

NCERT Solutions for Class 9 Science

Chapter 3 – 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 → 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 = $(5.3 + 6) \text{ g} = 11.3 \text{ g}$

And, total mass after the reaction = $(8.2 + 2.2 + 0.9) \text{ g} = 11.3 \text{ g}$

∴ 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 = $(8 \times 3) \text{ g} = 24 \text{ g}$

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 as 'a.m.u.' or 'u'.

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

Ans: Due to the 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_2O

(ii) Aluminum chloride

Ans: Aluminum chloride: AlCl_3

(iii) sodium sulphide

Ans: Sodium sulphide: Na_2S

(iv) Magnesium hydroxide

Ans: Magnesium hydroxide: $\text{Mg}(\text{OH})_2$

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

i) $\text{Al}_2(\text{SO}_4)_3$

Ans: Aluminium sulphate

ii) CaCl_2

Ans: Calcium chloride

iii) K_2SO_4

Ans: :Potassium sulphate

iv) KNO_3

Ans: Potassium nitrate

v) CaCO_3

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 the 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_2S 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 a total 5 atoms in PO_4^{3-} ion, one phosphorus atom and 4 oxygen atoms.

Intext Exercise 4

1. Calculate the molecular masses of $\text{H}_2, \text{O}_2, \text{Cl}_2, \text{CO}_2, \text{CH}_4, \text{C}_2\text{H}_6, \text{C}_2\text{H}_4, \text{NH}_3, \text{CH}_3\text{OH}$.

Ans: Molecular mass of $\text{H}_2 = 2 \times$ Atomic mass of H

$$= 2 \times 1 \text{ u} = 2 \text{ u}$$

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

$$= 2 \times 16 \text{ u} = 32 \text{ u}$$

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

$$= 2 \times 35.5 \text{ u} = 71 \text{ u}$$

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

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

Molecular mass of $CH_4 =$ Atomic mass of C + $4 \times$ Atomic mass of H

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

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

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

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

$$= (2 \times 12 + 4 \times 1) \text{ u} = 28 \text{ u}$$

Molecular mass of $NH_3 =$ Atomic mass of N + $3 \times$ Atomic mass of H

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

Molecular mass of $CH_3OH =$ Atomic mass of C + $3 \times$ Atomic mass of H + Atomic mass of O + Atomic mass of H = $(12 + 4 \times 1 + 16) \text{ u} = 32 \text{ u}$

2. Calculate the formula unit masses of ZnO , Na_2O , K_2CO_3 given atomic masses of $Z = 65\text{u}$, $Na = 23 \text{ u}$, $K = 39 \text{ u}$, $C = 12\text{u}$, and $O = 16\text{u}$.

Ans: Formula unit mass of $ZnO =$ Atomic mass of Zn + Atomic mass of O = $(65 + 16) \text{ u} = 81 \text{ u}$

Formula unit mass of $\text{Na}_2\text{O} = 2 \times \text{Atomic mass of Na} + \text{Atomic mass of O} = (2 \times 23 + 16) \text{ u} = 62 \text{ u}$

Formula unit mass of $\text{K}_2\text{CO}_3 = 2 \times \text{Atomic mass of K} + \text{Atomic mass of C} + 3 \times \text{Atomic mass of O} = (2 \times 39 + 12 + 3 \times 16) \text{ u} = 138 \text{ u}$

Refer to page 42.

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

Ans: Given mass of One mole of carbon atoms = 12 g

Therefore, Mass of 6.022×10^{23} , number of carbon atoms = 12 g

Mass of 1 atom of carbon will be:

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

$$= 1.9927 \times 10^{-23} \text{ g}$$

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)?

Ans: Atomic mass of Na = 23 u (Given)

Then, gram atomic mass of Na = 23 g

Now, 23 g of Na contains = 6.022×10^{23}

number of Na atoms

Thus, 100 g of Na contains = $\frac{6.022 \times 10^{23}}{23} \times 100$

number of Na atoms = 2.6182×10^{24} number of Na atoms

Atomic mass of Fe = 56 u (Given)

Then, gram atomic mass of Fe = 56 g

Now, 56 g of Fe contains = 6.022×10^{23} number of Fe atoms

Thus, 100 g of Fe contains = $\frac{6.022 \times 10^{23}}{56} \times 100$

number of Fe atoms = 1.0753×10^{24} number of Fe atoms

$2.6182 \times 10^{24} > 1.0753 \times 10^{24}$

Therefore, 100 grams of sodium contain a greater number of atoms than 100 grams of iron.

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 form 11 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

ammonium ion (NH_4^+), hydroxide ion (OH^-), carbonate ion, (CO_3^{2-}), sulphate ion (SO_4^{2-})

4. Write the chemical formulae of the following:

(a) Magnesium chloride

Ans: MgCl_2

(b) Calcium oxide

Ans: CaO

(c) Copper nitrate

Ans: $\text{Cu}(\text{NO}_3)_2$

(d) Aluminium chloride

Ans: AlCl_3

(e) Calcium carbonate

Ans: CaCO_3

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	Elements Present
Quick Lime	CaO	Calcium, Oxygen
Hydrogen Bromide	HBr	Hydrogen, Bromine
Baking Powder	NaHCO_3	Sodium, Hydrogen, Carbon, Oxygen
Potassium Sulphate	K_2SO_4	Potassium, Sulphur, Oxygen

6. Calculate the molar mass of the following substances:

a) Ethyne C_2H_2

Ans: Molar mass of

$$C_2H_2 = 2 \times 12 + 2 \times 1 = 28 \text{ g / mol}$$

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 $HCl = 1 + 35.5 = 36.5 \text{ g / mol}$

e) Nitric acid, HNO_3

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

7. What is the mass of:

(a) 1 mole of Nitrogen atoms?

Ans: The mass of 1 mole of N- atoms = 14 g

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

Ans: [Atomic mass of Al = 27u]

The mass of 4 moles of Al-atoms = $(4 \times 27)\text{g} = 108\text{ g}$

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

Ans: Atomic mass of Na = 23 u, Atomic mass of S = 32 u, Atomic mass of O = 16 u

The mass of 10 moles of sodium sulphite

$(\text{Na}_2\text{SO}_3) = 10 \times [2 \times 23 + 32 + 3 \times 16]\text{g} = 10 \times 126\text{g} = 1260\text{g}$