

Chapter-3

Atoms and Molecules

EXERCISE-3.1

1 mark

1. Write down the formulae of
 i. sodium oxide
 ii. aluminium chloride
 iii. sodium Sulphide
 iv. magnesium hydroxide

Ans.

Compound	Formula
Sodium oxide	Na_2O
Aluminum Chloride	AlCl_3
Sodium Sulphide	Na_2S
Magnesium Hydroxide	$\text{Mg}(\text{OH})_2$

2. Write down the names of compounds represented by following formulae:

- i. $\text{Al}_2(\text{SO}_4)_3$
 ii. CaCl_2
 iii. K_2SO_4
 iv. KNO_3
 v. CaCO_3

Ans.

Formula	Compound
$\text{Al}_2(\text{SO}_4)_3$	Aluminum sulphate
CaCl_2	Calcium chloride
K_2SO_4	Potassium sulphate
KNO_3	Potassium nitrate
CaCO_3	Calcium carbonate

3.What is meant by the term chemical formula?

Ans. A chemical formula is the representation of elements present in a compound with the help of symbols and also the number of atoms of each element with those numbers only. for eg: A molecule of water compound contains 2 atoms of hydrogen and one atom of oxygen hence its chemical formula is H_2O .

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

Ans. The postulate of Dalton's atomic theory which is the result of the law of conservation of mass is mentioned as below:

Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.

EXERCISE-3.2

2 mark

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.

sodium carbonate + ethanoic acid \rightarrow sodium ethanoate + carbon dioxide + water

Ans. According to law of conservation of mass:

mass of reactants = mass of products

Lets calculate and find out both results –

mass of reactants = mass of sodium carbonate + mass of ethanoic acid

= 5.3g + 6g

= 11.3g

mass of products = mass of sodium ethanoate + mass of carbon dioxide + mass of water

= 8.2g + 2.2g + 0.9g = 11.3g

Hence it is proved that these observations are in agreement with the law of conservation of mass.

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?

Ans. As per the given 1:8 ratio mass of oxygen gas required to react completely with 1g of hydrogen gas is 8g.

Therefore, mass of oxygen gas required to react completely with 3g of hydrogen gas will be = $3 \times 8 = 24\text{g}$

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

Ans. The postulate of Dalton's atomic theory which explains the law of definite proportions is "Atoms combine in the ratio of small whole numbers to form compounds and the relative number and kinds of atoms are constant in a given compound."

4. Define the atomic mass unit.

Ans. According to the latest recommendations of International Union of Pure and Applied Chemistry IUPAC the atomic mass unit amu is abbreviated as u or unified mass.

For chemical calculations the atomic masses of elements are expressed by taking the atomic mass of one atom of an element as the standard mass. Like the atomic mass of carbon is taken as 12 units and each unit is called as 1 a.m.u i.e.

1 amu = 1/12 of atomic masses of ${}_6\text{C}^{12}$.

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

Ans. An atom is an extremely minute particle and as such actual mass of an atom of hydrogen is considered to be $1.6 \times 10^{-24} \text{ g}$. That is why it is not possible to see an atom with naked eyes.

EXERCISE-3.3

4 mark

4. How many atoms are present in a

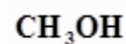
i H_2S molecule and

ii PO_4^{3-} ion?

Ans. i 2 atoms of hydrogen + 1 atom of sulphur = 3 atoms

ii 1 atom of phosphorus + 4 atoms of oxygen = 5 atoms

1. Calculate the molecular masses of



Ans. Molecular mass of H_2 = atomic mass of $\text{H} \times 2 = 1 \times 2 = 2u$.

Molecular mass of O_2 = atomic mass of $\text{O} \times 2 = 16 \times 2 = 32u$.

Molecular mass of Cl_2 = atomic mass of $\text{Cl} \times 2 = 35.5 \times 2 = 71u$.

Molecular mass of CO_2 = atomic mass of C + atomic mass of O $\times 2$

$$= 12 + (16 \times 2)$$

$$= 12 + 32$$

$$= 44 u$$

Molecular mass of CH_4 = 12 + atomic mass of hydrogen $\times 4$

$$= 12 + (1 \times 4)$$

$$= 12 + 4$$

$$= 16 \text{ u}$$

Molecular mass of $C_2H_6 = (12 \times 2) + (1 \times 6) = 24 + 6 = 30 \text{ u}$

Molecular mass of $C_2H_4 = (12 \times 2) + (1 \times 4) = 24 + 4 = 28 \text{ u}$

Molecular mass of $NH_3 = 14 + (1 \times 3) = 14 + 3 = 17 \text{ u}$

Molecular mass of $CH_3OH = 12 + (1 \times 3) + 16 + 1 = 12 + 3 + 16 + 1 = 32 \text{ u}$

2. Calculate the formula unit masses of ZnO , Na_2O , K_2CO_3 , given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Ans. Formula unit mass of:

i ZnO = Atomic mass of Zn + atomic mass of O = $65 + 16 \text{ u} = 81 \text{ u}$

ii Na_2O = Atomic mass of Na + atomic mass of O = $(23 \times 2) + 16 = 46 + 16 = 62 \text{ u}$

iii $K_2CO_3 = (39 \times 2) + 12 + (16 \times 3) = 78 + 12 + 48 = 138 \text{ u}$

3. If one mole of carbon atoms weighs 12 grams, what is the mass in grams of 1 atom of carbon?

Ans. Weight of one mole of carbon = atomic mass of carbon
1 atom of carbon = 12 u

Therefore, one mole of carbon contains = $12 \text{ g} = 6.022 \times 10^{23}$ atoms Avogadro number

so 1 atom of carbon = $12 / 6.022 \times 10^{23} \text{ g}$

or, $12 \text{ u} = \frac{12}{6.022} \times 10^{23} \text{ g}$

1 $\text{u} = \frac{12}{6.022} \times 10^{23} \times 12 \text{ g}$

$$1\text{ u} = \frac{1}{6.022} \times 10^{23}\text{ g}$$

$$1\text{ u} = 0.1660577 \times 10^{-23}\text{ g}$$

$$\text{or, } 1\text{ u} = 1.660577 \times 10^{-24}\text{ g}$$

4.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.

Ans. Mass of the given sample compound = 0.24g

Mass of boron in the given sample compound = 0.096g

Mass of oxygen in the given sample compound = 0.144g

% composition of compound = % of boron and % of oxygen

Therefore % of boron = mass of boron \times 100/mass of the sample compound

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

$$= 40\%$$

Therefore % of oxygen = mass of oxygen \times 100/mass of the sample compound

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

$$= 60\%$$

5. 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?

Ans. According to the law of chemical combination of constant proportions “in a chemical compound the elementary constituents always combine in constant proportions by weight/mass”. Therefore, whether 3 g carbon is burnt in 8 g oxygen or 3g carbon is burnt in 50g oxygen in both cases only 11g carbon dioxide will be formed.

6. What are polyatomic ions? Give examples.

Ans. When two or more atoms in a group are having a charge, such is called a polyatomic ion. For *eg* : NH_4^+ , NO_3^- etc.

EXERCISE-3.4

Frequently Asked Questions

1. Write the chemical formulae of the following.

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

Ans.

Compound	Chemical formula
Magnesium chloride	MgCl_2
Calcium oxide	CaO
Copper nitrate	CuNO_3
Aluminum chloride	AlCl_3
Calcium carbonate	CaCO_3

2. Give the names of the elements present in the following compounds.

- a Quick lime
- b Hydrogen bromide
- c Baking powder
- d Potassium sulphate.

Ans.

Compound	Formula	Elements present
Quick lime	CaO	Calcium and oxygen
Hydrogen bromide	HBr	Hydrogen and bromine
Baking powder	NaHCO_3	Sodium, hydrogen, carbon and oxygen
Potassium sulphate	K_2SO_4	Potassium, Sulphur and oxygen

3. 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

Ans. a Ethyne = $C_2H_2 = 12 \times 2 + 1 \times 2 = 24 + 2 = 26 \text{ u} = 26 \text{ g}$

b Sulphur molecular = $S_8 = 32 \times 8 = 256 \text{ u} = 256 \text{ g}$

c Phosphorus molecule = $P_4 = 31 \times 4 = 124 \text{ u} = 124 \text{ g}$

d Hydrochloric acid = $HCl = 1 + 35.5 = 36.5 \text{ u} = 36.5 \text{ g}$

e Nitric acid = $HNO_3 = 1 + 14 + (16 \times 3) = 15 + 48 = 63 \text{ u} = 63 \text{ g}$

4. 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) ?

Ans. a Atomic mass of nitrogen is 14 u.

therefore 1 mol of N = 14g

b Atomic mass of aluminium = 27u

therefore 1 mol of Al = 27g and so 4 mol of Al = $27 \times 4 = 108 \text{ g}$

c molecular mass of $Na_2SO_3 = 23 \times 2 + 32 + 16 \times 3 = 46 + 32 + 48 = 126 \text{ u}$

therefore 1 mol of Na_2SO_3 has weight/mass 126g.

hence, 10 mol of $Na_2SO_3 = 10 \times 126 = 1260 \text{ g}$