CLASS: IX **ATOMS AND MOLECULES** **SUB: CHEMISTRY**

Section A: Very Short Answer Type (2 Marks)

1) Calculate the formula mass of sodium carbonate.

Chemical Formula: Na_2CO_3
Atomic Masses: Na = 23 u, C = 12 u, O = 16
Calculation: Formula Mass = (2 × 23) + 12 + (3 × 16) = 46 + 12 + 48
Answer: 106 u

2) How many atoms are present in 1 mole of hydrogen gas?

Molecular Form: Hydrogen gas exists as a diatomic molecule (H_2).
Molecules in 1 Mole: 1 mole of H_2 molecules = 6.022×10^{23} molecules.
Total Atoms Calculation: Since each H_2 molecule contains 2 atoms: Total atoms = $2 \times 6.022 \times 10^{23}$
Answer: 1.2044×10^{24} atoms

3) From the given list, identify the diatomic molecules: Ne, Ar, O_2, F_2, Cl_2, H_2O, P_4, S_8, O_3.

Definition: Diatomic molecules consist of exactly two atoms bonded together.
Answer: O_2, F_2, Cl_2

4) Calculate the molar mass of ethyl alcohol (C_2H_5OH).

Atomic Masses: C = 12 g/mol, H = 1 g/mol, O = 16 g/mol
Calculation: Molar mass = (2 × 12) + (6 × 1) + 16 = 24 + 6 + 16
Answer: 46 g/mol

5) Calculate the molar mass of copper sulphate.

Chemical Formula: $CuSO_4$
Atomic Masses: Cu = 63.5 g/mol, S = 32 g/mol, O = 16 g/mol
Calculation: Molar mass = 63.5 + 32 + (4 × 16) = 63.5 + 32 + 64
Answer: 159.5 g/mol

6) What is the percentage of sulphur in sulphuric acid?

Chemical Formula: H_2SO_4
Molar Mass of H_2SO_4: (2 × 1) + 32 + (4 × 16) = 98 g/mol
Mass of Sulphur: 32 g/mol
Percentage Calculation: (32 / 98) × 100
Answer: 32.65%

7) Calculate the molecular mass of sugar ($C_{12}H_{22}O_{11}$).

Calculation: (12 × 12) + (22 × 1) + (11 × 16) = 144 + 22 + 176

Answer: 342 u

8) Calculate the number of moles in 10g of hydrogen.

For Diatomic Hydrogen Gas (H_2): Molar mass = 2 g/mol. Moles = 10 / 2 = 5 moles of H_2

For Atomic Hydrogen (H): Molar mass = 1 g/mol. Moles = 10 / 1 = 10 moles of H

Answer: 5 moles (as H_2 gas) or 10 moles (as atomic H)

9) Define the atomicity of a molecule of an element.

Definition: Atomicity is defined as the total number of atoms present in one molecule of an element or compound.

10) Define the atomic mass unit.

Definition: One atomic mass unit (1 u or 1 amu) is defined as a mass unit exactly equal to one-twelfth (1/12th) of the mass of one carbon-12 atom.

<u>Section B: Short Answer Type (3 Marks)</u>

1) Carbon and oxygen react with each other in the ratio 3:8 by mass. What weight of carbon should be used to react completely with 40g of oxygen?

Mass Ratio (Carbon : Oxygen): 3 : 8

Setting up proportion: Let required carbon mass = x. Then (x / 40) = (3 / 8)

Calculation: x = (3 × 40) / 8 = 15 g

Answer: 15 g of Carbon

2) Calculate the volume occupied by 2.8g of N_2 at STP.

Molar mass of N_2: 28 g/mol

Moles of N_2: 2.8 g / 28 g/mol = 0.1 mol

Molar Volume at STP: 22.4 L/mol

Volume Calculation: 0.1 mol × 22.4 L/mol = 2.24 L

Answer: 2.24 L

3) 8.4g of sodium bicarbonate on reaction with 20g of acetic acid liberated 4.4g of carbon dioxide gas into the atmosphere. What is the mass of the residue left?

Law Applied: Law of Conservation of Mass (Total Mass of Reactants = Total Mass of Products)

Reactants Mass: 8.4 g (Sodium bicarbonate) + 20.0 g (Acetic acid) = 28.4 g

Products Mass: 4.4 g (Carbon dioxide) + x (Residue)

Equation: 28.4 g = 4.4 g + x ==> x = 28.4 - 4.4 = 24.0 g

Answer: 24.0 g

4) What is the mass of 0.5 mole of water (H_2O)?

Molar mass of H_2O: (2 × 1) + 16 = 18 g/mol

Mass Calculation: Moles × Molar mass = 0.5 × 18

Answer: 9 g

5) Calculate the number of atoms of each element present in 122.5g of $KClO_3$.

Molar mass of $KClO_3$: 39 + 35.5 + (3 × 16) = 122.5 g/mol

Moles of $KClO_3$: 122.5 g / 122.5 g/mol = 1 mole

Molecules of $KClO_3$: $1 \times 6.022 \times 10^{23} = 6.022 \times 10^{23}$ molecules

Potassium (K) Atoms: $1 \times 6.022 \times 10^{23} = 6.022 \times 10^{23}$ atoms

Chlorine (Cl) Atoms: $1 \times 6.022 \times 10^{23} = 6.022 \times 10^{23}$ atoms

Oxygen (O) Atoms: $3 \times 6.022 \times 10^{23} = 1.8066 \times 10^{24}$ atoms

6) Calculate the number of moles in 2800 mL of oxygen gas at STP.

Volume conversion: 2800 mL = 2.8 L

Molar volume at STP: 22.4 L/mol

Calculation: Moles = 2.8 / 22.4

Answer: 0.125 moles

7) Calculate the number of moles in 12.044×10^{23} helium atoms.

Avogadro's constant (N_7): 6.022×10^{23} atoms/mol

Calculation: Moles = $(12.044 \times 10^{23}) / (6.022 \times 10^{23})$

Answer: 2 moles

8) Why does the atomic mass of an element not represent the actual mass of its atom?

Reason 1 (Relative Scale): Atomic mass is a relative mass unit measured against 1/12th the mass of a Carbon-12 atom, rather than the absolute physical mass in grams (which is extremely small, $\sim 10^{-24}$ g).

Reason 2 (Isotopes): Most natural elements exist as a mixture of isotopes with different mass numbers. The atomic mass recorded in the periodic table represents the weighted average mass of all naturally occurring isotopes.

9) What is the difference between the actual mass of a molecule and gram molecular mass?

Actual Mass of a Molecule: It is the true mass of a single isolated molecule expressed in grams (calculated as Molar Mass / 6.022×10^{23}).

Gram Molecular Mass: It is the mass of 1 mole (6.022×10^{23}) of molecules expressed in grams.

10) How many moles are present in 11.5g of sodium?

Atomic mass of Sodium (Na): 23 g/mol

Calculation: Moles = 11.5 / 23

Answer: 0.5 moles

Section C: Long Answer Type (5 Marks)

1) 25.4g of iodine and 14.2g of chlorine are made to react completely to yield a mixture of ICl and ICl_3. Calculate the ratio of the moles of ICl and ICl_3.

Atomic Masses: I = 127 g/mol, Cl = 35.5 g/mol

Moles of Iodine (I): 25.4 / 127 = 0.2 mol

Moles of Chlorine (Cl): 14.2 / 35.5 = 0.4 mol

Setting up equations: Let x = moles of ICl, and y = moles of ICl_3.

Equation (1) Iodine balance: x + y = 0.2

Equation (2) Chlorine balance: x + 3y = 0.4

Solving equations: Subtract (1) from (2): 2y = 0.2 ==> y = 0.1 mol (ICl_3)

Finding x: x = 0.2 - 0.1 = 0.1 mol (ICl)

Answer: Ratio of ICl : ICl_3 = 0.1 : 0.1 = 1 : 1

2) The molecular formula of ferric sulphate is $Fe_2(SO_4)_3$.

Calculate:

(a) The molar mass of $Fe_2(SO_4)_3$

(b) How many moles of each element are there in 40g of ferric sulphate?

a) Calculate the molar mass of $Fe_2(SO_4)_3$.

Formula: $Fe_2(SO_4)_3$

Calculation: Molar mass = (2 × Fe) + 3 × [S + (4 × O)]

Molar mass = (2 × 56) + 3 × [32 + (4 × 16)]

Molar mass = 112 + 3 × [32 + 64]

Molar mass = 112 + 3 × [96]

Molar mass = 112 + 288 = 400 g/mol

Answer (a): 400 g/mol

b) How many moles of each element are there in 40g of ferric sulphate?

Step 1: Calculate total moles of $Fe_2(SO_4)_3$ in 40g

Moles of $Fe_2(SO_4)_3$ = Given mass / Molar mass = 40 g / 400 g/mol = 0.1 mol

Step 2: Calculate moles of each element in 0.1 mol of $Fe_2(SO_4)_3$:

- Iron (Fe): Each mole of $Fe_2(SO_4)_3$ contains 2 moles of Fe. Total = 2 × 0.1 = 0.2 moles
- Sulphur (S): Each mole of $Fe_2(SO_4)_3$ contains 3 moles of S. Total = 3 × 0.1 = 0.3 moles
- Oxygen (O): Each mole of $Fe_2(SO_4)_3$ contains 12 moles of O (3 × 4). Total = 12 × 0.1 = 1.2 moles

Answer (b): Fe = 0.2 moles, S = 0.3 moles, O = 1.2 moles

3) A sample of ammonia (NH_3) weighs 2.00g. What mass of sulphur dioxide (SO_2) contains the same number of molecules as are in 2.00g of ammonia?

Molar mass of NH_3: 14 + 3 = 17 g/mol

Molar mass of SO_2: 32 + (2 × 16) = 64 g/mol

Principle: Equal number of molecules implies an equal number of moles.

Moles of NH_3: 2.00 / 17 mol

Mass of SO_2 Calculation: Moles × Molar mass of SO_2 = (2.00 / 17) × 64 = 128 / 17

Answer: 7.53 g

4) Calculate the number of moles of phosphorus (P) atoms in 100g of phosphorus. If phosphorus is considered to contain P_4 molecules, then how many moles of P_4 molecules are there?

Atomic mass of P: 31 g/mol

Moles of P atoms: 100 / 31 = 3.226 moles

Molar mass of P_4 molecule: 4 × 31 = 124 g/mol

Moles of P_4 molecules: 100 / 124 = 0.806 moles

Answer: 3.226 moles of P atoms | 0.806 moles of P_4 molecules

5) In a reaction 5.3g of sodium carbonate reacted with 6g of ethanoic acid. The products were 2.2g of carbon dioxide, 0.9g of water and 8.2g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.

Reaction Equation: Sodium carbonate + Ethanoic acid ==> Sodium ethanoate + Carbon dioxide + Water

Total Mass of Reactants: 5.3 g (Sodium carbonate) + 6.0 g (Ethanoic acid) = 11.3 g

Total Mass of Products: 8.2 g (Sodium ethanoate) + 2.2 g (Carbon dioxide) + 0.9 g (Water) = 11.3 g

Verification: Total Mass of Reactants (11.3 g) = Total Mass of Products (11.3 g)

Answer: Proves the Law of Conservation of Mass