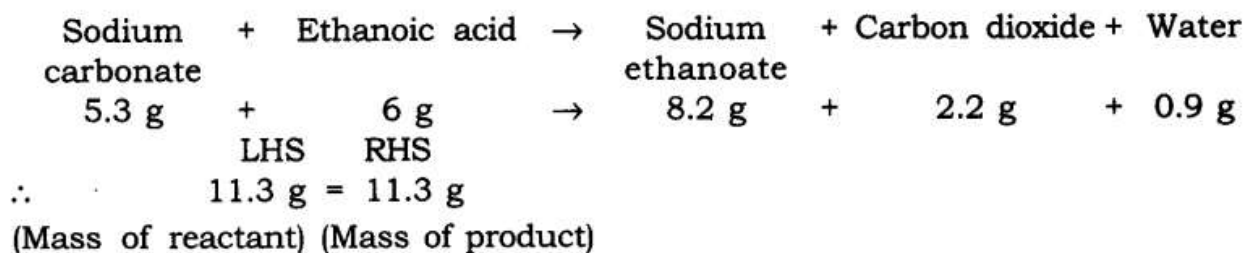


Chapter 3 Atoms and Molecules

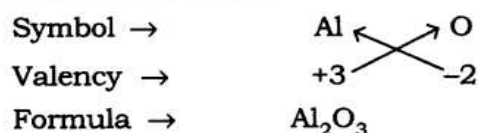
Question 1. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass carbonate.

Answer.



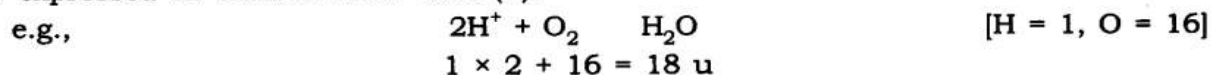
This shows that during a chemical reaction mass of reactant = mass of product.

(b) Aluminium oxide



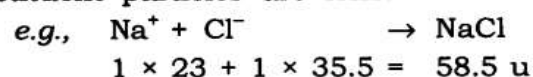
● Molecular Mass

It is the sum of the atomic masses of all the atoms in a molecule of the substance. It is expressed in atomic mass unit (u).



● Formula Unit Mass

It is the sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles are ions.

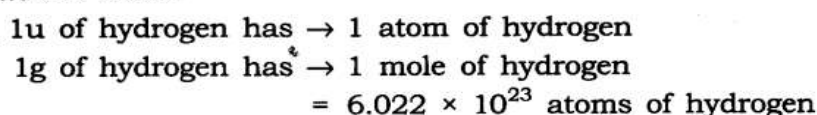


● Mole Concept

Definition of mole: It is defined as one mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.

$$1 \text{ mole} = 6.022 \times 10^{23} \text{ in number}$$

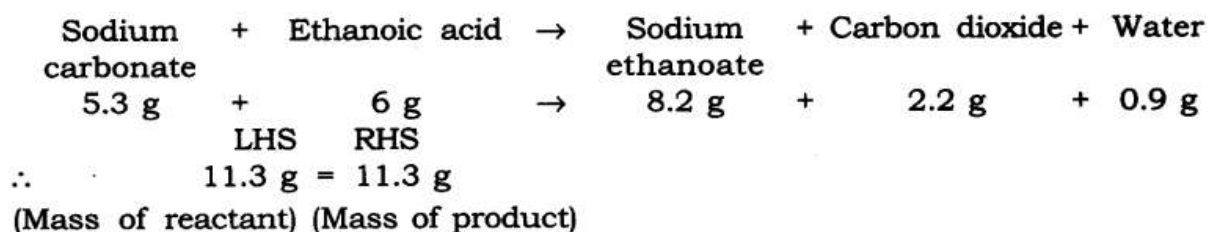
Molar mass = mass of 1 mole → is always expressed in grams, and is also known as gram atomic mass.



Textbook Page 32

Question 1. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass carbonate.

Answer:



This shows that during a chemical reaction mass of reactant = mass of product.

Question 2. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Answer: Ratio of H : O by mass in water is:

Hydrogen : Oxygen → H₂O

∴ 1 : 8 = 3 : x

x = 8 × 3

x = 24 g

∴ 24 g of oxygen gas would be required to react completely with 3 g of hydrogen gas.

Question 3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Answer: The postulate of Dalton's atomic theory that is the result of the law of conservation of mass is—the relative number and kinds of atoms are constant in a given compound. Atoms cannot be created nor destroyed in a chemical reaction.

Question 4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Answer: The relative number and kinds of atoms are constant in a given compound.

Class 9 Science NCERT Textbook Page 35

Question 1. Define the atomic mass unit.

Answer: One atomic mass unit is equal to exactly one-twelfth (1/12th) the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12.

Question 2. Why is it not possible to see an atom with naked eyes?

Answer: Atom is too small to be seen with naked eyes. It is measured in nanometres.

1 m = 10⁹ nm

NCERT Textbook Questions - Page 39

Question 1. Write down the formulae of

(i) Sodium oxide

(ii) Aluminium chloride

(iii) Sodium sulphide

(iv) Magnesium hydroxide

Answer: The formulae are

(i) Formula of Sodium Oxide

Symbol \rightarrow Na $\begin{array}{l} \diagup \text{O} \\ \diagdown \end{array}$

Charge \rightarrow +1 \leftarrow -2

Formula \rightarrow Na₂O

(ii) Formula of aluminium chloride

Symbol \rightarrow Al $\begin{array}{l} \diagup \text{Cl} \\ \diagdown \end{array}$

Charge \rightarrow +3 \leftarrow -1

Formula \rightarrow AlCl₃

(iii) Formula of Sodium Sulfide

Symbol \rightarrow Na $\begin{array}{l} \diagup \text{S} \\ \diagdown \end{array}$

Charge \rightarrow +1 \leftarrow -2

Formula \rightarrow Na₂S

(iv) Formula of magnesium hydroxide

Symbol \rightarrow Mg $\begin{array}{l} \diagup \text{OH} \\ \diagdown \end{array}$

Charge \rightarrow +2 \leftarrow 1

Formula \rightarrow Mg(OH)₂

Question 2. What is meant by the term chemical formula?

Answer: The chemical formula of the compound is a symbolic representation of its composition, e.g., chemical formula of sodium chloride is NaCl.

Question 3. How many atoms are present in a

(i) H₂S molecule and

(ii) PO₄³⁻ ion?

Answer: (i) H₂S \rightarrow 3 atoms are present

(ii) PO₄³⁻ \rightarrow 5 atoms are present

NCERT Textbook Questions - Page 40

Question 1. Calculate the molecular masses of H₂, O₂, Cl₂, CO₂, CH₄, C₂H₂, NH₃, CH₃OH.

Answer: The molecular masses are:

$$\text{H}_2 \Rightarrow 1 \times 2 \rightarrow 2 \text{ u}$$

$$\text{O}_2 \Rightarrow 16 \times 2 \rightarrow 32 \text{ u}$$

$$\text{Cl}_2 \Rightarrow 35.5 \times 2 \rightarrow 71 \text{ u}$$

$$\text{CO}_2 \Rightarrow 1 \times 12 + 2 \times 16 = 12 + 32 = 44 \text{ u}$$

$$\text{CH}_4 \Rightarrow 1 \times 12 + 4 \times 1 = 16 \text{ u}$$

$$\text{C}_2\text{H}_6 \Rightarrow 2 \times 12 + 6 \times 1 = 30 \text{ u}$$

$$\text{C}_2\text{H}_4 \Rightarrow (2 \times 12) + (4 \times 1) = 28 \text{ u}$$

$$\text{NH}_3 \Rightarrow (1 \times 14) + (3 \times 1) = 17 \text{ u}$$

$$\text{CH}_3\text{OH} \Rightarrow 12 + (3 \times 1) + 16 + 1 = 32 \text{ u}$$

Question 2. Calculate the formula unit masses of ZnO, Na₂O, K₂CO₃, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Answer: The formula unit mass of

(i) ZnO = 65 u + 16 u = 81 u

(ii) Na₂O = (23 u \times 2) + 16 u = 46 u + 16 u = 62 u

(iii) K₂CO₃ = (39 u \times 2) + 12 u + 16 u \times 3

= 78 u + 12 u + 48 u = 138 u

Class 9 Science NCERT Textbook Page 42

Question 1. If one mole of carbon atoms weigh 12 grams, what is the mass (in grams) of 1 atom of carbon?

Answer:

:

$$1 \text{ mole of carbon atoms } 6.022 \times 10^{23} \text{ atoms} = 12 \text{ g}$$

$$\text{Mass of 1 atom} = ?$$

$$\begin{aligned} \therefore \text{Mass of 1 atom of carbon} &= \frac{12}{6.022 \times 10^{23}} \\ &= 1.99 \times 10^{-23} \text{ g} \end{aligned}$$

Question 2. Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given atomic mass of Na = 23 u, Fe = 56 u)?

Answer:

:

$$23 \text{ g of Na} = 6.022 \times 10^{23} \text{ atoms (1 mole).}$$

$$\therefore 100 \text{ g of Na} = ?$$

$$= \frac{100 \times 6.022 \times 10^{23}}{23} = \frac{6022}{23} \times 10^{23}$$

$$= 26.182 \times 10^{23} = 2.6182 \times 10^{24} \text{ atoms}$$

$$56 \text{ g of Fe} = 6.022 \times 10^{23} \text{ atoms}$$

$$100 \text{ g of Fe} = ?$$

$$= \frac{100 \times 6.022 \times 10^{23}}{56} = \frac{6022 \times 10^{23}}{56}$$

$$= 10.753 \times 10^{23} = 1.075 \times 10^{24}$$

$$100 \text{ g of Na contain} \rightarrow 2.618 \times 10^{24} \text{ atoms}$$

$$100 \text{ g of Fe contain} \rightarrow 1.075 \times 10^{24} \text{ atoms}$$

\therefore 100 g of Na contains more atoms.

Questions From NCERT Textbook for Class 9 Science

Question 1. A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Answer: Boron and oxygen compound \rightarrow Boron + Oxygen

$$0.24 \text{ g} \rightarrow 0.096 \text{ g} + 0.144 \text{ g}$$

Percentage composition of the compound

For boron:

$$\begin{array}{l} 0.24 \text{ g} \rightarrow 0.096 \text{ g} \\ 100 \text{ g} \rightarrow ? \end{array}$$

$$\frac{100 \times 0.096}{0.24} = 40\%$$

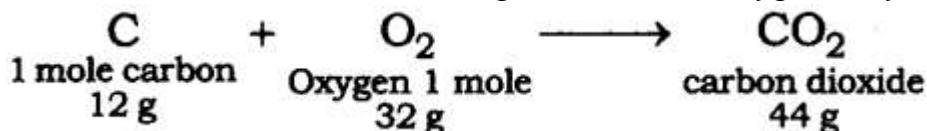
For oxygen:

$$\begin{array}{l} 0.24 \text{ g} \rightarrow 0.144 \text{ g of oxygen} \\ 100 \text{ g} \rightarrow ? \end{array}$$

$$\frac{100 \times 0.144}{0.24} = 60\%$$

Question 2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combination will govern your answer?

Answer: The reaction of burning of carbon in oxygen may be written as



It shows that 12 g of carbon burns in 32 g oxygen to form 44 g of carbon dioxide. Therefore 3 g of carbon reacts with 8 g of oxygen to form 11 g of carbon dioxide. It is given that 3.0 g of carbon is burnt with 8 g of oxygen to produce 11.0 g of CO₂. Consequently 11.0 g of carbon dioxide will be formed when 3.0 g of C is burnt in 50 g of oxygen consuming 8 g of oxygen, leaving behind 50 - 8 = 42 g of O₂. The answer governs the law of constant proportion.

Question 3. What are poly atomic ions? Give examples.

Answer: The ions which contain more than one atoms (same kind or may be of different kind) and behave as a single unit are called polyatomic ions e.g., OH⁻, SO₄²⁻, CO₃²⁻.

Question 4. Write the chemical formulae of the following:

- (a) Magnesium chloride
- (b) Calcium oxide
- (c) Copper nitrate
- (d) Aluminium chloride
- (e) Calcium carbonate.

Answer: (a) Magnesium chloride

Symbol → Mg Cl

Change → +2 -1

Formula → MgCl₂

(b) Calcium oxide

Symbol → Ca O

Charge → +2 -2

Formula → CaO

(c) Copper nitrate

Symbol → Cu NO

Change +2 -1

Formula → $\text{Cu}(\text{NO}_3)_2$

(d) Aluminium chloride

Symbol → Al Cl

Change → +3 -1

Formula → AlCl_3

(d) Calcium carbonate

Symbol → Ca CO_3

Change → +2 -2

Formula → CaCO_3

Question 5. Give the names of the elements present in the following compounds:

(a) Quick lime

(b) Hydrogen bromide

(c) Baking powder

(d) Potassium sulphate.

Answer: (a) Quick lime → Calcium oxide

Elements → Calcium and oxygen

(b) Hydrogen bromide

Elements → Hydrogen and bromine

(c) Baking powder → Sodium hydrogen carbonate

Elements → Sodium, hydrogen, carbon and oxygen

(d) Potassium sulphate

Elements → Potassium, sulphur and oxygen

Question 6. Calculate the molar mass of the following substances.

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorus molecule, P_4 (Atomic mass of phosphorus = 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Answer: The molar mass of the following: [Unit is 'g']

(a) Ethyne, $\text{C}_2\text{H}_2 = 2 \times 12 + 2 \times 1 = 24 + 2 = 26 \text{ g}$

(b) Sulphur molecule, $\text{S}_8 = 8 \times 32 = 256 \text{ g}$

(c) Phosphorus molecule, $\text{P}_4 = 4 \times 31 = 124 \text{ g}$

(d) Hydrochloric acid, $\text{HCl} = 1 \times 1 + 1 \times 35.5 = 1 + 35.5 = 36.5 \text{ g}$

(e) Nitric acid, $\text{HNO}_3 = 1 \times 1 + 1 \times 14 + 3 \times 16 = 1 + 14 + 48 = 63 \text{ g}$

Question 7. What is the mass of

(a) 1 mole of nitrogen atoms?

(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?

(c) 10 moles of sodium sulphite (Na_2SO_3)?

Answer: (a) Mass of 1 mole of nitrogen atoms = 14 g

(b) 4 moles of aluminium atoms

Mass of 1 mole of aluminium atoms = 27 g

∴ Mass of 4 moles of aluminium atoms = $27 \times 4 = 108 \text{ g}$

(c) 10 moles of sodium sulphite (Na_2SO_3)

Mass of 1 mole of $\text{Na}_2\text{SO}_3 = 2 \times 23 + 32 + 3 \times 16 = 46 + 32 + 48 = 126 \text{ g}$
 \therefore Mass of 10 moles of $\text{Na}_2\text{SO}_3 = 126 \times 10 = 1260 \text{ g}$

Question 8. Convert into mole.

(a) 12 g of oxygen gas

(b) 20 g of water

(c) 22 g of Carbon dioxide.

Answer: (a) Given mass of oxygen gas = 12 g

Molar mass of oxygen gas (O_2) = 32 g

Mole of oxygen gas $12/32 = 0.375$ mole

(b) Given mass of water = 20 g

Molar mass of water (H_2O) = $(2 \times 1) + 16 = 18 \text{ g}$

Mole of water = $20/18 = 1.12$ mole

(c) Given mass of Carbon dioxide = 22 g

Molar mass of carbon dioxide (CO_2) = $(1 \times 12) + (2 \times 16)$

= $12 + 32 = 44 \text{ g}$

\therefore Mole of carbon dioxide = $22/44 = 0.5$ mole

Question 9. What is the mass of:

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Answer: (a) Mole of Oxygen atoms = 0.2 mole

Molar mass of oxygen atoms = 16 g

Mass of oxygen atoms = $16 \times 0.2 = 3.2 \text{ g}$

(b) Mole of water molecule = 0.5 mole

Molar mass of water molecules = $2 \times 1 + 16 = 18 \text{ g}$.

Mass of $\text{H}_2\text{O} = 18 \times 0.5 = 9 \text{ g}$

Question 10. Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Answer: Molar mass of S_8 sulphur = 256 g = 6.022×10^{23} molecule

Given mass of sulphur = 16 g

$$\begin{aligned} \text{Molecules of sulphur} &= \frac{16 \times 6.022 \times 10^{23}}{256} = \frac{96.35 \times 10^{23}}{256} \\ &= 0.376 \times 10^{23} \\ &= 3.76 \times 10^{22} \text{ molecules} \end{aligned}$$

Question 11. Calculate the number of aluminium ions present in 0.051 g of aluminium oxide. (Hint: The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)

Answer: Molar mass of aluminium oxide Al_2O_3

= $(2 \times 27) + (3 \times 16)$

= $54 + 48 = 102 \text{ g}$.

∴ 102 g of Al_2O_3 contains = $2 \times 6.022 \times 10^{23}$ aluminium ions

∴ 0.051 g of Al_2O_3 contains = $\frac{2 \times 6.022 \times 10^{23}}{102} \times 0.051$

$$= \frac{12.044 \times 10^{23} \times 0.051}{102} = \frac{0.614 \times 10^{23}}{102}$$

*

$$= 0.006022 \times 10^{23}$$

$$= 6.022 \times 10^{20} \text{ Al}^{3+} \text{ ions}$$