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Class	10th	Chapter	15
Subject	Chemistry	Board	Punjab

CHAPTER 15: Stoichiometry

1. Volume occupied by 15 moles of ammonia gas at RTP:

(a) 224 dm^3 (b) 160 dm^3 **(c)** 360 dm^3 (d) 265 dm^3

- **Answer: (c)**

2. How many moles of natural gas CH_4 will be present in a cylinder if its volume is 18 dm^3 at RTF?

(a) 0.75 mol (b) 0.67 mol (c) 0.85 mol (d) 0.56 mol

- **Answer: (a)**

3. What will be the molar concentration of potassium hydroxide solution if 2.0 g of it are dissolved in 100 cm^3 of solution?

(a) 0.36 mol/dm^3 (b) 0.53 mol/dm^3 (c) 0.70 mol/dm^3 (d) 0.45 mol/dm^3

- **Answer: (a)**

4. What will be the mass of NaCl needed to make up 15 dm^3 of its solution with a concentration of 0.7 g/dm^3?

(a) 21 g **(b)** 10.5 g (c) 31.5 g (d) 5.4 g

- **Answer: (b)**

5. Find out the concentration of H_2SO_4 in mol/dm^3 if its 10 cm^3 react with 20 cm^3 of NaOH solution having concentration 0.1 mol/dm^3.

(a) 0.01 mol/dm^3 (b) 0.001 mol/dm^3 **(c)** 0.1 mol/dm^3 (d) 0.15 mol/dm^3

- **Answer: (c)**

6. If the molar mass of a compound is 178 g/mol and its empirical formula is $C_9H_8O_4$. What is its molecular formula?

(a) $C_9H_8O_4$ (b) $C_{18}H_{16}O_8$ (c) $C_9H_{14}O_4$ (d) $C_8H_9O_4$

- **Answer: (a)**

7. When natural gas burns in air, which component is the limiting reactant?

(a) Both components (b) Neither component is a limiting reactant (c) Air **(d) Natural gas**

- **Answer: (d)**

8. If the actual yield of a compound is 0.198 g **while the theoretical field is** 0.217 g**. What will be the percentage yield?**

(a) 50% **(b)** 91.2% (c) 80% (d) 90%

- **Answer: (b)**

B. Short Answer Questions

- **15.1 What is the molar volume of a gas at RTP?**
  - 24 $dm^3 mol^{-1}$ at Room Temperature and Pressure (20°C and 1 atm).
- **15.2 How does the concept of molar volume useful for us?**
  - It allows direct conversion between the volume of a gas and the number of moles (or molecules) without needing mass measurements.
- **15.3 How does the molar volume relate to the Avogadro's law?**
  - Avogadro's law states equal volumes of all gases under the same conditions contain equal numbers of molecules; hence, one mole of any ideal gas occupies a constant molar volume.
- **15.4 Why two different compounds may show the same empirical formula?**
  - Because empirical formula represents the **simplest whole-number ratio** of atoms, and different compounds can share the same atomic ratio (e.g., formaldehyde CH_2O and glucose $C_6H_{12}O_6$).
- **15.5 Why is percentage yield important?**
  - It measures the efficiency, success rate, and economic viability of a chemical reaction or synthesis process in industry.
- **15.6 What is the concentration of a solution in** mol/dm^3 **if it contains** 49 g **of** H_2SO_4 **in one** dm^3 **of solution?**
  - Molar mass of $H_2SO_4 = 98$ g/mol. Molarity $= \frac{49}{98} = 0.5$ mol/dm^3.

C. Constructed Response Questions

- **15.1 How would you identify the limiting reactant in a chemical reaction?**
  - Calculate the number of moles of each reactant, divide by their respective stoichiometric coefficients, and the reactant giving the **smallest mole ratio** is the limiting reactant.
- **15.2 Why is it important to find the purity of a compound which is used as a medicine?**
  - To ensure correct dosage efficacy and prevent toxic side effects from dangerous impurities or by-products.
- **15.3 Will there be a limiting reactant in a reversible reaction?**

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- Generally, limiting reactants apply to reactions that go to completion; in reversible equilibrium systems, reactants and products coexist, so complete consumption does not define limiting reagents in the same way.

- **15.4 How do you know if a formula is empirical or not?**
  - If the subscripts in the chemical formula cannot be divided further by a common whole number, it is an empirical formula.
- **15.5 Write down one method to find out the molecular mass of a compound without knowing its molecular formula.**
  - **Rast's camphor method** or **Elevation of boiling point / Depression of freezing point (colligative properties)**.

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D. Numerical Problems

- **15.1 Calculate the number of moles, volume and number of molecules in** 4.0 g **of** CH_4 **at RTP.**
  - *Molar mass of* CH_4 = 16 g/mol.
  - *Moles* = $\frac{4.0\text{ g}}{16\text{ g/mol}} = 0.25$ mol.
  - *Volume at RTP* = $0.25\text{ mol} \times 24\text{ dm}^3/\text{mol} = 6.0\text{ dm}^3$.
  - *Number of molecules* = $0.25 \times 6.022 \times 10^{23} = 1.505 \times 10^{23}$ molecules.
- **15.2 What mass of** NaCl **need to be dissolved in** 150 cm^3 **of a solution if the concentration of the solution is** 0.4 mol/dm^3**?**
  - *Volume* = $\frac{150}{1000} = 0.15\text{ dm}^3$.
  - *Moles of* NaCl = Molarity × Volume (\text{dm}^3$)} = 0.4 \times 0.15 = 0.06\text{ mol}$.
  - *Molar mass of* NaCl = 58.5 g/mol.
  - *Mass* = 0.06 mol × 58.5 g/mol = 3.51 g.
- **15.3 Find out the percentage of sodium in** $NaHCO_3$**.**
  - *Molar mass of* $NaHCO_3 = 23 + 1 + 12 + 3(16) = 84$ g/mol.
  - *Mass of* Na = 23 g.
  - *Percentage of* Na = $\frac{23}{84} \times 100 = 27.38\%$.
- **15.4 A sulphide of iron contains** 1.926 g **of sulphur and** 2.333 g **of iron. Find out the empirical formula of this compound.**
  - *Moles of Fe* = $\frac{2.333}{55.85} = 0.0418$ mol.
  - *Moles of S* = $\frac{1.926}{32.1} = 0.060$ mol.
  - *Atomic ratio (Fe : S)* = $\frac{0.0418}{0.0418} : \frac{0.060}{0.0418} = 1 : 1.43 \approx 2 : 3$.
  - *Empirical formula* = Fe_2S_3.
- **15.5 Molecular formula calculation from mass composition:**
  - Using given percentages (C = 40.0%, H = 6.71%, O = 53.3%) and molar mass, empirical formula is CH_2O (Mass = 30). Given molar mass = 28.8 × ... or derived via mole data. (Results in CH_2O or scaled molecular formula).
- **15.6 Limiting Reactant Problem (**$N_2 + 3H_2 \rightarrow 2NH_3$**):**
  - Reacting 12 g of H_2 and 64 g of N_2.
  - Moles of $H_2 = \frac{12}{2} = 6$ mol. (Required $N_2 = 6/3 = 2$ mol).
  - Moles of $N_2 = \frac{64}{28} = 2.28$ mol.
  - Since 2 mol of N_2 required for 6 mol of H_2 is less than available 2.28 mol, H_2 **is the limiting reactant**.
- **15.7 Percentage yield calculation:**

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- Actual yield = 23.7 g. Calculate theoretical yield from stoichiometry of given reactants, then:
- Percentage Yield $= \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100.$

- **15.8 Percentage purity of gold:**
  - Percentage Purity $= \frac{\text{Mass of pure gold}}{\text{Total mass of sample}} \times 100 = \frac{2.45\ \text{kg}}{3.66\ \text{kg}} \times 100 = 66.94\%.$

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