

Chapter 5

Language of Chemistry

Chapter Objectives

In this chapter, you will learn about:

- ◆ Chemical reactions and chemical equations
- ◆ Characteristics of chemical reactions
- ◆ Writing chemical equations

Why does lime water turn milky when carbon dioxide is passed through it? What happens when coal is burnt? What happens when a substance undergoes a chemical change? Discuss in class.

CHEMICAL REACTIONS

We have learnt that there are different changes that take place almost at all times around us. These changes may be physical or chemical. The changes in which the chemical composition of a substance changes completely and forms a new substance, as a result, are called **chemical changes**.

A **chemical reaction** is a chemical change where different substances react and their chemical composition changes to form a new substance as a **product**. During a chemical reaction, the reacting substances also called **reactants**, interact with each other chemically and energy transfer takes place to form product(s).

During a chemical reaction, two or more substances may react to form one or more than one product.

On the basis of the chemical change that reactants undergo, chemical reactions can be of different types:

- **Synthesis or combination reaction:** In this type of reaction, two or more reactants combine together to form a new product.

- **Decomposition reaction:** In this type of reaction, a single compound breaks down to form two or more simpler substances.
- **Displacement reaction:** In a displacement reaction, a more reactive substance displaces a less reactive substance from the compound.
- **Double displacement reaction:** In this type of reaction, two substances react with each other to form two new products.
- **Neutralisation reaction:** In this reaction, an acid and a base react to form a neutral product.

You will study about details of all these types of chemical reactions in higher classes.

Characteristics of Chemical Reactions

How do you think we can identify whether a reaction is a chemical reaction?

When a chemical reaction takes place, a number of changes occur that can be observed and that help in the identification of a chemical reaction.

Some of the characteristics of occurrence of chemical reactions are discussed here.

- Change in colour of the substance. For example, during the process of rusting, a reddish-brown powdery substance forms on the iron material.
- Change in the state of the reactants.
- Change in the smell.
- Evolution of gas.
- Formation of precipitate.
- Evolution or absorption of heat.

Let us perform a few activities to understand some characteristics of chemical reactions.



Fig. 5.1 Change in colour during rusting (chemical reaction)



Fig. 5.2 Precipitate formed during a chemical reaction

ACTION TIME 1

Aim: To demonstrate change in smell during a chemical reaction.

Materials required: dilute sodium hydroxide (dil. NaOH), ammonium chloride (NH_4Cl), dilute hydrochloric acid (dil. HCl), Bunsen burner, test tube, test tube holder, spatula, dropper

Procedure:

1. Hold a test tube with the test-tube holder and add some ammonium chloride using a spatula in it. Also, add a few drops of dilute NaOH to it and heat it over the Bunsen burner.
2. Now, using a dropper, carefully add dilute HCl into the test tube.
3. Observe the change that takes place.

Observation: A foul smell is liberated when the test tube is heated.

Conclusion: The foul smell indicates the formation of ammonia (NH_3) gas. The product (NH_3) is chemically different than the reactants (NH_4Cl , NaOH, HCl). Hence, this is a chemical reaction.

ACTION TIME 2

Aim: To show that gas is evolved during a chemical reaction.

Materials required: dilute HCl, solid sodium carbonate, test tubes, test-tube holder, dropper, spatula

Procedure:

1. Hold a test tube with the test tube holder and add some solid sodium carbonate into a test tube using a spatula.
2. Now, using a dropper, carefully add dilute HCl in the test tube and observe.

Observation: Gas is released from the solution.

Conclusion: When dil. HCl is added to sodium carbonate, a chemical reaction takes place which produces carbon dioxide gas and water.

ACTION TIME 3

Aim: To demonstrate the formation of precipitate during a chemical reaction.

Materials required: lead acetate, potassium iodide (KI), test tube

Procedure: Mix some lead acetate and potassium iodide in a test tube. Observe the change.

Observation: Yellow-coloured precipitate is formed.

Conclusion: Lead acetate and potassium iodide react chemically and form a yellow-coloured precipitate (lead iodide). This shows occurrence of a chemical reaction.



ACTION TIME 4

Aim: To demonstrate evolution of heat during a chemical reaction.

Materials required: dilute sodium hydroxide (dil. NaOH), dilute hydrochloric acid (dil. HCl), test tube, laboratory thermometer, dropper, test-tube stand

Procedure: Take a dry and clean test tube in a test-tube stand. Add 2 ml of HCl in the test tube and take the temperature of the acid using a thermometer and note it down. Now, add 2 ml of sodium hydroxide in the test tube containing HCl. Again, using the thermometer, record the temperature.

Observation: The test tube became hot on adding sodium hydroxide due to increase in temperature.

Conclusion: A neutralisation reaction took place, as sodium hydroxide reacted with HCl and resulted in the formation of sodium chloride and water.

The temperature of the solution increased, as it is an exothermic reaction and heat was evolved.

Quick Check 1

State whether the following statements are True (T) or False (F).

1. In a decomposition reaction, two or more reactants combine together to form a new product.
2. A more reactive substance displaces a less reactive substance in a displacement reaction.
3. In a precipitation reaction of lead acetate and potassium iodide, a blue-coloured precipitate is formed.
4. Evolution of gas is one of the characteristics of chemical equations.
5. In a double displacement reaction, one substance breaks to form two new products.

CHEMICAL EQUATIONS

The *chemical equations* are the representation of the reactants and products involved in chemical reactions using words or their respective symbols and formulae. A word equation is written using the names of the reactant and products, and a chemical equation is written by using the symbols and formulae of the reactants and products in the chemical reaction.

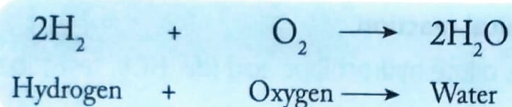
A simple equation can be written as:



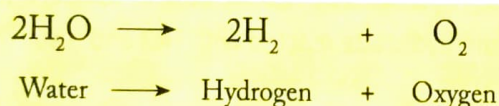
The substances that react together in a chemical reaction are called **reactants** and the substances formed as a result of the chemical reactions are called **products**. In the above equation, A and B are reactants while C and D are products. While

writing a chemical equation, the reactants are always written on the left-hand side and products are written on the right-hand side. The arrow between the reactants and products represents the direction in which the chemical reaction is taking place.

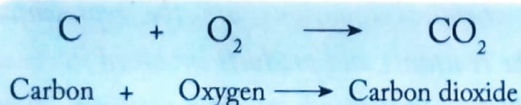
Example 1: Chemical reaction between hydrogen and oxygen (reactants) produces water (product). The word and the chemical equation for this chemical reaction can be represented as:



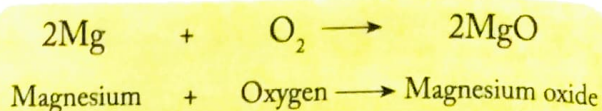
Example 2: The word and the chemical equation for the decomposition reaction of water into hydrogen and oxygen can be written as:



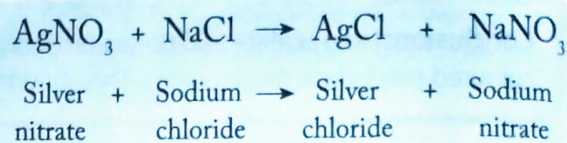
Example 3: The word and the chemical equation for the chemical reaction involved in the formation of carbon dioxide can be represented as:



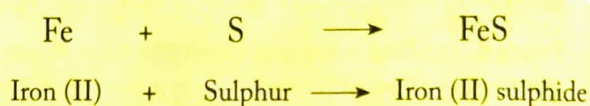
Example 4: The word and the chemical equation for a reaction between magnesium and oxygen can be written as:



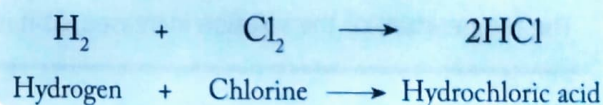
Example 5: The word and the chemical equation for a double displacement reaction between silver nitrate and sodium chloride can be written as:



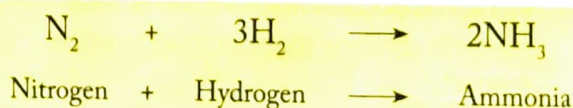
Example 6: The word and the chemical equation for the combination reaction between iron and sulphur can be written as:



Example 7: The word and the chemical equation for a reaction between hydrogen and chlorine can be written as:



Example 8: The word and the chemical equation for a combination reaction between nitrogen and hydrogen can be written as:



Quick Check 2

1. Write the following word equations in terms of symbols and formulae:

- Carbon dioxide + Water \longrightarrow Carbonic acid
- Iron + Sulphur \longrightarrow Iron sulphide
- Magnesium + Chlorine \longrightarrow Magnesium chloride

2. Write the word equations for the following reactions:

- $3\text{Mg} + \text{N}_2 \longrightarrow \text{Mg}_3\text{N}_2$
- $\text{Ca} + \text{Cl}_2 \longrightarrow \text{CaCl}_2$
- $4\text{Na} + \text{O}_2 \longrightarrow 2\text{Na}_2\text{O}$

KEY TERMS

Chemical reaction: A chemical change where different substances react and their chemical composition changes to form a new substance as a product

Reactants: The substances that react together in a chemical reaction

Products: The substances formed as a result of a chemical reaction

Chemical equation: It is the representation of the reactants and products involved in chemical reactions using words or their respective symbols and formulae

QUICK NOTES

- * The changes in which the chemical composition of a substance changes completely and forms a new substance as a result are called chemical changes.
- * A chemical reaction is a chemical change where different substances react and their chemical composition changes to form a new substance as a product.
- * During a chemical reaction, two or more substances may react to form one or more than one new substance.
- * The substances that react together in a chemical reaction are called reactants and the substances formed as a result of the chemical reactions are called products.
- * Chemical reactions are characterised by a change in smell, change in state of the reactants, evolution of gas, formation of precipitate and evolution or absorption of heat.
- * The chemical equations are the representation of the reactants and products involved in chemical reactions using words or their respective symbols and formulae.

RUN-THROUGH

I. Very Short Answer Questions.

A. Tick (✓) the correct option.

1. Which sign is used to indicate the direction of a chemical reaction?

- | | | | |
|----------------------|--------------------------|---------------|--------------------------|
| a. \longrightarrow | <input type="checkbox"/> | b. \uparrow | <input type="checkbox"/> |
| c. $>$ | <input type="checkbox"/> | d. $<$ | <input type="checkbox"/> |

2. Which of the following is not a feature of a chemical reaction?

- | | | | |
|-----------------------|--------------------------|---|--------------------------|
| a. Change in smell | <input type="checkbox"/> | b. Evolution or absorption of heat | <input type="checkbox"/> |
| c. Occurrence of rain | <input type="checkbox"/> | d. Occurrence of change in state of the reactants | <input type="checkbox"/> |

3. Which of the following is formed when lead acetate reacts with potassium iodide?

- | | | | |
|-----------------------|--------------------------|----------------------|--------------------------|
| a. Yellow precipitate | <input type="checkbox"/> | b. Brown precipitate | <input type="checkbox"/> |
| c. Green precipitate | <input type="checkbox"/> | d. White precipitate | <input type="checkbox"/> |

4. Complete the chemical reaction: $\text{H}_2 + \text{Cl}_2 \longrightarrow \dots\dots\dots?$

- | | | | |
|--------------------------|--------------------------|----------------------------|--------------------------|
| a. H_2Cl | <input type="checkbox"/> | b. HCl_2 | <input type="checkbox"/> |
| c. 2HCl | <input type="checkbox"/> | d. H_2Cl_2 | <input type="checkbox"/> |

5. Which gas is released when sodium carbonate and diluted hydrochloric acid react?

a. Oxygen

☐

b. Nitrogen

☐

c. Carbon dioxide

☐

d. Hydrogen

☐

B. State whether the following statements are True or False. Correct the false statement.

1. In a chemical equation, the reactants of a chemical reaction are written on the left-hand side.

2. The reactants and products are separated by an arrow.

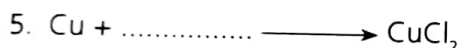
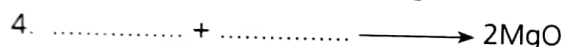
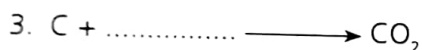
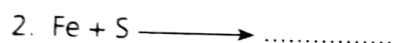
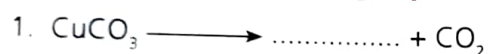
3. During a chemical reaction heat is always evolved.

4. Formation of precipitate is a characteristic feature of a chemical reaction.

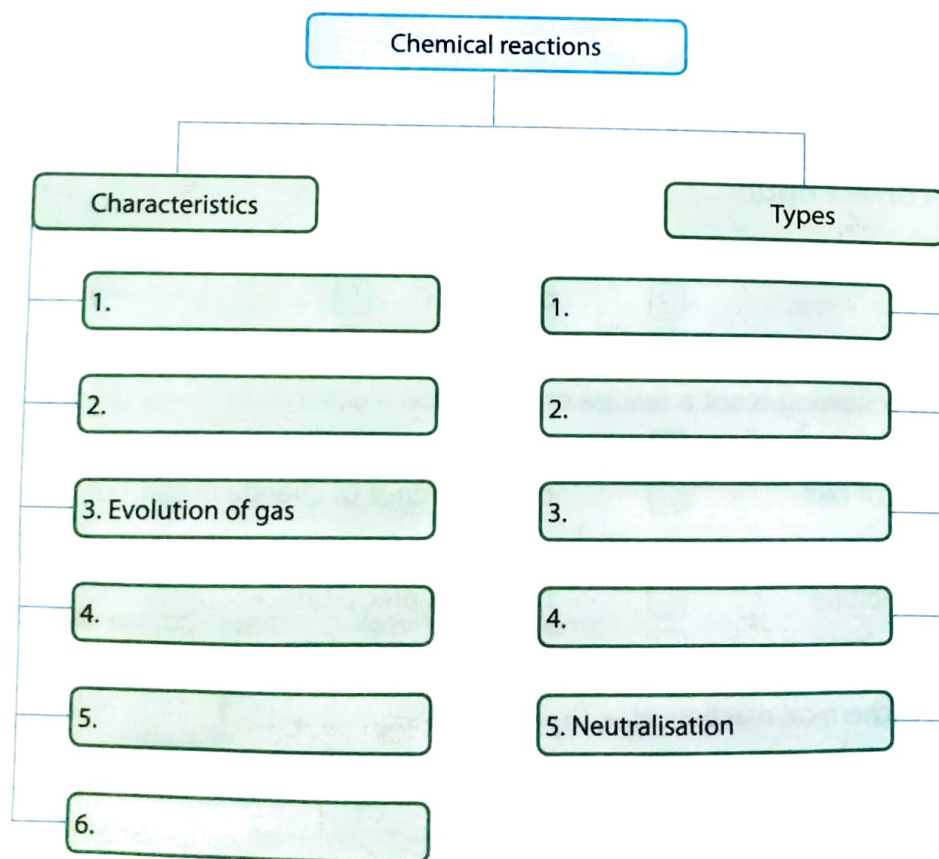
5. There are different types of chemical reactions.

6. A chemical reaction is always represented using the chemical formulae and symbols.

C. Complete the following equations.



D. Complete the concept map.



II. Short Answer Questions.

A. Question and Answers.

1. What is a chemical reaction?
2. What do you understand by a chemical equation?
3. What are the different types of chemical reactions?
4. What are the characteristics of a chemical reaction?

B. Define the following terms.

1. Reactants
2. Products
3. Chemical equation
4. Evolution of gas

III. Long Answer Questions.

1. How can you show that during a chemical reaction:
 - a. Gas is evolved?
 - b. Change in smell takes place?
2. With the help of an activity, show that the formation of precipitate is a characteristic of some chemical reactions.
3. What are chemical equations? How can we write chemical equations? Explain with examples.

IV. Challenge

1. When magnesium is burnt in the presence of oxygen, over a flame, white ash is formed. This process is called oxidation of magnesium.
 - a. Find out what is the ash known as.
 - b. Explain the reaction involved and give the chemical equation for the reaction.
2. Why should we balance a chemical equation?
3. Do the same reactants combine to form the same products?
4. Do all the chemical reactions proceed with the same condition(s) provided to them?
5. In some of the chemical reactions, gas is evolved. Will the law of conservation of energy still hold true in that case?

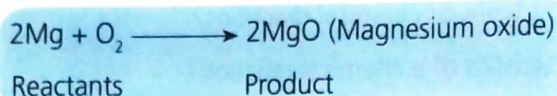
V. Enrichment

- A. **Balancing a Chemical Equation:** When a product is formed from a reactant, changes at the atomic and molecular level take place. But the number of the atoms or molecules does not change. They just reorganise in order to form a new compound. This means that the number of atoms on the reactants' side is equal to the number of atoms on the products' side.

Infact, in a chemical reaction, matter can neither be created nor destroyed. It is just converted from one form to another. Therefore, the total mass of the reactants is equal to the total mass of products. This forms one of the most important laws in chemistry, called the **law of conservation of mass**. This law states that '*Matter can neither be created nor destroyed but can be transformed from one form to another.*'

Hence, it becomes **imperative** to balance a chemical equation, so as to justify the law of conservation of mass. In order to balance a chemical equation, we have to equalise the number of atoms on both the reactant and the product side.

For example, the number of atoms on the reactant side is equal to the number of atoms on the product side in the given reaction. So, it is a balanced chemical equation.



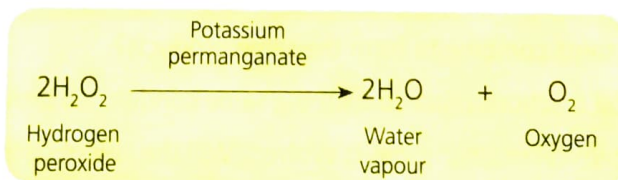
Here, 2 magnesium atoms react with 2 oxygen atoms forming magnesium oxide. This magnesium oxide contains 2 atoms, each of magnesium as well as oxygen.

- B. Speeding up a Chemical Reaction:** A chemical reaction involves a chemical change which happens when two or more particles, which can be molecules, atoms or ions, interact. For example, when iron and oxygen react, they change to a new substance, iron oxide (rust). Iron oxide has different chemical properties than iron and oxygen respectively.

A chemical reaction is the result of collisions between particles (molecules, atoms and ions). According to this collision model, if the collision is strong enough, it can break the chemical bonds in the reactants, resulting in a rearrangement of the atoms to form products. The more the molecules collide, the faster the reaction. Increase in the number of collisions can be produced in two ways: either the concentrations of the reactants are increased, or the temperature is increased. In either case, more molecules are colliding.

The rate of reaction can also be increased by use of a **catalyst**. A catalyst is a substance that speeds up the reaction without participating in it either as a reactant or a product. Catalysts are thus not consumed in the reaction.

For example, a catalyst of potassium permanganate is used to speed up the process, in which hydrogen peroxide is decomposed into water and oxygen gas. Adding potassium permanganate to hydrogen peroxide will cause a reaction that produces a lot of heat, and water vapour will shoot out.

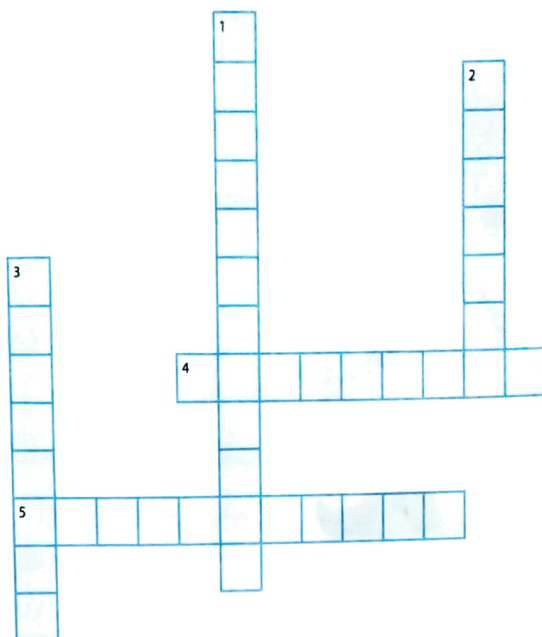


One very important example of a catalyst is an enzyme, which speeds up complex reactions in the human body. At ordinary body temperature, these reactions are too slow, but the enzyme fastens them along. Thus, human life can be said to depend on chemical reactions aided by a form of catalyst.

SCIENCE QUEST

What are redox reactions? Search and write at least two redox reactions. Take help from your teacher in searching books from the library or search on the Internet also.

Solve the crossword.



Across

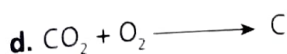
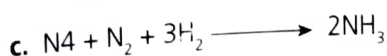
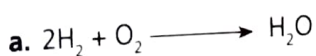
4. These substances react together during a chemical change.
5. In this type of reaction, reactants combine together to form a new product.

Down

1. During reaction, a more reactive substance displaces a less reactive substance.
2. A new substance formed during a chemical change.
3. During a reaction, a substance changes completely and forms a new product.

PICTURE SURVEY

1. What is wrong in the given equations?



2. Which of the following is a characteristic showing that a chemical reaction has taken place?

a.



b.



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