

## 4. Chemical Reactions and Equations

- A chemical equation is a shorthand description of a reaction. It symbolically represents the reactants, products and their physical states.
- In a balanced chemical equation, number of atoms of each type involved in the chemical reaction is equal on the reactants and products sides of the equation.
- If charged species are involved, the sum of the charges on reactants should be equal to sum of charges on the products.
- During balancing of a chemical equation, no change in the formula of reactant(s) and product(s) is allowed.
- A balanced chemical equation obeys the law of conservation of mass and the law of constant proportions.
- In a combination reaction two or more substances combine to form a new single substance.
- In a decomposition reaction, a single substance decomposes to give two or more substances. Thus decomposition reactions are opposite to combination reactions.
- Reactions in which heat is given out during product formation are called **exothermic reactions** and reactions in which heat is absorbed during product formation are called **endothermic reactions**.
- A displacement reaction is one in which an element displaces another element from its compound.
- When two different ions are exchanged between two reactants double displacement reaction occurs.
- Precipitation reactions are the result of ion exchange between two substances, producing insoluble salts.
- Oxidation is the gain of oxygen or loss of hydrogen and reduction is loss of oxygen or gain of hydrogen. Oxidation and reduction reactions occur simultaneously and are jointly called **redox reactions**.
- Redox reactions can broadly be defined in terms of loss and gain of electrons. Gain of electron(s) is reduction and loss of electrons is oxidation.

### Build Your Understanding

#### Chemical Equations

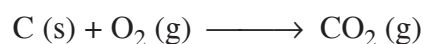
Chemical reactions are conveniently represented with the help of a chemical equation using chemical formulae of reactants and products as shown below



#### Types of Chemical Reactions

Chemical reactions are classified into the following categories:

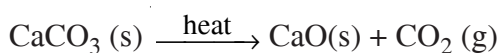
1. **Combination Reactions** are the ones in which a single product is formed from two or more reactants. Example:



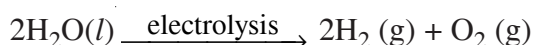
2. **Decomposition Reactions** are those in which a compound decomposes into two or more substances (elements or compounds).

#### Types of decomposition reactions

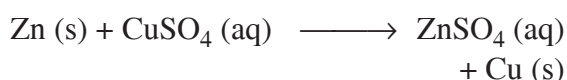
- (i) **Thermal Decomposition Reaction** is the one in which the decomposition occurs with the help of heat Example:



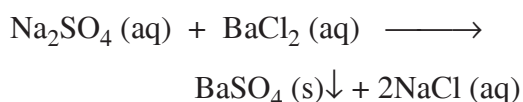
- (ii) **Electrolytic Decomposition Reaction** is the one in which the decomposition occurs with the help of electrical energy. The process is called **electrolysis**.  
Example:



3. **Displacement Reactions** are those in which one element displaces another element from its compounds. Example:



4. **Double Displacement Reactions** are those in which there is an exchange of ions between the reactants. Example:

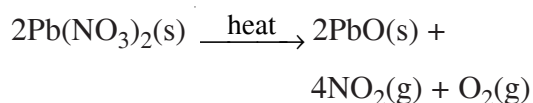


### Exothermic and Endothermic Reactions

**Exothermic Reactions** are those in which heat is given out. Example:



**Endothermic reactions** are those in which heat is absorbed. Example :



### Oxidation and Reduction (Redox) Reactions

- (i) **In terms of loss or gain of oxygen:** When a substance gains oxygen during a reaction, it is said to be **oxidized** (process is called oxidation) and when a substance loses oxygen during a reaction, it is said to be reduced (the process is called reduction) and the reaction is called a **redox** reaction.
- (ii) **In term of loss or gain of electrons:** The species which loses electrons is said to be oxidized and the process is called oxidation

and the species which gains electrons is said to be reduced and the process is called reduction.

### Oxidizing and Reducing Agents

**Oxidizing agent** is the substance which oxidizes another substance. It itself gets reduced in the reaction.

**Reducing agent** is the substance which reduces another substance. It itself gets oxidized in the reaction.

### Effects of Redox Reactions in Everyday Life

Two commonly observed effects are (i) corrosion and (ii) rancidity

#### (i) Corrosion

It is a destructive chemical process in which metals are oxidized in presence of air and moisture.

**Examples** (i) Rusting of iron (ii) tarnishing of silver (iii) formation of green coating on copper, brass and bronze items

#### Prevention of corrosion

- (i) Applying a protective coating such as oil or paint
- (ii) Plating the metal (iron) with a layer of less reactive or less easily oxidizable metal such as nickel
- (iii) Connecting or coating of a more reactive or more easily oxidizable metal such as connecting with magnesium or coating a layer of zinc (galvanization)

#### (ii) Rancidity

Rancidity is the process of oxidation of fats and oils resulting in the formation of acids. This process changes the smell and taste of stale fats and oil. Prevention :

- (i) Keeping food items in air tight containers
- (ii) Addition of antioxidants to food items which prevent the oxidation process.

### ★ Stretch Yourself

1. Balancing of chemical equations is often a tedious task. Why can't we use unbalanced equation?
2. A balanced chemical equation can provide a lot of information involving moles, masses and volumes of substances taking part in a reaction. Which one of the following equations provides less information and why?
  - (a)  $\text{HCl(aq)} + \text{NaOH(aq)} \longrightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$
  - (b)  $\text{H}_2 + \text{I}_2 \longrightarrow 2\text{HI}$

### ? Test Yourself

1. Balance the following equation
$$\text{Fe}_2\text{O}_3(\text{s}) + \text{CO}(\text{g}) \longrightarrow \text{Fe}(\text{s}) + \text{CO}_2(\text{g})$$
2. Identify what types of reaction is this?
$$\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \longrightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$$
3. In the reaction
$$2\text{Na}(\text{s}) + \text{Cl}_2(\text{g}) \longrightarrow 2\text{NaCl}(\text{s})$$
Identify the substance that
  - (i) loses electrons
  - (ii) gains electrons
  - (iii) is oxidising agent
  - (iv) is reducing agent
4. What are antioxidants and what is their use?