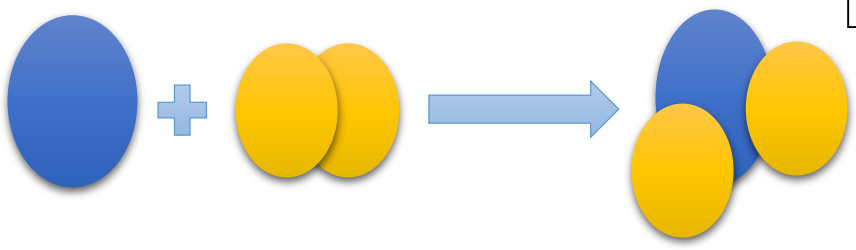
Chemical Equation

"Chemical reactions are represented by chemical equations in which reactants are written on the left side of the arrow and products are written on the right side of the arrow."

- Reactants ⟶ Products

For example: Reaction of Sulphur with oxygen



Sulphur Oxygen Sulphur dioxide

Word Equation:

$S + O_2 \longrightarrow SO_2$

Related SLO

Students' Learning Outcomes

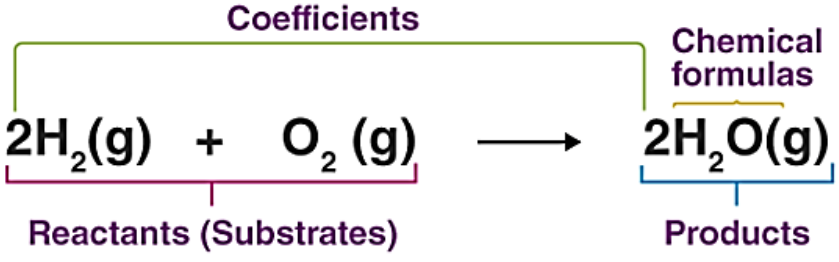
- Write and balance chemical equations.
- Define the law of conservation of mass and demonstrate the law with an experiment.

Exercise based Question

1. What is a chemical equation?
2. Write the rules for balancing equations.
3. How chemical equation is written?

Rules to write a chemical equation:

- **Conservation of Atoms**: The total number and type of atoms must remain the same during the reaction.
- **Correct Symbols and Formulas**: The symbols of elements and the formulas of compounds must be written correctly.
- **Physical States**: The physical states of substances are indicated as solid (s), liquid (l), gas (g), and aqueous solution (aq).
- **Equation Balance**: Identify whether the chemical equation is balanced or not.
- **Balancing Equations**: If the equation is not balanced, balance it by placing coefficients before the formulas of the substances. Note that the number '1' is not written.



Short question

Q: What is the difference between?

Subscript: It is the number written on the right lower corner of a symbol or formula.

Coefficient: It is a number that is placed in front of a chemical symbol or formula.

Exercise based Question

Q: What is trial and error method?

Ans: According to this method, trial and error process of adjusting coefficients before symbols in continued till the number of atoms of each substance on both sides of an equation become equal.

Balanced chemical equation:

A balanced chemical equation has equal number of atoms of each element on both the reactant and product sides of the equation.

Exercise based Question

4. Differentiate between:
Balanced and unbalanced chemical equation.

The balanced nitric oxide-hydrogen reaction

$$2NO_{(g)} + 5H_{2(g)} \longrightarrow 2NH_{3(g)} + 2H_2O_{(g)}$$

	reactants	products
nitrogen	2	2
oxygen	2	2
hydrogen	10	10

Exercise based MCQ's

2. 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. $Fe + Cl_2 \longrightarrow FeCl_3$

Exercise based MCQ's

3. The following equation is properly balanced when:

x CO (g) + y O_2 (g) ⟶ z CO_2

a. x = 1, y = 2, z = 3
b. x = 2, y = 1, z = 1
c. x = 2, y = 2, z = 2
d. x = 2, y = 1, z = 2 ✓

Unbalanced chemical equation:

An unbalanced chemical equation does not have the same number of atoms of each element on both the reactant and product sides.

Unbalanced hydrogen-oxygen reaction

reactants $H_2(g)$ + $O_2(g)$ $\xrightarrow{spark}$ $H_2O(l)$ products

2.0 g 32.0 g 18.0 g

oxygen	2			1 unbalanced
hydrogen	2			2

Exercise based MCQ's

4. Which of the following is an unbalanced chemical equation?

a. $CH_4\,(g) + 2\,O_2\,(g) \longrightarrow 2H_2O\,(g) + CO_2\,(g)$

b. $Na\,(s) + Cl_2\,(g) \longrightarrow NaCl\,(s)$ ✓

c. $C\,(s) + Cu_2O\,(s) \longrightarrow CO\,(g) + 2Cu\,(s)$

d. $C\,(s) + O_2\,(g) \longrightarrow CO_2\,(g)$

Exercise based equations

Complete and balance the following incomplete equations.

a. $2\,Mg_{\,(s)} + O_{2\,(g)} \longrightarrow 2\,MgO_{\,(s)}$

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

c. $Fe_{\,(s)} + S_{\,(s)} \longrightarrow FeS_{\,(s)}$

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

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

Exercise based Equations

Balance the following equations.

a. $Ca(HCO_3)_2 + 2\ HCl \longrightarrow CaCl_2 + 2\ CO_2 + 2\ H_2O$

b. $2\ NaBr + Cl_2 \longrightarrow 2\ NaCl + Br_2$

c. $4\ Fe + 3\ O_2 \longrightarrow 2\ Fe_2O_3$

d. $2\ NH_4OH + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + 2\ H_2O$

e. $Zn + 2\ HCl \longrightarrow ZnCl_2 + H_2$

Exercise based Equations

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

Iron + Hydrochloric acid:

$Fe + 2\ HCl \qquad FeCl_2 + H_2$

Calcium oxide + Carbon dioxide:

$CaO + CO_2 \qquad CaCO_3$

Carbon monoxide + Oxygen:

$2\ CO + O_2 \qquad 2\ CO_2$

Methane + Oxygen:

$CH_4 + 2\ O_2 \qquad CO_2 + 2\ H_2O$

Carbon dioxide + Water:

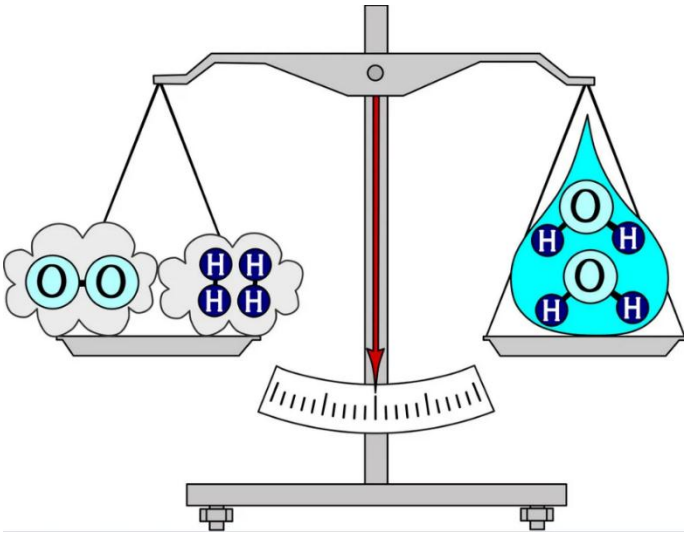
$CO_2 + H_2O \qquad H_2CO_3$

Law of Conservation of Mass (Matter)

While balancing chemical equation, "Law of conservation of mass" is followed.

A French scientist, Antoine Lavoisier proved that experimentally:

Total mass of reactants = Total mass of products



Knowledge based MCQ's

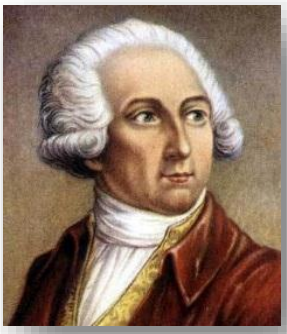
5. Why is it important to balance a chemical equation?

a. To ensure the reactants and products are in the correct state
b. To follow the law of conservation of mass ✓
c. To make the equation more complex
d. To create new elements

From the results of his experiments he presented the "Law of Conservation of Mass".

According to this law:

"Matter can neither be created nor destroyed during a chemical reaction but it may change from one form to another."



INFO

Antoine Lavoisier (1743-1794) was a French scientist.

He is known as the "father of modern chemistry".

Exercise based Question

3. State the law of conservation of mass.

4. Why the mass of ash obtained when a piece of coal is burnt less than the mass of the coal?

Steps to balance a chemical equation

Step 1:

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 2:

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 atom	N is balanced
2 H atoms	6 H atoms	H is unbalanced

Step 3:

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 atom	N is balanced
6 H atoms	6 H atoms	H is balanced

1. Symbols and formulae of reactants are written on the _____ side of equation.			
a. Left	b. Right	c. Center	d. Both
Reason: In a chemical equation, the reactants are written on the left side of the equation, while the products are written on the right side.			
2. Who put forward law of conservation of mass?			
a. Einstein	b. Lavoisier	c. Newton	d. Robert Hooke
Reason: Antoine Lavoisier, a French chemist, is credited with formulating the Law of Conservation of Mass in the late 18th century.			
3. In a chemical reaction, the symbol "s" represent:			
a. Liquid	b. Solid	c. Gas	d. None of these
Reason: In chemical equations, "s" stands for solid, indicating that the substance is in the solid state.			
4. The equation in which number of atoms on both sides are not equal:			
a. Balanced equation	b. Unbalanced equation	c. Standard equation	d. Quadratic equation
Reason: An unbalanced equation is one where the number of atoms of each element is not the same on both sides of the equation.			
5. Law of conservation of mass was put forth in:			
a. 1783	b. 1784	c. 1785	d. 1786
Reason: Antoine Lavoisier published his work on the Law of Conservation of Mass in 1784.			
6. Symbols and formulae of products are witten on the _____ side of equation.			
a. Left	b. Right	c. Center	d. Both
Reason: In a chemical equation, the reactants are written on the left side, and the products are written on the right side of the equation.			
7. We can change the _____ when we balance the equation:			
a. Reactants	b. Products	c. Coefficient	d. Subscript
Reason: To balance a chemical equation, we adjust the coefficients (the numbers placed before the compounds) to ensure the same number of each type of atom on both sides of the equation.			
8. What term is used for the substances that are present before a chemical reaction occurs?			
a. Enzymes	b. Reactants	c. Products	d. Catalyst
Reason: The substances that participate in a chemical reaction and are present before the reaction starts are called reactants.			
9. How many atoms are present in one molecule of $Mg(HCO_3)_2$?			
a. 2	b. 4	c. 6	d. 11

Reason: Total = 1 (Mg) + 2 (H) + 2 (C) + 6 (O) = 11 atoms			
10. During a chemical reaction, the total mass of the products is _____ to the total mass of reactants.			
a. Less	b. greater	c. equal	d. two times
Reason: According to the Law of Conservation of Mass, the total mass of the products in a chemical reaction is equal to the total mass of the reactants.			