NCERT SOLUTIONS

Atoms and Molecules

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IN CHAPTER QUESTIONS

PART - 1

Q1. 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.

Ans. Sodium carbonate reacts with ethanoic acid converted into sodium ethanoate, carbon dioxide, and water.

Sodium carbonate	+	Ethanoic acid	$\longrightarrow$	Sodium ethanoate	+	Carbon dioxide	+ Water
5.3g		6g		8.2g		2.2g	0.9g

$(5.3+6)g = 11.3g \longrightarrow (8.2+2.2+0.9)g = 11.3g$

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

Hence, the given observations are in agreement with the law of conservation of mass.

Q2. 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. It is given that the ratio of hydrogen and oxygen by mass to form water is 1 : 8.

Then, the mass of oxygen gas required to react completely with 1 g of hydrogen gas is 8 g.

Therefore, the mass of oxygen gas required to react completely with 3 g of hydrogen gas is 8×3 g = 24 g.

Q3. 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 is, atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction.

Q4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans. The postulate of Dalton's atomic theory based on the law of definite proportion is:

"The relative number and kind of atoms in a given compound remains constant."

PART - 2

Q1. Define atomic mass unit.

Ans. Atomic mass unit equal to exactly one-twelth the mass of one atom of carbon-12 is called one atomic mass unit. It is written as 'u'.

Q2. Why is it not possible to see an atom with naked eyes?

Ans. The size of an atom is too small thats why it is not possible to see it with naked eyes.

PART - 3

Q1. Write down the formulae of
(i) sodium oxide
(ii) aluminium chloride
(iii) sodium sulphide
(iv) magnesium hydroxide

Ans. (i) Sodium oxide : Na_2O
(ii) Aluminium chloride : $AlCl_3$
(iii) Sodium suphide : Na_2S
(iv) Magnesium hydroxide : $Mg(OH)_2$

Q2. Write down the names of compounds represented by the following formulae:
(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) K_2SO_4
(iv) KNO_3 (v) $CaCO_3$

Ans. (i) $Al_2(SO_4)_3$: Aluminium sulphate
(ii) $CaCl_2$: Calcium chloride
(iii) K_2SO_4 : Potassium sulphate
(iv) KNO_3 : Potassium nitrate
(v) $CaCO_3$: Calcium carbonate

Q3. What is meant by the term chemical formula?

Ans. The chemical formula of a compound means the symbolic representation of the composition of a compound. For example, from the chemical formula CO_2 of carbon dioxide, we come to know that one carbon atom and two oxygen atoms are chemically bonded together to form one molecule of the compound, carbon dioxide.

Q4. How many atoms are present in a

(i) H_2S molecule and

(ii) PO_4^{3-} ion?

Ans. (i) In a H_2S molecule, three atoms are present; two of hydrogen and one of sulphur.

(ii) In a PO_4^{3-} ion, five atoms are present; one of phosphorus and four of oxygen

PART - 4

Q1. Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4,NH_3,CH_3OH.

Ans. Molecular mass of H_2 = 2 × Atomic mass (H)

$= 2 \times 1 = 2$ u

Molecular mass of O_2 = 2 × Atomic mass (O)

$= 2 \times 16 = 32$ u

Molecular mass of Cl_2 = 2 × Atomic mass (Cl)

$= 2 \times 35.5 = 71$ u

Molecular mass of CO_2 = Atomic mass (C) + 2 × Atomic mass (O) = 12 + 2 × 16 = 44 u

Molecular mass of CH_4 = Atomic mass (C) + 4 × Atomic mass (H) = 12 + 4 × 1 = 16 u

Molecular mass of C_2H_6 = 2 × Atomic mass of C + 6 × Atomic mass of H = 2 × 12 + 6 × 1 = 30 u

Molecular mass of C_2H_4 = 2 × Atomic mass (C) + 4 × Atomic mass (H) = 2 × 12 + 4 × 1 = 28 u

Molecular mass of NH_3 = Atomic mass of N + 3 × Atomic mass of H = 14 + 3 × 1 = 17 u

Molecular mass of CH_3OH = Atomic mass (C) + 4 × Atomic mass (H) + Atomic mass (O)

= 12 + 4 × 1 + 16 = 32 u

PART - 5

Q1. If one mole of carbon atoms weighs 12 gram, what is the mass (in gram) of 1 atom of carbon?

Ans. One mole of carbon atoms weighs 12 g (Given)

i.e., mass of 1 mole of carbon atoms = 12 g

$\therefore$ One atom of carbon has mass

$$= 12 \text{ g} \times \frac{1}{6.022 \times 10^{23}} = 1.99 \times 10^{-23} \text{ g}$$

Q2. 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. 100 grams of sodium

No. of sodium atoms

$$= \frac{(\text{Given mass})}{(\text{Gram atomic mass})} \times (\text{Avogadro's no.})$$

$$= \frac{(100\text{g})}{(23\text{g})} \times (6.022 \times 10^{23}) = 2.618 \times 10^{24} \text{ atoms}$$

100 grams of iron

No. of iron atoms

$$= \frac{(\text{Given mass})}{(\text{Gram atomic mass})} \times (\text{Avogadro's no.})$$

$$= \frac{(100\text{g})}{(56\text{g})} \times (6.022 \times 10^{23}) = 1.075 \times 10^{24} \text{ atoms}$$

100 g of sodium has more number of atoms.

EXERCISES

Q1. 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 boron = 0.096 g (Given)

Mass of oxygen = 0.144 g (Given)

Mass of sample = 0.24 g (Given)

$$\text{Percentage of boron} = \frac{\text{Mass of boron}}{\text{Mass of sample}} \times 100$$

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

$$\text{Percentage of oxygen} = \frac{\text{Mass of oxygen}}{\text{Mass of sample}} \times 100$$

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

Thus, percentage of boron by weight in the compound = 40%

And, percentage of oxygen by weight in the compound = 60%

Q2. 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 $\rightarrow$ 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. The remaining 42 g of oxygen will be left unreactive.

In this case also, only 11 g of carbon dioxide will be formed.

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

Q3. What are polyatomic ions? Give examples?

Ans. A polyatomic ion is a group of atoms carrying a charge (positive or negative). For example, ammonium ion (NH_4^+), hydroxide ion (OH^-), carbonate ion (CO_3^{2-}), sulphate ion (SO_4^{2-}).

Q4. Write the chemical formulae of the following:

(a) Magnesium chloride

(b) Calcium oxide

(c) Copper nitrate

(d) Aluminium chloride

(e) Calcium carbonate

Ans. (a) Magnesium chloride : $MgCl_2$

(b) Calcium oxide : CaO

(c) Copper nitrate : $Cu\ (NO_3)_2$

(d) Aluminium chloride : $AlCl_3$

(e) Calcium carbonate : $CaCO_3$

Q5. Give the names of the elements present in the following compounds:

(a) Quick lime (b) Hydrogen bromide

(c) Baking powder (d) Potassium sulphate

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

Q6. 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) Molar mass of ethyne, $C_2H_2 = 2 \times 12 + 2 \times 1 = 26$ g

(b) Molar mass of sulphur molecule,

$S_8 = 8 \times 32 = 256$ g

(c) Molar mass of phosphorus molecule,

$P_4 = 4 \times 31 = 124$ g

(d) Molar mass of hydrochloric acid,

$HCl = 1 + 35.5 = 36.5$ g

(e) Molar mass of nitric acid,

$HNO_3 = 1 + 14 + 3 \times 16 = 63$ g

Q7. 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) The mass of 1 mole of nitrogen atoms is 14 g.

(b) The mass of 4 moles of aluminium atoms is (4×27) g = 108 g

(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is $10 \times [2 \times 23 + 32 + 3 \times 16]$ g

$= 10 \times 126$ g = 1260 g

Q8. Convert into mole.

(a) 12 g of oxygen gas

(b) 20 g of water

(c) 22 g of carbon dioxide

Ans. (a) 32 g of oxygen gas = 1 mole

Then, 12 g of oxygen gas $= \dfrac{12}{32}$

= 0.375 mole

(b) 18 g of water = 1 mole

Then, 20 g of water $= \dfrac{18}{20}$

= 1.11 moles (approx)

(c) 44 g of carbon dioxide = 1 mole

Then, 22 g of carbon dioxide $= \dfrac{22}{44}$

= 0.5 mole

Q9. What is the mass of :

(a) 0.2 mole of oxygen atoms ?

(b) 0.5 mole of water molecules ?

Ans. (a) Mass of one mole of oxygen atoms = 16 g

mass of 0.2 mole of oxygen atoms = 0.2×16g = 3.2 g

(b) Mass of one mole of water molecule = 18 g

mass of 0.5 mole of water molecules = 0.5×18 g = 9 g

Q10. Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Ans. 1 mole of solid sulphur (S_8) = 8 × 32 g = 256 g

i.e., 256 g of solid sulphur contains = 6.022×10^{23} molecules

Then, 1 g of solid sulphur contains = $\frac{6.02\times10^{23}}{256}$

16 g of solid sulphur contains = $\frac{6.02\times10^{23}\times16}{256}$

= 3.76×10^{22} molecules (approx)

Q11. 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)

Ans. 1 mole of aluminium oxide (Al_2O_3) = 2 × 27 + 3 × 16 = 102 g

i.e., 102 g of Al_2O_3 = 6.022×10^{23} molecules of Al_2O_3

Then, 0.051 g of Al_2O_3 contains

= 3.011×10^{20} molecules of Al_2O_3

The number of aluminium ions (Al^{3+}) present in one molecule of aluminium oxide is 2.

Therefore, the number of aluminium ions (Al^{3+}) present in 3.011×10^{20} molecules (0.051 g) of aluminium oxide (Al_2O_3) = $2 \times 3.011 \times 10^{20}$

= 6.022×10^{20}