

Chapter 15

1. Introduction to Chemical Reaction

- A **chemical reaction** is a process where one or more substances (reactants) are transformed into new substances (products) with **different chemical properties**.
- In a chemical reaction, **bonds between atoms are broken and new bonds are formed**, resulting in new compounds or elements.

2. Chemical Equation

A chemical equation represents a chemical reaction using **symbols and formulas**.

a. Word Equation

- In a word equation, the **names** of the reactants and products are written.

Examples:

1. Hydrogen + Oxygen → Water
2. Magnesium + Oxygen → Magnesium oxide

b. Formula Equation

- In a formula equation, **chemical formulas** are used to represent the substances involved.

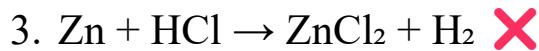
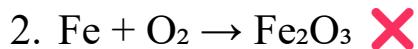
Examples:

1. $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
2. $\text{Mg} + \text{O}_2 \rightarrow \text{MgO}$

3. Balanced Chemical Equation

- A balanced chemical equation has **equal numbers of each type of atom** on both sides of the equation, satisfying the **Law of Conservation of Mass**.

Examples:



4. Types of Chemical Reactions

a. Combination / Addition / Synthesis Reaction

- Two or more substances combine to form a **single product**.

General form: $\text{A} + \text{B} \rightarrow \text{AB}$

Examples:

- $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$
- $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
- $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$

b. Decomposition / Dissociation Reaction

- A single compound breaks down into **two or more simpler substances**.

General form: $\text{AB} \rightarrow \text{A} + \text{B}$

Examples:

- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$ (Electrolysis)
- $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$

c. Displacement / Replacement Reaction

i. Single Displacement Reaction

- One element replaces another **less reactive element** in a compound.

General form: A + BC → AC + B

Examples:

- $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$

ii. Double Displacement Reaction

- Two compounds exchange **ions or elements** to form two new compounds.

General form: AB + CD → AD + CB

Examples:

- $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{NaNO}_3 + \text{AgCl}$
- $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$

d. Acid-Base Reaction (Neutralization Reaction)

- An acid reacts with a base to produce **salt and water**.

General form: Acid + Base → Salt + Water

Examples:

- $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- $\text{H}_2\text{SO}_4 + \text{Ca}(\text{OH})_2 \rightarrow \text{CaSO}_4 + 2\text{H}_2\text{O}$

5. Rate of Chemical Reaction

- The **rate of a chemical reaction** is the **speed** at which reactants are converted into products.
- It depends on various **physical and chemical factors**.

Major Factors Affecting Reaction Rate:

1. Temperature

- Increasing temperature increases the kinetic energy of particles → more effective collisions → faster reaction.

2. Concentration of Reactants

- Higher concentration = more particles = more collisions = faster reaction.

3. Surface Area of Reactants

- Finely divided or powdered reactants react faster due to more exposed surface.

4. Catalyst

- A catalyst **lowers the activation energy** required for the reaction without being consumed itself.

5. Nature of Reactants

- Some elements or compounds react more quickly based on their **chemical properties** (e.g., alkali metals are more reactive than transition metals).

6. Pressure (for gaseous reactions)

- Increased pressure forces gas particles closer together, increasing the rate of collisions.

7. Light (in photochemical reactions)

- Light can initiate or speed up certain reactions, like photosynthesis or decomposition of silver salts.

Key Terms to Remember

- **Reactants** – substances that undergo change.
- **Products** – new substances formed.
- **Exothermic reaction** – releases heat (e.g., combustion).
- **Endothermic reaction** – absorbs heat (e.g., photosynthesis).
- **Catalyst** – a substance that speeds up a reaction without being used up.

Did You Know?

- **Fireflies glow** due to a chemical reaction called **bioluminescence**, where an enzyme called **luciferase** reacts with **luciferin** in the presence of oxygen.
- **Rusting of iron** is a slow chemical reaction — it's actually **oxidation** where iron reacts with water and oxygen to form **iron oxide**.
- The **elephant toothpaste** experiment is a dramatic example of a **decomposition reaction** involving hydrogen peroxide and potassium iodide.
- **Instant cold packs** use an **endothermic reaction**, where ammonium nitrate dissolves in water and absorbs heat — making the pack feel cold.
- **Candle flames** have different colors because of different temperatures and incomplete combustion reactions.

