3. Chemical Reactions and Equations

- In a chemical reaction, at least one of the following will occur:
- Change in state
- Change in colour
- Evolution of a gas
- Change in temperature
- Formation of a precipitate

A **chemical equation** is the symbolic representation of a chemical reaction in the form of chemical formulae, signs, symbols, and directions. In which the reactant entities are given on the left-hand side and the product entities on the right-hand side.

- **Balanced chemical equation**

Reactants → Products

LHS RHS

Total number of atoms on the LHS = Total number of atoms on the RHS

- How to balance an equation
- Write reactants and products
- Balance the maximum number of a particular atom on both sides
- Balance other atoms
- A complete balanced equation should look like

  CO g + 2H2 g →340 atm CH3OH l

Types of reactions

- **Combination reaction**
  - Two or more reactants combine to form one single product.
  - **Examples**

    CaO s + H2O l → Ca(OH)2 aqCalcium oxide Water Calcium hydroxide (Quick lime) (Slaked lime)
    C s + O2 g → CO2 gCarbon Oxygen Carbon dioxide 2H2 g + O2 g → 2H2O lHydrogen Oxygen Water

- **Exothermic reaction** – Heat gets released in the reaction. Most combination reactions are exothermic. For example,

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

- **Endothermic reaction** – Heat is absorbed in the reaction. Very few combination reactions are endothermic. For example,

  12N2 g + O2 g → NO2 g

- **Decomposition reaction**
  - A single reactant breaks into several simple products.
  - **Examples**

    2FeSO4 Ferrous sulphate→ Δ Fe2O3Ferric oxide+SO2 +SO3CaCO3Limestone → Δ CaOCalcium oxide+ CO22AgClSilver chloride→

  - All decomposition reactions are **endothermic [they absorb heat]**.

- **Displacement reactions:**
  - In displacement reactions, a more reactive metal can displace a less reactive metal from their compounds in aqueous solutions. (However, a less reactive metal cannot displace a more reactive metal.)

  Example:

CuSO4 + Zn → ZnSO4 + Cu Copper Sulphate Zinc Zinc Sulphate Copper (Blue) (Colou

Fe s + CuSO4 aq → Cu s + FeSO4 aqIron Copper sulphate Copper Iron sulphate

- **Double displacement reaction**
  - Exchange of ions occurs between two compounds.
  - Example

Na2SO4 aq + BaCl2 s → BaSO4 aq + 2NaCl sSodium sulphate Barium chloride Barium sulphate Sodium chloride

- When the aqueous solution of two compounds react by exchanging their respective ions, such that one of the products formed is insoluble salt and appears in the form of a precipitate, then the reaction is said to be **precipitation reaction**.
- When an acid solution reacts with a base and the two exchange their respective ions, such that only salt and water are products, then the reaction is called **neutralisation reaction**.
- When two compounds react with each other and displace their ions, in such a manner that one of the product formed either decomposes into gaseous compounds or is formed in gaseous state, then the reaction is called **gas-forming reaction**.

- **Oxidation** →When a substance gains oxygen or loses hydrogen

$$2Cu + O_2 \xrightarrow{Heat} 2CuO \qquad [Oxidation\ of\ Cu]$$

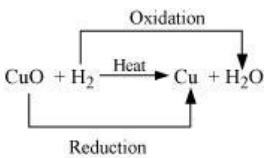
$$CuO + H_2 \xrightarrow{Heat} Cu + H_2O \qquad [Oxidation\ of\ H_2]$$

- **Oxidation in everyday life**
  - **Corrosion –** When a metal is oxidised by the action of air and moisture [that's why metals are coated]
  - **Rancidity** – When fats and oils are oxidised, their smell and taste change [that's why food is kept in air-tight containers]

- **Reduction** → When one substance loses oxygen or gains hydrogen

$$CuO + H_2 \xrightarrow{Heat} Cu + H_2O \qquad [Reduction\ of\ CuO]$$

- **Redox** – Oxidation–reduction reaction



1. The speed of chemical reaction depends on various factors like temperature, concentration of reactants, pressure, surface area and catalyst.

2. All these effects can be explained on the basis of collision theory according to which every chemical reaction depends on collision between the particles. Greater the collision between the particles, greater will be the speed of the reaction.

3. The rate of collision can be increased by increasing the concentration of the reactants.

4. An increase in temperature increases the energy of the particles so greatly, that they collide with each other more frequently and with greater energy. Thus higher the temperature, higher will be the speed of the reaction.

5. Increase in pressure causes the molecules to come close to each other and increases their chances of collision. Thus higher the pressure, higher will be the speed of the reaction.

6. Surface area means how much area of reactant is exposed for reaction. The more the contact of surface between the reactants, the higher will be the speed of reaction.

7.Catalyst provides a surface where the reactants can combine with each other. Actually catalyst lowers the activation energy by reducing the amount of energy required to break and form the bonds during the reaction. They do not get consumed in the reaction.