- **Organic Acids** are present in plants and animals (living beings).

  Eg:

  * HCOOH (Formic Acid/Methanoic Acid, found in **stings of bees/ants**)
  * CH_3COOH (Acetic Acid/Ethanoic Acid, found in **Vinegar**)

- **Inorganic Acids** are found from rocks and minerals.

  Eg: HCl (Hydrochloric Acid), HNO_3 (Nitric Acid), H_2SO_4 (Sulphuric Acid)

- **Based on their Basicity**

  Basicity = The number of H atoms replaceable by a base in a particular acid.

  - **Monabasic Acid** gives one H^+ ion per molecule of the acid in solution.

    Eg: HCl, HNO_3

  - **Dibasic Acid** gives two H^+ ions per molecule of the acid in the solution.

    Eg: H_2SO_4, H_2CO_3

  - **Tribasic Acid** gives three H^+ ions per molecule of the acid in the solution.

    Eg: H_3PO_4

- **Based on Ionisation**

  - **Strong Acids** ionise completely in water.

    Eg: HCl

  - **Weak Acids** ionise partially in water.

    Eg: CH_3COOH

- **Based on Concentration**

  - **Concentrated Acid** has a relatively high percentage of acid in its aqueous solution.
  - **Dilute Acid** has a relatively low percentage of acid in its aqueous solution.

Chemical Properties of Acids

- **Reaction of acids with Metals**

  Acids give hydrogen gas along with respective salt when they react with a metal.

  $\text{Metal} + \text{Acid} \longrightarrow \text{Salt} + \text{Hydrogen}$

  Examples:

  - $Zn + 2\,HCl \longrightarrow ZnCl_2 + H_2\uparrow$
  - $2\,Na + 2\,HCl \longrightarrow 2\,NaCl_2 + H_2\uparrow$
  - $Fe + 2\,HCl \longrightarrow FeCl_2 + H_2\uparrow$

- $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$

- **Reaction of acids with Metal Carbonates**

  Acids react with metal carbonates to give respective salt, carbon dioxide and water.

  $\text{Metal Carbonate} + \text{Acid} \longrightarrow \text{Salt} + \text{Carbon Dioxide} + \text{Water}$

  Examples:

  - $CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2\uparrow$
  - $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2\uparrow$
  - $CaCO_3 + 2\,HCl \longrightarrow CaCl_2 + H_2O + CO_2\uparrow$
  - $Na_2CO_3 + 2\,HCl \longrightarrow 2\,NaCl + H_2O + CO_2\uparrow$
  - $MgCO_3 + 2\,HCl \longrightarrow MgCl_2 + H_2O + CO_2\uparrow$
  - $Na_2CO_3 + 2\,HNO_3 \longrightarrow NaNO_3 + H_2O + CO_2\uparrow$

- **Reaction of acids with Metal Hydrogen Carbonates (Bicarbonates)**

  Acids give CO_2 gas, respective salt and water when they react with metal hydrogen carbonates.

  $\text{Metal Bicarbonate} + \text{Acid} \longrightarrow \text{Salt} + \text{Water} + \text{Carbon Dioxide}$

  Examples:

  - $NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2\uparrow$
  - $2\,NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2\,H_2O + 2\,CO_2\uparrow$

Notes:

- Sodium Bicarbonate ($NaHCO_3$) is also known as Sodium Hydrogen Carbonate, **Baking Soda** and **Baking Powder**
- The gas evolved in the reaction of acid and metal hydrogen carbonate or bicarbonate, **turns lime water milky**. This indicates that the gas is Carbon Dioxide (CO_2).
  This is due to the formation of white ppt of **Calcium Carbonate**, $CaCO_3$

  $$CaOH_2 + CO_2 \longrightarrow H_2O + CaCO_3\downarrow$$
  Carbon Dioxide turns lime water milky.

- But when excess CO_2 is passed through lime water, it makes the milky colour disappear.
  This happens because of formation of **calcium hydrogen carbonate**. As it is soluble in water, the milky colour dissapears.

  $$CaCO_3 + H_2O + CO_2 \longrightarrow CaHCO_3(aq)$$
  Excess carbon dioxide makes the milky colour disappear.

- **Calcium Carbonate**, $CaCO_3$ is a salt found in **eggshells**, **chalk powder** and **marble**.

- **Reaction of acids with Metallic oxides**

  Metal oxides are basic in nature. Thus, when an acid reacts with a metal oxide, both neutralize each other. In this reaction, respective salt and water is formed.

  $\text{Acid} + \text{Metal Oxide} \longrightarrow \text{Salt} + \text{Water}$

  Examples:

  - $2\,HCl + CaO \longrightarrow CaCl_2 + H_2O$
  - $H_2SO_4 + ZnO \longrightarrow ZnSO_4 + H_2O$
  - $6\,HCl + Al_2O_3 \longrightarrow 2\,AlCl_3 + 3\,H_2O$

Strong and Weak Acids

Strong Acids	Weak Acids

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These acids completely dissociate in water. |

These acids dissociate partially in water. |

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