Chapter 5

CHEMICAL REACTIONS

STUDENTS' LEARNING OUTCOMES

After studying this chapter, students will be able to:

- ☑ Define chemical reactions and give examples.
- ☑ Explain the rearrangement of atoms in chemical reactions.
- ☑ Explain the balancing of a chemical equation.
- ☑ Define the law of conservation of mass.
- ☑ Identify the nature of chemical changes in various reactions.
- ☑ Describe changes in the states of matter in a chemical reaction.
- ☑ Explain the types of chemical reactions with examples.
- ☑ Explain the energy changes in chemical reactions.
- ☑ Describe the importance of exothermic reactions in daily life.

We have already learnt about elements and compounds which are the examples of pure matter. The substances such as hydrogen (H_2), oxygen (O_2) etc. are the elements while water (H_2O), carbon dioxide (CO_2), etc., are the compounds. It is our daily observation that water can be changed into ice. It can also be changed into steam. During both these changes, chemical composition of water (H_2O) and its chemical properties are not changed. It means that liquid water, ice and steam are the three physically different forms of the same substance, i.e., water (H_2O). On the other hand, when we pass electricity through acidified water (H_2O), it changes into hydrogen (H_2) and oxygen (O_2) which are entirely different substances with different chemical compositions and chemical properties. Such a change in a substance during which entirely new substances with different chemical compositions and properties are formed is called a chemical change. A chemical change is always brought about by a chemical reaction. In this chapter, we will learn further about chemical reactions.

5.1 Chemical Reactions

We deal with a large number of chemical reactions in our daily life. During these reactions, atoms present in different substances rearrange themselves form new substances. Burning of coal and natural gas (methane) in air are well known examples of chemical reactions. Chemically coal is carbon (c). It exists in solid state and is black in colour. Its burning in air is in fact a chemical reaction of carbon with oxygen of the air to form carbon dioxide (CO_2). Carbon dioxide is a colourless gas. Its chemical composition and chemical properties are entirely different from those of carbon and oxygen. The rearrangement of atoms that takes place during this chemical reaction can be represented as follows in Figure 5.1.

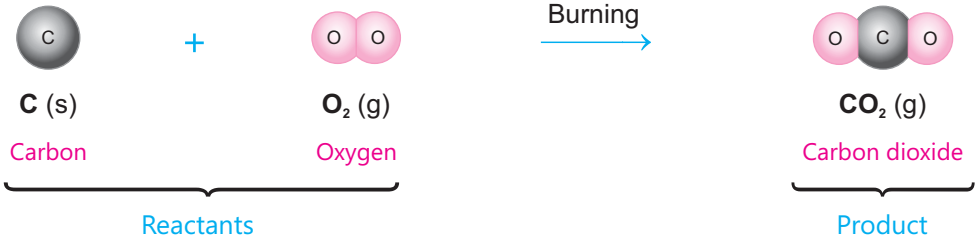


Figure 5.1: Rearrangement of atoms during chemical reaction of carbon with oxygen

Substances which take part in a chemical reaction are called **reactants** and those which are formed as a result of the reaction are called **products**.

When methane burns in air, carbon dioxide and water are formed. During the rearrangement of atoms in burning of methane (natural gas), carbon atom of methane gets attached with two oxygen atoms to give carbon dioxide while hydrogen atoms attach themselves with oxygen atom to give water vapours (Figure 5.2).

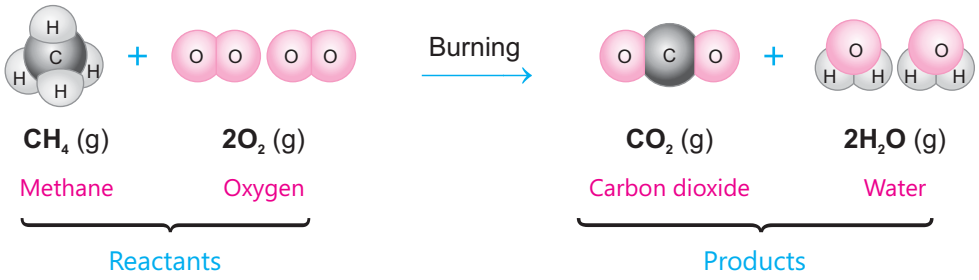


Figure 5.2: Rearrangement of atoms during chemical reaction of methane with oxygen

The rearrangement of atoms during the chemical reaction of hydrogen with oxygen to form liquid water is shown below in Figure 5.3.

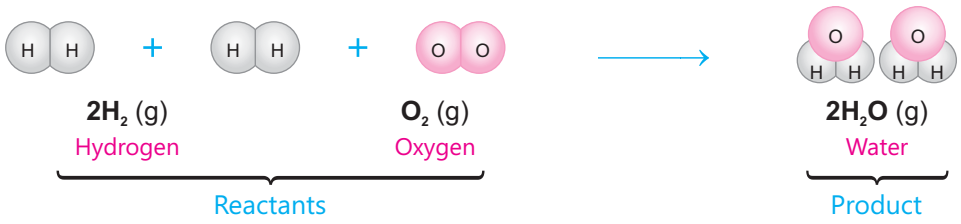


Figure 5.3: Rearrangement of atoms during chemical reaction of hydrogen with oxygen

5.1.1 Applications of Chemical Reactions

Burning, respiration and photosynthesis, etc., are the examples of chemical reactions which take place everywhere in our environment. Fuel (natural gas or petrol, etc.) on its burning in vehicle engine produces different gases. The gases so produced develop pressure to move the piston in the engine and to run the vehicle. Heat produced during burning of fuel in our kitchens is used to cook food. Similarly, heat produced during burning of fuel in industries is used to produce steam from water.

During photosynthesis in plants, carbon dioxide (CO_2) and water (H_2O) react to produce glucose ($C_6H_{12}O_6$). This reaction takes place in the presence of sunlight and green pigment chlorophyll.

$$6CO_{2\,(g)} + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_{6\,(aq)} + 6O_{2\,(g)}$$

Carbon dioxide — Water — Glucose — Oxygen

During respiration, the oxygen of air reacts with food (glucose) to produce, carbon dioxide and water in the cells of living organisms. The energy produced during this reaction is used to perform all the body functions in living organisms.

$$C_6H_{12}O_{6\,(s)} + 6O_{2\,(g)} \longrightarrow 6CO_{2\,(g)} + 6H_2O + \text{Energy}$$

Glucose — Oxygen — Carbon dioxide — Water

Conversion of milk into yogurt and formation of baking products involve the chemical changes which are brought about by microorganisms. Such chemical changes or reactions are called fermentation reactions.

Activity 5.1

Apparatus / Material required

China dish, burner, tripod stand, sulphur powder, iron turnings

Procedure

- Take a few iron turnings and a small amount of sulphur powder in a china dish.
- Heat the contents of china dish for a few minutes as shown in the figure.
- Stop heating and observe the contents in the china dish.
- Record your observation.

We will learn from the activity 5.1 that iron (Fe) reacts with sulphur (S) on heating. The result of this reaction is the formation of a black mass of iron sulphide.

$$\underset{\text{Iron}}{Fe_{(s)}} + \underset{\text{Sulphur}}{S_{(s)}} \longrightarrow \underset{\text{Iron sulphide}}{FeS_{(s)}}$$

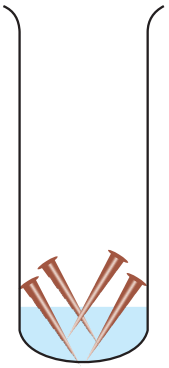
Activity 5.2

Apparatus / Material required

Test tube, iron nails and water

Procedure

- Take some iron nails in the test tube.
- Add a little water in the test tube in such a way that the iron nails are not fully dipped as shown in the figure.
- Leave the nails in the test tube partially dipped in water.
- Observe the nails after two days.
- Record your observation.



We will learn from the activity 5.2 that iron (Fe) reacts with oxygen of the air to form iron oxide (Fe_2O_3). The reaction is called rusting of iron and it takes place in the presence of moisture.

$$\underset{\text{Iron}}{4Fe_{(s)}} + \underset{\text{Oxygen}}{3O_{2\,(g)}} \longrightarrow \underset{\text{Iron oxide}}{2Fe_2O_{3\,(s)}}$$

5.2 Chemical Equations and their Balancing

A chemical equation is the representation of a chemical reaction in terms of symbols, formulae and signs, etc. In a chemical equation the reactants and products are separated by an arrow. Symbols and formulae of the reactants are written on the left hand side of the arrow whereas the products are written on the right hand side of the arrow. The arrow is directed towards the products. Physical states of reactants and products are also expressed along with their formulae or symbols by (s), (g) and (aq) which stand for solid, gas and aqueous states respectively. For example; the chemical equation representing the reaction of sulphur with oxygen to from sulphur dioxide is written as follows.

$$S_{(s)} + O_{2\,(g)} \longrightarrow SO_{2\,(g)}$$

Sulphur Oxygen Sulphur dioxide

The chemical equation written above shows that sulphur in its solid state reacts with oxygen gas. The product of the reaction, i.e., sulphur dioxide is also a gas. The signs (s) and (g) indicate the physical states of the reactants and the products.

Similarly, the chemical equation given below indicates that zinc in its solid state reacts with aqueous solution of sulphuric acid and produces aqueous solution of zinc sulphate and hydrogen gas.

$$Zn_{(s)} + H_2SO_{4\,(aq)} \longrightarrow ZnSO_{4\,(aq)} + H_{2\,(g)}$$

Zinc Sulphuric acid Zinc sulphate Hydrogen

5.2.1 Balancing the Chemical Equation

The chemical equation in which the number of atoms of each element on both sides of the equation, i.e., reactant side and product side are equal is called a balanced chemical equation. For example, the chemical equation shown below is a balanced chemical equation.

$$Hcl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O$$

The chemical equation in which the number of atoms of each element on both sides of the equation, i.e., reactant side and product side is not equal is called an unbalanced chemical equation. For example, the chemical equation given below is an unbalanced chemical equation.

$$H_{2\,(g)} + Cl_{2\,(g)} \longrightarrow HCl_{(g)}$$

Unbalanced equations can be balanced by different methods. The trial and error method is commonly used. According to this method, trial and error process of adjusting coefficients before symbols or formulae is continued till the number of atoms of each element on both sides of the equation becomes equal.

The working rules for balancing a chemical equation are as follows:

(i) Write the unbalanced equation and count the number of atoms of each element on both sides of the arrow.

(ii) Work with one element at a time.

(iii) Multiply the symbol or formula with suitable integers (2, 3, 4, 5, etc.) on that side of the equation where the number of atoms of a particular element is less and try to balance this element on both sides of the equation. Start multiplying with relatively small numbers.

(iv) Repeat the process for all the elements one by one.

(v) Balance the diatomic molecules like H_2, N_2, O_2, Cl_2, etc. at the end.

Some examples for balancing the equation are given below:

Example 1

Consider the following equation:

$$N_{2(g)} + H_{2(g)} \longrightarrow NH_{3(g)}$$

Step I

Count the number of atoms of each element on both sides of the arrow.

Reactants	Products	Balanced/Unbalanced
2 N atoms	1 N atom	N is unbalanced
2 H atoms	3 H atoms	H is unbalanced

Step II

Add appropriate coefficient to balance N:

$$N_{2(g)} + H_{2(g)} \longrightarrow 2NH_{3(g)}$$

Reactants	Products	Balanced/Unbalanced
2 N atoms	2 N atoms	N is balanced
2 H atoms	6 H atoms	H is unbalanced

Step III

Now try to balance H atoms.

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

Reactants	Products	Balanced/Unbalanced
2 N atoms	2 N atoms	N is balanced
6 H atoms	6 H atoms	H is balanced

Thus the equation is balanced.

Example 2

$$CH_{4(g)} + O_{2(g)} \longrightarrow H_2O_{(g)} + CO_{2(g)}$$

Step I

Count the number of atoms of each element or compound on both sides of the arrow:

Reactants	Products	Balanced/Unbalanced
1 C atom	1 C atom	C is balanced
4 H atoms	2 H atoms	H is unbalanced
2 O atoms	3O atoms	O is unbalanced

Step II

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow 2H_2O_{(g)} + CO_{2(g)}$$

Add appropriate coefficients:

Reactants	Products	Balanced/Unbalanced
1 C atom	1 C atom	C is balanced
4 H atoms	4 H atoms	H is balanced
4 O atoms	4O atoms	O is balanced

Thus the equation is balanced.

Example 3

$$CaCl_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow CaCO_{3(s)} + NaCl_{(aq)}$$

Step I

Count the number of atoms of each element or compound on both sides of the arrow.

Reactants	Products	Balanced/Unbalanced
1 Ca atom	1 Ca atom	Ca is balanced
2 Cl atoms	1 Cl atom	Cl is unbalanced
2 Na atoms	1 Na atom	Na is unbalanced
1 C atom	1 C atom	C is balanced
3 O atoms	3 O atoms	O is balanced

Step II

Add appropriate coefficients to balance Na and Cl.

$$CaCl_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow CaCO_{3(s)} + 2NaCl_{aq)}$$

Reactants	Products	Balanced/Unbalanced
1 Ca atom	1 Ca atom	Ca is balanced
2 Cl atoms	2 Cl atoms	Cl is balanced
2 Na atoms	2 Na atoms	Na is balanced
1 C atom	1 C atom	C is balanced
3 O atoms	3 O atoms	O is balanced

Thus the equation is balanced.

Mini Exercise

Balance the following equations.

$$Fe_{(s)} + Cl_{2(g)} \longrightarrow FeCl_{3(s)}$$

$$Al_{(s)} + O_{2(g)} \longrightarrow Al_2O_{3(s)}$$

$$Na_2CO_{3(aq)} + HClO_{3(aq)} \longrightarrow NaClO_{3(aq)} + CO_{2(g)} + H_2O$$

$$CO_{2(g)} + H_2O \longrightarrow C_6H_{12}O_{6(aq)} \quad O_{2(g)}$$

5.3 Law of Conservation of Mass (Matter)

Law of conservation of mass was put forward by a French Chemist Lavoisier in 1785. This law states that during a chemical reaction, mass is neither created nor destroyed but it changes from one form to another. In other words during a chemical reaction, total mass of the products is equal to the total mass of the reactants.

Activity 5.3

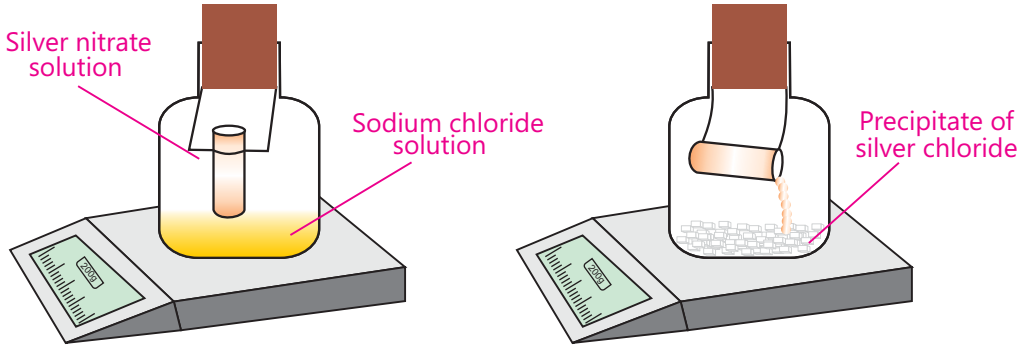
Apparatus / Material Required

Conical flask, weight balance, sodium chloride solution, silver nitrate solution

Procedure

- Take a small amount of sodium chloride solution in a conical flask and silver nitrate solution in a small test tube.
- Place the test tube (containing silver nitrate solution) in the flask along its wall in such a way that two solutions do not mix with each other.

- Seal the flask with a cork and weigh it along with its contents.
- Shake the test tube in the flask and allow the two solutions to mix with each other.
- Observe what happens when two solutions mix with each other and record your observation.
- Weigh the flask again and note whether both the weights are equal or not.



Through the activity 5.3 we observe the formation of white precipitate of silver chloride (AgCl) as a product of the reaction between sodium chloride (NaCl) and silver nitrate ($AgNO_3$) solutions. The balanced chemical equation for the reaction is as follows:

$$AgNO_{3\,(aq)} + NaCl_{\,(aq)} \longrightarrow AgCl_{\,(s)} + NaNO_{3\,(aq)}$$

We also notice that during a chemical reaction total mass of the products is equal to the total mass of reactants. This verifies the law of conservation of mass.

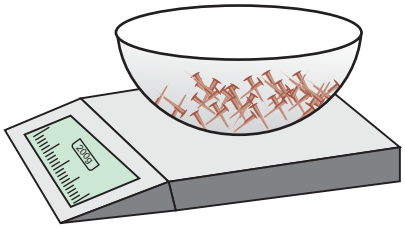
Activity 5.4 - Higher Order Thinking

Apparatus / Material Required

China dish and pieces of iron

Procedure

- Take some iron nails in the china dish.
- Weigh the china dish along with iron nails with the help of an electric balance.
- Place the china dish containing iron nails in a bathroom for five days.
- Weigh the china dish along with iron nails again after five days.
- Note whether the weight (mass) of the iron nails increases, decreases or does not change after keeping them in the bathroom.



Explain the phenomenon taking place in the china dish.

5.4 Types of Chemical Reactions

Thousands of chemical reactions are taking place all the time in the world. They are classified into different types. Here we will discuss only two types, i.e., addition reactions and decomposition reactions.

5.4.1 Addition Reactions

The chemical combination of two or more substances to form one compound is called addition reaction. The following are the examples of addition reactions:

$2H_2$ (g)	+	O_2 (g)	⟶	$2H_2O$ (g)
Hydrogen		Oxygen		Water
H_2 (g)	+	Cl_2 (g)	⟶	2HCl (g)
Hydrogen		Chlorine		Hydrogen chloride
N_2 (g)	+	$3H_2$ (g)	⟶	$2NH_3$ (g)
Nitrogen		Hydrogen		Ammonia
2Mg (s)	+	O_2 (g)	⟶	2MgO (s)
Magnesium		Oxygen		Magnesium oxide
2Na (s)	+	Cl_2 (g)	⟶	2NaCl (s)
Sodium		Chlorine		Sodium chloride
CaO (s)	+	CO_2 (g)	⟶	$CaCO_3$ (s)
Calcium oxide		Carbon dioxide		Calcium carbonate

5.4.2 Decomposition Reactions

A chemical reaction during which a compound splits up into two or more simple substances is called a decomposition reaction. Usually heat is required to bring about decomposition of compounds. The following are some examples of decomposition reactions.

$2KClO_3$ (s)	Heat ⟶	2KCl (s)	+	$3O_2$ (g)
Potassium chlorate		Potassium chloride		Oxygen
$CaCO_3$ (s)	Heat ⟶	CaO (s)	+	CO_2 (g)
Calcium carbonate		Calcium oxide		Carbon dioxide

$$2Pb(NO_3)_{2\,(s)} \xrightarrow{Heat} 2PbO_{(s)} + 4NO_{2\,(g)} + O_{2\,(g)}$$

Lead nitrate — Lead oxide — Nitrogen dioxide — Oxygen

5.5 Energy Changes in Chemical Reactions

In order to know about the nature of chemical change in various reactions we need to know about the change in energy of substances. The energy of a substance is a particular amount of energy due to which the structure of the substance remains stable. A substance undergoes a chemical change or chemical reaction when its energy is changed. The change in energy of a substance takes place by absorbing or releasing heat or light. On the basis of the change in energy, chemical reactions can be classified into two types, i.e., exothermic and endothermic reactions.

5.5.1 Exothermic Reactions

Exo means outside and therm means heat. Exothermic reactions are those reactions during which heat is given out. Burning is a common example of exothermic reaction. Fossil fuel (coal, natural gas, etc.) burns in the air to release heat.

$$C_{(s)} + O_{2\,(g)} \longrightarrow CO_{2\,(g)} + Heat$$

$$CH_{4\,(g)} + 2O_{2\,(g)} \longrightarrow CO_{2(g)} + 2H_2O + Heat$$

$$Fe_{(s)} + S_{(s)} \longrightarrow FeS_{(s)} + Heat$$

Fireworks are also the examples of exothermic reactions (Figure 5.4).

Figure 5.4: Fireworks

Activity 5.5 - Exothermic Reaction

Apparatus / Material Required

Beaker, unslaked lime and water

Procedure

- Take a beaker and fill it half with water.
- Add some unslaked lime (CaO) in the beaker and stir it.
- After 20 to 30 seconds, touch the outer sides of the beaker.

What do you feel?

Why does it happen so?

During activity 5.5, sides of the beaker become warm. The heat which makes the mixture in the beaker and sides of the beaker warm is released by exothermic reaction between calcium oxide and water.

$$CaO_{(s)} + H_2O_{(\ell)} \longrightarrow Ca(OH)_{2\,(aq)} + Heat$$

Calcium oxide — Water — Calcium hydroxide

5.5.2 Endothermic Reactions

Endo means inside. The reactions during which heat is absorbed are called endothermic reactions. Thermal decomposition of calcium carbonate to produce carbon dioxide on commercial scale is an endothermic reaction.

$$CaCO_{3\,(s)} + Heat \longrightarrow CaO_{(s)} + CO_{2\,(g)}$$

Calcium carbonate — Calcium oxide — Carbon dioxide

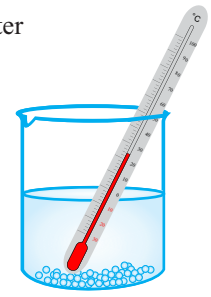
Activity 5.6 - Endothermic Reaction

Apparatus / Material Required

Beaker, sodium carbonate solution, calcium chloride solution, thermometer

Procedure

- Take some sodium carbonate solution in a beaker.
- Insert a thermometer in the solution and note down the temperature.
- Mix calcium chloride solution in it.
- Note down the temperature again after mixing.



Why does it happen so?

During activity 5.6, you will feel that the sides of the beaker become cold. This is because an endothermic reaction takes place by absorbing heat from the surrounding walls of the beaker.

$$\underset{\text{Calcium chloride}}{CaCl_2\,(aq)} + \underset{\text{Sodium carbonate}}{Na_2CO_3\,(aq)} + \text{Heat} \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3\,(s)} + \underset{\text{Sodium chloride}}{2NaCl\,(aq)}$$

Formation of nitric oxide from nitrogen and oxygen and hydrogen iodide from hydrogen and iodine are also the examples of endothermic reactions.

$$\underset{\text{Nitrogen}}{N_2\,(g)} + \underset{\text{Oxygen}}{2O_2\,(g)} + \text{Heat} \longrightarrow \underset{\text{Nitric oxide}}{2NO_2\,(g)}$$

$$\underset{\text{Hydrogen}}{H_2\,(g)} + \underset{\text{Iodine}}{I_2\,(g)} + \text{Heat} \longrightarrow \underset{\text{Hydrogen iodide}}{2HI\,(g)}$$

5.5.3 Importance of Exothermic Reactions in Daily Life

Exothermic reactions have great importance in our daily life. They are extensively used to fulfill our needs of heat energy for various purposes. The heat released during burning of fuel at our homes is used for cooking food and to warm our rooms. The heat released during burning of petrol or diesel in the vehicle engine increases pressure of the products (gases) to push and move the piston in the cylinder. The force of the piston turns the wheels and makes the vehicle move.

Heat produced by the burning of fuel in thermal power stations is used in generating electricity. Heat produced during digestion of food in our body keeps us warm and alive. Ignition of dynamite and gunpowder are also highly exothermic reactions and are termed as explosions. Such explosions are used for blasting in mines.

KEY POINTS

- The process during which a substance changes into entirely new substance with different chemical composition and properties is called chemical reaction.
- During chemical reactions, atoms present in different substances are rearranged to form new substances.
- The substances which take part in a chemical reaction are called reactants and those which are formed as a result of the reaction are called products.
- The representation of a chemical reaction in terms of symbols, formulae and signs used for indicating physical states of the substances is called chemical equation.
- The use of co-efficients to balance the number of different types of atoms in a chemical equation is called the balancing of chemical equation.
- Law of conservation of mass states that during a chemical reaction, the total mass of the reactants is equal to the total mass of the products.
- Addition reactions involve the chemical combination of two or more substances to form one compound.
- A chemical reaction which involves the splitting up of one compound into two or more simple substances is called decomposition reaction.
- The chemical reactions during which heat is evolved are called exothermic reactions.
- The chemical reactions during which heat is absorbed are called endothermic reactions.
- Heat evolved during exothermal reaction is used to cook food, drive vehicles and generate electricity.

QUESTIONS

5.1 Encircle the correct option.

(i) Carbon burns in air to release energy along with the formation of:

a. carbon dioxide. b. carbon dioxide and water.
c. carbon dioxide and hydrogen d. carbon monoxide and water.

(ii) The products of the reaction between zinc and dilute sulphuric acid are:

a. Zinc oxide and water b. Zinc sulphide and water
c. Zinc sulphate and hydrogen. d. Zinc sulphide and hydrogen

(iii) Which of the following is an unbalanced chemical equation?

a. $CH_{4(g)} + 2O_{2(g)} \longrightarrow 2H_2O_{(g)} + CO_{2(g)}$

b. $Na_{(s)} + Cl_{2(g)} \longrightarrow NaCl_{(s)}$

c. $C_{(s)} + Cu_2O_{(s)} \longrightarrow CO_{(g)} + 2Cu_{(s)}$

d. $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$

(iv) Heating of solid potassium chlorate produces a gas:

a. chlorine. b. carbon dioxide.

c. carbon monoxide. d. oxygen.

(v) Which of the following is an exothermic reaction?

a. Formation of iron sulphide by heating the mixture of iron and sulphur.

b. Formation of nitric oxide by heating the mixture of nitrogen and oxygen.

c. Formation of hydrogen iodide by heating the mixture of hydrogen and iodine.

d. Formation of calcium oxide and carbon dioxide by heating calcium carbonate.

(vi) Which of the following is a balanced chemical equation?

a. $Fe + 3Cl_2 \longrightarrow 2FeCl_3$ b. $Fe + 3Cl_2 \longrightarrow FeCl_3$

c. $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$ d. $Fe + Cl_2 \longrightarrow FeCl_3$

(vii) The following equation is properly balanced when:

$x\,CO_{(g)} + y\,O_{2(g)} \longrightarrow z\,CO_{2(g)}$

a. x = 1, y = 2 and z = 3 b. x = 2, y = 1 and z = 1

c. x = 2, y = 2 and z = 2 d. x = 2, y = 1 and z = 2

(viii) How many oxygen atoms are present in one molecule of $Mg(HCO_3)_2$?

a. 2. b. 4.

c. 6. d. 8.

(ix) The reaction between calcium oxide and carbon dioxide to form calcium carbonate is an example of:

a. addition reaction b. decomposition reaction

c. acid-base reaction d. neutralization reaction

(x) Thermal decomposition of calcium carbonate produces a gas:

a. oxygen b. carbon dioxide

c. nitrogen d. carbon monoxide

5.2 Answer the following questions briefly.

(i) Define a chemical reaction.

(ii) What are reactants?

(iii) What are products?

(iv) What is a chemical equation?

(v) State the law of conservation of mass.

5.3 Differentiate between the following.

(i) Addition reaction and decomposition reaction.

(ii) Balanced chemical equation and unbalanced chemical equation.

(iii) Exothermic reaction and endothermic reaction.

5.4 Complete and balance the following incomplete equations.

(i) $Mg_{(s)} + O_{2(g)} \longrightarrow$

(ii) $CH_{4(g)} + O_2(g) \longrightarrow$

(iii) $Fe_{(s)} + S_{(s)} \longrightarrow$

(iv) $N_{2(g)} + H_{2(g)} \longrightarrow$

(v) $Na_{(s)} + Cl_{2(g)} \longrightarrow$

5.5 Balance the following equations.

(i) $Ca(HCO_3)_2 + HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

(ii) $NaBr + Cl_2 \longrightarrow NaCl + Br_2$

(iii) $Fe + O_2 \longrightarrow Fe_2O_3$

(iv) $NH_4OH + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_2O$

(v) $Zn + HCl \longrightarrow ZnCl_2 + H_2$

5.6 When coal burns, it leaves ash behind. Ash so produced is lighter than the coal which has burnt. Justify the decrease in mass in the light of law of conservation of mass.

5.7 Write at least two examples of the following chemical reactions.

(i) Addition reaction (ii) Decomposition reaction

(iii) Exothermic reaction (iv) Endothermic reaction

5.8 How do the following reactants react together? Write down complete reactions and balance the resulting equations.

(i) Iron + Hydrochloric acid

(ii) Calcium oxide + Carbon dioxide

(iii) Carbon monoxide + Oxygen

(iv) Methane + Oxygen

(v) Carbon dioxide + Water

5.9 Describe the applications of chemical reactions.

5.10 Write down the rules for balancing chemical equations.

5.11 Describe the importance of exothermic reactions in everyday life.

5.12 Give two examples of chemical reactions from everyday life which are essential for life.