Chapter

# ATOMS AND MOLECULES

**Intext Exercise 1** 

1. In a reaction, 5.3g of sodium carbonate reacted with 6g of ethanoic acid. The products were 2.2g of carbon dioxide, 0.9g water and 8.2g 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: Given,

Mass of sodium carbonate = 5.3 g

Mass of ethanoic acid = 6 g

Mass of sodium ethanoate = 8.2 g

Mass of carbon dioxide = 2.2 g

Mass of water = 0.9 g

Now, total mass before the reaction = (5.3 + 6) g = 11.3 g

And, total mass after the reaction = (8.2 + 2.2 + 0.9) g = 11.3 g

 $\therefore$ Total mass before the reaction = Total mass after the reaction

Hence, this is 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:** In water, H:O (by mass) =1:8

The mass of oxygen gas required to react completely with 1 g of hydrogen gas = 8 g.

So, the mass of oxygen gas required to react completely with 3 g of hydrogen gas

 $= (8 \times 3) g = 24 g$ 

# **3.** 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 based on the law of conservation of mass is: "Atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction."

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

**Ans:** "The elements consist of atoms having fixed mass and that the number and kind of atoms of each element in a given compound is fixed." This explains the law of definite proportion.

# **Intext Exercise 2**

#### 1. Define atomic mass unit.

Ans: Mass unit equal to exactly one-twelfth the  $\left(\frac{1}{12^{th}}\right)$  mass of one atom of carbon-12 is called one atomic mass unit. It is represented by as 'a.m.u.' or 'u'.

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

Ans: Due to small size of an atom we cannot see them with naked eyes.

**Intext Exercise 3** 

#### 1. Write down the formulae of

(i) Sodium oxide

**Ans:** Sodium Oxide: Na<sub>2</sub>O

# (ii) Aluminium chloride

**Ans:** Aluminium chloride: AlCl<sub>3</sub>

# (iii) sodium sulphide

Ans: Sodium sulphide: Na<sub>2</sub>S

# (iv) Magnesium hydroxide

**Ans:** Magnesium hydroxide: Mg(OH)<sub>2</sub>

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

i)  $Al_2(SO_4)_3$ 

Ans: Aluminium sulphate

ii) CaCl<sub>2</sub>

Ans: Calcium chloride

iii) K<sub>2</sub>SO<sub>4</sub>

Ans: :Potassium sulphate

iv) KNO<sub>3</sub>

Ans: Potassium nitrate

v) CaCO<sub>3</sub>

Ans: : Calcium carbonate

# 3. What is meant by the term chemical formula?

**Ans:** The symbolic representation of composition of a compound is known as chemical formula. Chemical formula gives us the idea of number of atoms present.

Example: from the chemical formula  $CO_2$  of Carbon Dioxide, we come to know that one carbon atom and two oxygens atoms are chemically bonded together to form one molecule of the compound, carbon dioxide.

#### 4. How many atoms are present in a:

#### i) H<sub>2</sub>S molecule

Ans: There are total 3 atoms present in  $H_2S$  molecule, two hydrogen atoms and one Sulphur atom.

# ii) $PO_4^{3-}$ ion

**Ans:** There are total 5 atoms in  $PO_4^{3-}$  ion, one phosphorus atom and 4 oxygen atoms.

#### **Intext Exercise 4**

1. Calculate the molecular masses of  $H_2, O_2, CI_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.$ 

**Ans:** Molecular mass of  $H_2 = 2 \times$  Atomic mass of H

 $= 2 \times 1 u = 2 u$ 

Molecular mass of  $O_2 = 2 \times$  Atomic mass of O

 $= 2 \times 16 u = 32 u$ 

Molecular mass of  $Cl_2 = 2 \times$  Atomic mass of Cl

$$= 2 \times 35.5 \,\mathrm{u} = 71 \,\mathrm{u}$$

Molecular mass of  $CO_2$  = Atomic mass of C + 2×Atomic mass of O

$$=(12+2\times 16)$$
 u = 44 u

Molecular mass of  $CH_4$  = Atomic mass of C + 4×Atomic mass of H

$$=(12+4\times 1) u = 16 u$$

Molecular mass of  $C_2H_6 = 2 \times Atomic mass of C + 6 \times Atomic mass of H$ 

$$= (2 \times 12 + 6 \times 1) u = 30 u$$

Molecular mass of  $C_2H_4 = 2 \times Atomic mass of C + 4 \times Atomic mass of H$ 

$$= (2 \times 12 + 6 \times 1) u = 30 u$$

Molecular mass of  $NH_3$  = Atomic mass of N + 3×Atomic mass of H

$$=(14+3\times 1) u = 17 u$$

Molecular mass of  $CH_3OH$  = Atomic mass of C + 3×Atomic mass of H + Atomic mass of O

+ Atomic mass of  $= (12+4\times1+16) u = 32 u$ 

2. Calculate the formula unit masses of  $ZnO,\,Na_2O,\,K_2CO_3$  given atomic masses of

Zn = 65u, Na = 23u, K = 39u, C = 12u, and O = 16u.

Ans: Formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O

$$=(65+16) u = 81 u$$

Formula unit mass of  $Na_2O = 2 \times Atomic mass of Na + Atomic mass of O$ 

$$= (2 \times 23 + 16) u = 62 u$$

Formula unit mass of  $K_2CO_3 = 2 \times$  Atomic mass of K + Atomic mass of C +  $3 \times$  Atomic mass O

$$= (2 \times 39 + 12 + 3 \times 16)u$$
  
= 138u

# **NCERT QUESTIONS:**

**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.

Ans:

Given,

Mass of boron = 0.096 g

Mass of oxygen = 0.144 g

Mass of sample = 0.24 g

The percentage of boron by weight in the compound  $=\frac{0.096}{0.24} \times 100\% = 40\%$ 

And, percentage of oxygen by weight in the compound  $=\frac{0.144}{0.24} \times 100\% = 60\%$ 

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 combinations will govern your answer?

Ans: Carbon + Oxygen  $\longrightarrow$  Carbon dioxide

3 g of carbon reacts with 8 g of oxygen to produce 11 g of carbon dioxide.

If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen to form11 g of carbon dioxide.

The remaining (50 - 8) = 42 g of oxygen will be left unreacted.

The above answer is governed by the law of constant proportions.

# 3. What are polyatomic ions? Give examples?

**Ans:** A polyatomic ion is a group of atoms carrying a charge either positive or negative.

For example,

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ammonium ion (NH_4^+), hydroxide ion (OH^-), carbonate ion, (CO_3^{2-}), sulphate ion (SO_4^{2-})
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# 4. Write the chemical formulae of the following:

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(a) Magnesium chloride
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Ans: MgCl<sub>2</sub>

(b) Calcium oxide

Ans: CaO

(c) Copper nitrate

**Ans:**  $Cu(NO_3)_2$ 

(d) Aluminium chloride

Ans: AlCl<sub>3</sub>

(e) Calcium carbonate

Ans: CaCO<sub>3</sub>

5. 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	Chemical Formula	<b>Elements Present</b>
Quick Lime	• CaO	Calcium, Oxygen
• Hydrogen Bromide	• HBr	• Hydrogen, Bromine
• Baking Powder	• NaHCO <sub>3</sub>	• Sodium, Hydrogen, Carbon, Oxygen
Potassium Sulphate	• K <sub>2</sub> SO <sub>4</sub>	• Potassium, Sulphur, Oxygen

#### 6. Calculate the molar mass of the following substances:

**a.** Ethyne  $C_2H_2$ 

**Ans:** Molar mass of  $C_2H_2 = 2 \times 12 + 2 \times 1 = 28g / mol$ 

**b.** Sulphur molecule,  $S_8$ 

**Ans:** Molar mass of  $S_8 = 8 \times 32 = 256 \text{ g/mol}$ 

**c.** Phosphorus molecule  $P_4$  (atomic mass of phosphorus = 31)

**Ans:** Molar mass of  $P_4 = 4 \times 31 = 124 \text{ g/mol}$ 

**d.** Hydrochloric acid, HCl

Ans: Molar mass of HCl = 1+35.5 = 36.5 g / mol

e. Nitric acid, HNO<sub>3</sub>

**Ans:** Molar mass of  $HNO_3 = 1 + 14 + 3 \times 16 = 63g / mol$