Chapter 1
Chemical Reactions and Equations

- A chemical reaction is a process in which one or more substances are transformed into new substances with different physical and chemical properties.
- There are different types of chemical reactions such as combination reactions, decomposition reactions, displacement reactions, double displacement reactions, and redox reactions.
- In a chemical reaction, reactants are the starting substances that undergo a chemical change to form new substances, known as products.
- Reactants are placed on the left-hand side of a chemical equation, while products are placed on the right-hand side.
- The chemical equation represents the chemical reaction, and it shows the reactants and products involved in the reaction.
- For example, in the reaction of hydrogen gas with oxygen gas to form water, the reactants are hydrogen and oxygen, and the product is water. The chemical equation for this reaction is:
  $2H_2 + O_2 \text{ ---> } 2H_2O$
- Balancing chemical equations is the process of ensuring that the number of atoms of each element in the reactants is equal to the number of atoms of the same element in the products. It is based on the law of conservation of mass.
- Factors that affect the rate of a chemical reaction are: temperature, concentration of reactants, surface area, and catalysts.
- The study of chemical reactions is important in understanding various phenomena that occur in our daily lives, such as the digestion of food, rusting of iron, combustion, and many others.

Observations during a chemical reaction

Change in temperature: The temperature may increase or decrease depending on the nature of the reaction. For example, when a chemical reaction is exothermic, it releases heat and the temperature increases, while an endothermic reaction absorbs heat and the temperature decreases.

Change in color: The color of the reactants or products may change, indicating a chemical change. For example, the color of iron changes from shiny silver to reddish-brown when it rusts due to a chemical reaction with oxygen in the air.

Formation of a precipitate: A precipitate is a solid that forms from a solution during a chemical reaction. It appears as a cloudy or milky suspension in the solution.

Production of gas: Gas may be produced during a chemical reaction, which may be visible as bubbles or a change in pressure. For example, when an acid reacts with a metal, hydrogen gas is produced.

Change in odor: A new odor may be produced during a chemical reaction, indicating the formation of a new substance. For example, the smell of burning wood is due to a chemical reaction that produces smoke and ash.

Types of chemical reactions

Combination reactions: In a combination reaction, two or more reactants combine to form a single product. The general equation for a combination reaction is A + B -> AB. Example:

$$\underset{\text{(Quick lime)}}{CaO(s)} + H_2O(l) \rightarrow \underset{\text{(Slaked lime)}}{Ca(OH)_2(aq)}$$

Decomposition reactions: In a decomposition reaction, a single reactant breaks down into two or more products. The general equation for a decomposition reaction is AB -> A + B.

Types of decomposition reactions

- **Thermal decomposition**: This type of decomposition reaction occurs when a compound is heated and breaks down into simpler substances.
  Example:

$$\underset{\text{(Limestone)}}{CaCO_3(s)} \xrightarrow{\text{Heat}} \underset{\text{(Quick lime)}}{CaO(s)} + CO_2(g)$$

- **Electrolytic decomposition**: This type of decomposition reaction occurs when an electric current is passed through a compound, causing it to break down into simpler substances.
  Example:

$$2H_2O(l) \xrightarrow{\text{Electric Current}} O_2(g) + 2H_2(g)$$

- **Photolytic decomposition**: This type of decomposition reaction occurs when a compound is exposed to light and breaks down into simpler substances.
  Example:

$$2AgCl(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + Cl_2(g)$$

Single displacement reactions: In a single displacement reaction, one element in a compound is replaced by another element. The general equation for a single displacement reaction is A + BC -> AC + B.

Example:

$$\underset{\text{(Copper sulphate)}}{Fe(s) + CuSO_4(aq)} \rightarrow \underset{\text{(Iron sulphate)}}{FeSO_4(aq)} + Cu(s)$$

Double displacement reactions: In a double displacement reaction, two compounds exchange ions to form two new compounds. The general equation for a double displacement reaction is AB + CD -> AD + CB.

Example:

$$\underset{\text{(Sodium sulphate)}}{Na_2SO_4(aq)} + \underset{\text{(Barium chloride)}}{BaCl_2(aq)} \rightarrow \underset{\text{(Barium sulphate)}}{BaSO_4(s)} + \underset{\text{(Sodium chloride)}}{2NaCl(aq)}$$

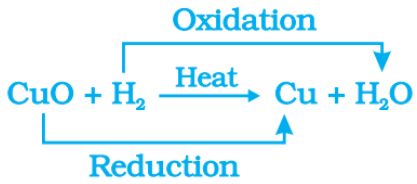
In above example, barium sulphate formed is insoluble in water. This insoluble substance formed is known as a precipitate. Any reaction that produces a precipitate can be called a **precipitation reaction**.

Oxidation and Reduction Reactions

- **Oxidation**: Addition of oxygen or removal of hydrogen from a compound is known as oxidation
  Examples: $2Cu + O_2 \xrightarrow{Heat} 2CuO$

  $2HI(g) \longrightarrow H_2(g) + I_2(g)$
- **Reduction:** Addition of hydrogen or removal of oxygen from a compound is called reduction**.**
  Examples: $CuO(s) + CO(g) \longrightarrow Cu(s) + CO_2(g)$

  $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$
- **Oxidizing agent:** substance which gives oxygen or removes hydrogen.
- **Reducing agent:** substance which gives hydrogen or removes oxygen.
- **Redox reactions** are the reactions in which oxidation and reduction takes place simultaneously.
  Example:



Exothermic and Endothermic Reactions

- **Exothermic Reactions:** Reactions in which heat is released along with the formation of products are called exothermic chemical reactions.
  Example:

  $C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l) + energy$
  (Glucose)
- **Endothermic Reactions:** Reactions in which energy is absorbed are known as endothermic reactions.
  Example:

  $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$
  (Limestone) (Quick lime)

Corrosion and Rancidity

- **Corrosion:** The process of slow conversion of metals into their undesirable compounds due to their reaction with oxygen, water, acids, gases etc. present in the atmosphere is called corrosion**.**
  Example: rusting of iron, tarnishing of silver, copper turning green, etc.

- **Rancidity:** The taste and odor of food materials containing fat and oil changes when they are left exposed to air for a long time. This is called rancidity. It is caused due to the oxidation of fat and oil present in food materials. It can be prevented by vacuum-packing or replacing the air by nitrogen while packaging.

Balancing a chemical equation

- Write the unbalanced equation, using the correct formulas for the reactants and products.
- Identify an element that appears in more than one molecule on either side of the equation.
- Choose a coefficient for that element on one side of the equation, and use that coefficient to balance the same element on the other side of the equation.
- Check if the equation is balanced. If it is, move on to the next element. If not, adjust the coefficients and try again.
- Repeat steps 3 and 4 for each element until the equation is balanced.
  Here's an example using the inspection method:
- Unbalanced equation: Fe + HCl → FeCl3 + H2
- Write the unbalanced equation: Fe + HCl → FeCl3 + H2
- Identify an element that appears in more than one molecule: In this case, chlorine appears in both HCl and FeCl3.
- Choose a coefficient for chlorine on one side of the equation: Let's start with 2HCl on the left side, which gives us 2 chlorine atoms. To balance the chlorine on the right side, we need to add a coefficient of 2 in front of FeCl3, giving us 2Fe + 2HCl → 2FeCl3 + H2.
- Check if the equation is balanced: Count the number of atoms of each element. We have 2 iron atoms, 6 chlorine atoms, and 2 hydrogen atoms on both sides of the equation. The equation is balanced.
- The equation is now balanced. The balanced equation is:

$$2Fe + 2HCl \rightarrow 2FeCl3 + H2$$