Comprehensive Study Notes: Class 10 Chemistry

Chapter 2: Acids, Bases and Salts

Based on the Latest Syllabus and Exam Pattern

1. Introduction to Acids and Bases

Chemical substances are classified into acids, bases, and salts based on their chemical properties.

Acids

- **Physical Properties:** Sour in taste, turn blue litmus paper red.
- **Chemical Nature:** They release hydrogen ions (H^+) in an aqueous solution.
- **Examples:** Hydrochloric acid (HCl), Sulfuric acid (H_2SO_4), Acetic acid (CH_3COOH).

Bases

- **Physical Properties:** Bitter in taste, soapy to touch, turn red litmus paper blue.
- **Chemical Nature:** They release hydroxide ions (OH^-) in an aqueous solution. Bases that are soluble in water are called **alkalis**.
- **Examples:** Sodium hydroxide (NaOH), Potassium hydroxide (KOH), Calcium hydroxide ($Ca(OH)_2$).

Indicators

Indicators are substances that change their color or odor in acidic or basic media.

- **Natural Indicators:** Litmus (extract from lichen), Turmeric.
- **Synthetic Indicators:** Methyl orange (turns red in acid, yellow in base), Phenolphthalein (colorless in acid, pink in base).
- **Olfactory Indicators:** Substances whose odor changes in acidic or basic media (e.g., Vanilla extract, Onion, Clove oil).

2. Chemical Properties of Acids and Bases

Reaction with Metals

- **Acids:** React with active metals to form salt and hydrogen gas.

$$\textbf{Acid} + \textbf{Metal} \rightarrow \textbf{Salt} + \textbf{Hydrogen gas}$$

Example: $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2 \uparrow$

- **Bases:** Certain bases react with metals to yield salt and hydrogen gas. *Example:* $Zn + 2NaOH \rightarrow Na_2ZnO_2$ (Sodium zincate) $+ H_2 \uparrow$

Reaction with Metal Carbonates and Metal Hydrogen Carbonates

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

$$\textbf{Acid} + \textbf{Metal Carbonate} \rightarrow \textbf{Salt} + CO_2 + H_2O$$

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

Note: Passing the evolved CO_2 gas through lime water turns it milky due to the formation of insoluble calcium carbonate ($CaCO_3$).

Reaction of Acids and Bases with Each Other (Neutralization)

The reaction between an acid and a base to give a salt and water is known as a neutralization reaction.

$$\textbf{Acid} + \textbf{Base} \rightarrow \textbf{Salt} + \textbf{Water}$$

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

Reaction of Metallic and Non-Metallic Oxides

- **Metallic Oxides with Acids:** Metallic oxides are basic in nature. They react with acids to form salt and water.
  Example: $CuO + 2HCl \rightarrow CuCl_2 + H_2O$
- **Non-Metallic Oxides with Bases:** Non-metallic oxides are acidic in nature. They react with bases to form salt and water.
  Example: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

3. What Do All Acids and Bases Have in Common?

- **Acids** generate H^+ (aq) ions in water, which are responsible for their acidic properties. These ions cannot exist alone and exist as hydronium ions (H_3O^+).
- **Bases** generate OH^- (aq) ions in water.
- The process of dissolving an acid or a base in water is highly **exothermic**. Care must be taken to always add acid to water with constant stirring, not water to acid.

4. Strength of Acids and Bases: The pH Scale

A scale for measuring hydrogen ion concentration in a solution is called the **pH scale**.

- The p in pH stands for *potenz* (power) in German.
- **Scale Range:** 0 (very acidic) to 14 (very alkaline).
- **Neutral Solution:** pH = 7 (e.g., pure water).
- **Acidic Solution:** pH < 7. Lower pH means higher H^+ concentration and stronger acid.
- **Basic Solution:** pH > 7. Higher pH means higher OH^- concentration and stronger base.

Importance of pH in Everyday Life

1. **Plants and Animals:** Our body works within the pH range of 7.0 to 7.8. Acid rain (pH < 5.6) lowers the pH of river water, making survival difficult for aquatic life.
2. **Digestive System:** Our stomach produces hydrochloric acid (pH 1.2) which helps in digestion. Excess acid causes indigestion, which is neutralized using antacids (mild bases like Milk of Magnesia).
3. **Tooth Decay:** Tooth decay starts when the pH of the mouth is lower than 5.5. Bacteria degrade sugar to produce acid. Using toothpaste (basic) neutralizes the excess acid.
4. **Self-Defense by Animals and Plants:** Bee stings leave an acid (methanoic acid) causing pain. Rubbing baking soda gives relief. Nettle leaves inject methanoic acid, traditionally treated by rubbing dock plant leaves.

5. More About Salts

Salts are ionic compounds formed by neutralization reactions.

- **Family of Salts:** Salts having the same positive or negative radicals belong to the same family (e.g., NaCl and Na_2SO_4 belong to the sodium family).
- **pH of Salts:**
  - Strong Acid + Strong Base $\rightarrow$ Neutral Salt (pH = 7)
  - Strong Acid + Weak Base $\rightarrow$ Acidic Salt (pH < 7)
  - Weak Acid + Strong Base $\rightarrow$ Basic Salt (pH > 7)

6. Chemicals from Common Salt (NaCl)

Common salt is an important raw material for various materials of daily use.

1. Sodium Hydroxide ($NaOH$)

Preparation (Chlor-alkali process): When electricity is passed through an aqueous solution of sodium chloride (brine), it decomposes to form sodium hydroxide.

$$2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electricity}} 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Uses: Degreasing metals, soaps and detergents, paper making.

2. Bleaching Powder ($CaOCl_2$)

Preparation: Produced by the action of chlorine on dry slaked lime.

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

Uses: Bleaching cotton and linen in the textile industry, oxidizing agent in chemical industries, disinfecting drinking water.

3. Baking Soda ($NaHCO_3$ - Sodium Hydrogen Carbonate)

Preparation:

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

Uses: For making baking powder (mixture of baking soda and a mild edible acid like tartaric acid), as an antacid, in soda-acid fire extinguishers.

4. Washing Soda ($Na_2CO_3 \cdot 10H_2O$)

Preparation: Recrystallization of sodium carbonate gives washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$$

Uses: In glass, soap, and paper industries; manufacture of borax; removing permanent hardness of water.

5. Plaster of Paris ($CaSO_4 \cdot \frac{1}{2}H_2O$)

Preparation: On heating gypsum ($CaSO_4 \cdot 2H_2O$) at 373 K, it loses water molecules to become calcium sulphate hemihydrate.

$$CaSO_4 \cdot 2H_2O \xrightarrow{373\ K} CaSO_4 \cdot \tfrac{1}{2}H_2O + 1\tfrac{1}{2}H_2O$$

Uses: Doctors use it as a plaster for supporting fractured bones, making toys, materials for decoration, and making surfaces smooth.