# O-Level Pure Chemistry: Mole Concept & Stoichiometry

## Prelim Practice Questions

---

### Section A: Basic Mole Calculations

**1.** Calculate the number of moles in: (a) 11.5 g of sodium (Na) [1] (b) 4.4 g of carbon dioxide, $CO_2$ [1] (c) $3.01 \times 10^{23}$ molecules of oxygen gas, $O_2$ [1]

**2.** Calculate the mass of: (a) 0.25 mol of calcium carbonate, $CaCO_3$ [1] (b) 2.5 mol of water, $H_2O$ [1]

**3.** Calculate the number of particles (atoms/molecules) in: (a) 0.5 mol of neon gas, Ne [1] (b) 0.1 mol of ammonia, $NH_3$ [1]

---

### Section B: Empirical & Molecular Formula

**4.** A compound contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass. Determine the empirical formula of this compound. Show your working. [3]

**5.** A hydrocarbon has the empirical formula $CH_2$. Its molar mass is 84 g/mol. Deduce the molecular formula of this hydrocarbon. [2]

**6.** 2.30 g of an oxide of nitrogen contains 0.70 g of nitrogen and the rest oxygen. Determine the empirical formula of this oxide. [3]

---

### Section C: Reacting Masses

**7.** Magnesium reacts with hydrochloric acid according to the equation: $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Calculate the mass of magnesium chloride formed when 4.8 g of magnesium reacts completely with excess hydrochloric acid. [3]

**8.** Calcium carbonate decomposes on heating: $CaCO_3 \rightarrow CaO + CO_2$

Calculate the mass of calcium oxide formed when 25.0 g of calcium carbonate is completely decomposed. [3]

**9.** Iron reacts with oxygen to form iron(III) oxide: $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Calculate the mass of iron needed to produce 32.0 g of iron(III) oxide. [3]

---

## Section D: Limiting Reagent

**10.** 5.0 g of zinc is added to 100 cm³ of 0.5 mol/dm³ hydrochloric acid. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

(a) Calculate the number of moles of zinc used. [1] (b) Calculate the number of moles of hydrochloric acid used. [1] (c) Determine the limiting reagent, showing your working. [2] (d) Calculate the maximum mass of zinc chloride that could be formed. [2]

**11.** 3.4 g of ammonia, $NH_3$, is reacted with 8.0 g of oxygen gas. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

Determine which reactant is in excess, and calculate the mass of NO formed. [4]

---

## Section E: Percentage Yield & Percentage Purity

**12.** A student reacts 10.0 g of impure calcium carbonate with excess hydrochloric acid. The mass of pure calcium carbonate that reacted was calculated to be 8.5 g. Calculate the percentage purity of the calcium carbonate sample. [2]

**13.** In an experiment, 20.0 g of copper(II) oxide is expected to produce 16.0 g of copper. Only 12.8 g of copper was actually obtained. Calculate the percentage yield of copper. [2]

---

## Section F: Gas Volumes (Molar Gas Volume)

**14.** Calculate the volume occupied by 0.25 mol of carbon dioxide gas at room temperature and pressure (r.t.p.), where 1 mole of gas occupies 24 dm³ at r.t.p. [1]

**15.** Calcium carbonate reacts with excess dilute hydrochloric acid: $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

Calculate the volume of $CO_2$ gas produced (at r.t.p.) when 5.0 g of calcium carbonate reacts completely. [3]

**16.** 120 cm³ of hydrogen gas reacts completely with chlorine gas to form hydrogen chloride gas: $H_2 + Cl_2 \rightarrow 2HCl$

Calculate the volume of hydrogen chloride gas produced (all volumes measured at the same temperature and pressure). [2]

---

## Section G: Concentration & Titration Calculations

**17.** Calculate the number of moles of solute in 250 cm³ of 0.20 mol/dm³ sodium hydroxide solution. [1]

**18.** 25.0 cm³ of 0.10 mol/dm³ sodium hydroxide solution exactly neutralises 20.0 cm³ of hydrochloric acid. $NaOH + HCl \rightarrow NaCl + H_2O$

Calculate the concentration of the hydrochloric acid, in mol/dm³. [3]

**19.** In a titration, 22.5 cm³ of 0.15 mol/dm³ sulfuric acid exactly neutralises 25.0 cm³ of sodium hydroxide solution. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

Calculate the concentration of the sodium hydroxide solution, in mol/dm³. [3]

---

## Section H: Water of Crystallisation

**20.** A hydrated salt has the formula $CuSO_4 \cdot xH_2O$. When 5.0 g of this hydrated salt is heated to constant mass, 3.2 g of anhydrous copper(II) sulfate remains. Determine the value of x. [Mr: $CuSO_4$ = 160, $H_2O$ = 18] [3]

---

## Section I: Mixed/Applied Questions

**21.** A student wants to prepare 100 cm³ of 0.50 mol/dm³ copper(II) sulfate solution from solid copper(II) sulfate crystals, $CuSO_4 \cdot 5H_2O$. [Mr: $CuSO_4 \cdot 5H_2O$ = 250]

(a) Calculate the number of moles of $CuSO_4 \cdot 5H_2O$ needed. [1] (b) Calculate the mass of $CuSO_4 \cdot 5H_2O$ required. [1] (c) Describe briefly how the student would prepare this solution using the calculated mass. [2]

**22.** Ethanol burns completely in oxygen: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

Calculate the volume of oxygen gas (at r.t.p.) needed to completely burn 4.6 g of ethanol. [Mr: $C_2H_5OH$ = 46] [3]

---

*End of practice set — [Total: 60 marks]*

*Tip: Attempt all questions first before checking answers. Show all working clearly, including balanced equations, mole ratios, and units at each step — this is where most marks are awarded in O-Level stoichiometry questions.*