

# Chemistry:- Chemical Reactions and Equations

In this chapter, we explore the concept of chemical reactions and their symbolic representation. We observe various situations in daily life, such as milk being left at room temperature, iron tawas exposed to a humid atmosphere, grapes fermenting, food being cooked, digestion, and respiration. Chemical reactions can be observed through changes in state, color, the evolution of a gas, and temperature.

One example is the burning of a magnesium ribbon in air, which results in the formation of magnesium oxide. This reaction can be represented in a word equation, where the reactants are magnesium and oxygen and the new substance is magnesium oxide. The arrowhead points towards the products and shows the direction of the reaction.

In summary, chemical reactions occur when substances change in their nature and identity, such as milk being left at room temperature, iron tawas exposed to a humid atmosphere, grapes fermenting, food being cooked, and respiration. By observing these reactions, we can better understand the various types of chemical reactions and their symbolic representations.

Chemical equations can be simplified by using chemical formulas instead of words. They represent chemical reactions, such as the ones for magnesium, oxygen, and magnesium oxide. If the number of atoms in each element is the same on both sides, the equation is balanced. If not, it is unbalanced. Balancing a chemical equation involves balancing the total mass of the elements present in the products and the total mass of the elements present in the reactants. To balance a chemical equation, draw boxes around each formula without changing anything inside them. For example, to balance oxygen atoms, put the coefficient '4' as  $4\text{H}_2\text{O}$  instead of  $\text{H}_2\text{O}_4$  or  $(\text{H}_2\text{O})_4$ . To balance hydrogen atoms, choose any of the elements in the partly balanced equation. This helps in understanding the law of conservation of mass and balancing chemical equations.

To balance a chemical equation, start by determining the maximum number of atoms in the compound, such as  $\text{Fe}_3\text{O}_4$  and oxygen. The equation should be balanced by adding three atoms of Fe on the LHS. The hit-and-trial method is used to balance the equation by using the smallest whole number coefficient.

To understand the physical states of the reactants and products, write symbols of their physical states along with their chemical formulas. Gaseous, liquid, aqueous, and solid states are represented by notations (g), (l), (aq), and (s), respectively. The symbol (g) is used with  $\text{H}_2\text{O}$  to indicate that water is used in the form of steam.

To balance Eq. (1.2), examine the balanced equation and find that only one element, iron, is left to be balanced. The equation should be balanced using the smallest whole number coefficient. This method helps make chemical equations more informative and accurate.

Chemical reactions involve breaking and making bonds between atoms to produce new substances. These reactions involve the breaking and making of bonds between atoms, such as in the formation of slaked lime (calcium hydroxide) by combining calcium oxide and water. Examples of combination reactions include burning coal, forming water from  $\text{H}_2$  and  $\text{O}_2$  (g), and respiration, which is an exothermic process.

Exothermic reactions involve heat being released along with the formation of products, such as burning natural gas, breaking down carbohydrates into glucose, and decomposing vegetable matter into compost. Examples of combination reactions include the formation of slaked lime for whitewashing walls, where calcium hydroxide reacts slowly with carbon dioxide in the air to form a thin layer of calcium carbonate.

In summary, chemical reactions involve the breaking and making of bonds between atoms to produce new substances, such as slaked lime, hydrogen chloride, barium chloride, sodium hydroxide, and compost. Understanding these reactions is crucial for understanding the properties of chemical reactions and their applications.

Calcium carbonate is formed after whitewashing and gives walls a shiny finish. Marble's chemical formula is  $\text{CaCO}_3$ . Lead nitrate powder is heated over a flame, resulting in the emission of brown fumes, which are nitrogen dioxide. Ferrous sulfate crystals, which lose water when heated, decompose into ferric oxide, sulfur dioxide, and sulfur trioxide. This decomposition is an important process used in various industries, such as cement manufacturing. Calcium oxide, also known as lime, is used in the manufacture of cement. Thermal decomposition, carried out by heating, is another example of a decomposition reaction. Another example is the decomposition of silver chloride in a china dish. The color of a silver chloride dish changes when exposed to sunlight.

The text describes a process for observing the color change of silver chloride in sunlight, which turns gray into silver metal. The process involves using a plastic mug with carbon electrodes, a 6 volt battery, and water. The water is filled with dilute sulfuric acid, and two test tubes filled with water are inverted over the carbon electrodes. Bubbles at both electrodes displace water, and the volume of gas collected is measured. The teacher must perform this step carefully. The text also discusses the decomposition reactions of iron nails and the reaction of a substance 'X' with water.

In this experiment, three iron nails are cleaned and placed in test tubes with a copper sulfate solution. After 20 minutes, the nails are removed from the tubes, and the blue color of the copper sulfate solution fades. The decomposition reactions require energy, either in the form of heat, light, or electricity, to break down the reactants.

In a displacement reaction, iron has displaced or removed another element, copper, from the copper sulfate solution. Other examples of displacement reactions include  $\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$  (1.25) (copper sulfate) (zinc sulfate)  $\text{Pb(s)} + \text{CuCl}_2\text{(aq)} \rightarrow \text{PbCl}_2\text{(aq)} + \text{Cu(s)}$  (1.26) (copper chloride) (lead chloride).

A double displacement reaction occurs when sodium sulfate and barium chloride are mixed, forming a white substance called a precipitate. This precipitate is called a precipitation reaction.

Oxidation and reduction reactions occur when a substance gains oxygen during a reaction, while a substance loses oxygen during a reaction. Examples of redox reactions include  $\text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO}$  (1.31) and  $\text{MnO}_2 + 2\text{HCl} \rightarrow \text{MnCl}_2 + \text{H}_2\text{O} + \text{Cl}_2$  (1.32).

In conclusion, if a substance gains oxygen or loses hydrogen during a reaction, it is oxidized.

The color of copper sulfate solution changes when an iron nail is dipped in it, and an example of a double displacement reaction is given in Activity 1.10. Corrosion is a

process where a metal is attacked by substances around it, such as moisture or acids, causing damage to car bodies, bridges, iron railings, ships, and all metal objects, especially iron. This is a serious problem that costs an enormous amount of money to replace. Rancidity is the change in smell and taste of fats and oils when they are oxidized. Antioxidants are added to foods containing fats and oils to slow down oxidation. Chip manufacturers flush bags with gas to prevent oxidation. In a reaction, a magnesium ribbon burns in the air and changes into a white substance, magnesium oxide.

A balanced chemical equation represents the reactants, products, and their physical states symbolically. It is essential to balance equations to ensure the numbers of atoms involved are the same on the reactant and product sides. Combination reactions combine two or more substances to form a new single substance, while decomposition reactions are the opposite of combination reactions. Exothermic reactions involve heat being given out along with the products, while endothermic reactions absorb energy. Displacement reactions occur when an element displaces another element from its compound, while precipitation reactions produce insoluble salts. Reactions also involve the gain or loss of oxygen or hydrogen by substances. Oxidation is the gain of oxygen or loss of hydrogen, while reduction is the loss of oxygen or gain of hydrogen.

Examples of balanced chemical equations include hydrogen gas combining with nitrogen to form ammonia, hydrogen sulfide gas burning in the air to give water and sulfur dioxide, barium chloride reacting with aluminum sulfate to give aluminum chloride and a precipitate of barium sulfate, and potassium metal reacting with water to give potassium hydroxide and hydrogen gas. Decomposition reactions are the opposite of combination reactions and involve the gain or loss of oxygen or hydrogen.

X is an element, and a black-colored compound forms. Paint is applied to iron articles for protection. Oil- and fat-containing food items are flushed with nitrogen.

## Understanding Chemical Reactions and Their Symbolic Representation

### Understanding Chemical Reactions

- Chemical reactions occur when substances change in nature and identity.
- Examples include the burning of a magnesium ribbon in air, resulting in the formation of magnesium oxide.
- Chemical equations can be simplified using chemical formulas, representing chemical reactions.

### Balancing Chemical Equations

- Balancing a chemical equation involves balancing the total mass of the elements present in the products and the total mass of the elements present in the reactants.
- Balancing involves determining the maximum number of atoms in the compound and adding three atoms of Fe on the LHS.
- The hit-and-trial method is used to balance the equation by using the smallest whole number coefficient.

## Understanding Physical States of Reactants and Products

- Physical states of the reactants and products are represented by symbols of their physical states along with their chemical formulas.
- Gaseous, liquid, aqueous, and solid states are represented by notations (g), (l), (aq), and (s).

#### Exothermic Reactions

- Exothermic reactions involve heat being released along with the formation of products.
- Examples include burning coal, forming water from  $H_2$  and  $O_2$ , and respiration.

In summary, understanding chemical reactions is crucial for understanding their properties and applications.

#### Decomposition and Decomposition Reactions

- Calcium carbonate, marble's chemical formula, forms after whitewashing for a shiny finish.
- Lead nitrate powder, when heated, emits brown fumes, nitrogen dioxide.
- Ferrous sulfate crystals decompose into ferric oxide, sulfur dioxide, and sulfur trioxide.
- Thermal decomposition, carried out by heating, is another important process.
- Silver chloride's color changes when exposed to sunlight.
- Decomposition reactions require energy to break down reactants.
- Displacement reactions involve iron displaced or removed another element, copper, from the copper sulfate solution.
- Double displacement reaction occurs when sodium sulfate and barium chloride are mixed, forming a white precipitate.
- Oxidation and reduction reactions occur when a substance gains or loses oxygen during a reaction.
- Corrosion is a process where a metal is attacked by substances around it, causing damage to metal objects.
- Rancidity is the change in smell and taste of fats and oils when they are oxidized.
- Antioxidants are added to foods containing fats and oils to slow down oxidation.
- Combination reactions combine two or more substances to form a white substance.