

Atoms and Molecules: Exercise Questions

Q.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.

Sol. Given: Mass of boron = 0.096g

Mass of oxygen = 0.144g

Mass of sample = 0.24g

Boron and oxygen compound -----> Boron + Oxygen

0.24 g -----> 0.096 g + 0.144g

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

Thus, percentage of oxygen by weight in the compound = $100 - 40 = 60\%$

Q.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?

Sol. Carbon + Oxygen → Carbon dioxide

According to question, 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. If 3g of carbon is burnt in 50g of oxygen, then 3g of carbon will react with only 8 g of oxygen. The remaining part of oxygen i.e. 42 g will be left un-reactive. Only 11g of carbon dioxide will be formed. The answer is governed by the law of constant proportions.

Q.3 What are polyatomic ions? Give examples?

Sol. A polyatomic ion is a group of atoms which contain a charge (positive or negative).

Example: ammonium ion (NH_4^+), hydroxide ion (OH^-), carbonate ion (CO_3^{2-}), etc.

Q.4 Write the chemical formula of the following:

(a) Magnesium chloride

(b) Calcium oxide

(c) Copper nitrate

(d) Aluminium chloride

(e) Calcium carbonate

Sol. the chemical formula of the following:

(a) Magnesium chloride: MgCl_2

(b) Calcium oxide: CaO

(c) Copper nitrate: $\text{Cu}(\text{NO}_3)_2$

(d) Aluminium chloride: AlCl_3

(e) Calcium carbonate: CaCO_3

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

(a) Quick lime

(b) Hydrogen bromide

(c) Baking powder

(d) Potassium sulphate

Sol:

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

Q.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

Sol. (a) Ethyne, $C_2H_2 = 2 \times 12 + 2 \times 1 = 28g$
(b) Sulphur molecule, $S_8 = 8 \times 32 = 256g$
(c) Phosphorus molecule, $P_4 = 4 \times 31 = 124g$
(d) Hydrochloric acid, $HCl = 1 + 35.5 = 36.5g$
(e) Nitric acid, $HNO_3 = 1 + 14 + 3 \times 16 = 63g$

Q.7 What is the mass of --?

- (a) 1 mole of nitrogen atoms?
- (b) 4 mole of aluminium atoms (Atomic mass of aluminium = 27)?
- (c) 10 moles of sodium sulphite (Na_2SO_3)?

Sol. (a) The mass of 1 mole of nitrogen atoms = 14g.
(b) The mass of 4 moles of aluminium atoms = $(4 \times 27) g = 108g$
(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) = $10 \times [2 \times 23 + 32 + 3 \times 16] g = 10 \times 126g = 1260g$

Q.8 Convert into mole.

- (a) 12g of oxygen gas
- (b) 12g of water
- (c) 22g of carbon dioxide

Sol. (a) Given: mass of oxygen gas = 12g
Since 32 g of oxygen gas = 1 mole
Then, 12g of oxygen gas = $(12/32)$ mole = 0.375 mole

(b) Given: Mass of water = 12 g
Since 18g of water = 1 mole
Then, 20 g of water = $(20/18)$ mole = 1.11 moles

(c) Given: Mass of Carbon dioxide = 22g
Since, 44g of carbon dioxide = 1 mole
Then, 22g of carbon dioxide = $(22/44)$ mole = 0.5 mole

Q.9 What is the mass of:

- (a) 0.2 mole of oxygen atoms?
- (b) 0.5 mole of water molecules?

Sol. (a) Given: Mole of oxygen atoms = 0.2mole
Mass of one mole of oxygen atoms = 16g
Then, mass of 0.2 mole of oxygen atoms = $0.2 \times 16g = 3.2g$

(b) Given: Mole of water molecule = 0.5 mole
Mass of one mole of water molecule = $2 \times 1 + 16 = 18g$
Then, mass of 0.5 mole of water molecules = $0.5 \times 18g = 9g$

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

Sol. Mass of 1 mole of solid sulphur (S_8) = $8 \times 32g = 256g$
i.e., 256g of solid sulphur contains = 6.022×10^{23} molecules
Then, 16g of solid sulphur contains = $\frac{6.022 \times 10^{23}}{256} \times 16$ molecules = 3.76×10^{22} molecules (approx)

Q.11 Calculate the number of aluminium ions present in 0.051g 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 = 27u)

Sol. 1 mole of aluminium oxide (Al_2O_3) = $2 \times 27 + 3 \times 16 = 102\text{g}$
i.e., 102g of $\text{Al}_2\text{O}_3 = 6.022 \times 10^{23}$ molecules of Al_2O_3
Then,

$$0.051 \text{ g of } \text{Al}_2\text{O}_3 \text{ contains} = \frac{6.022 \times 10^{23}}{102} \times 0.051 \text{ molecules}$$

$$= 3.011 \times 10^{20} \text{ molecules of } \text{Al}_2\text{O}_3$$

The number of aluminium ions (Al^{3+}) in one molecules of aluminium oxide = 2.

Therefore,

$$\begin{aligned} \text{The number of aluminium ions } (\text{Al}^{3+}) \text{ present in } 3.11 \times 10^{20} \text{ molecules (0.051g) of aluminium} \\ \text{oxide } (\text{Al}_2\text{O}_3) &= 2 \times 3.011 \times 10^{20} \\ &= 6.022 \times 10^{20} \end{aligned}$$