

GRADE 11 STUDY GUIDE | 2025

Quantitative Aspects of Chemical Change

Physical Sciences

1. The Mole Concept

$$n = m/M \quad (n=\text{moles, } m=\text{mass in g, } M=\text{molar mass in g/mol})$$

$$n = N/N_A \quad (N=\text{number of particles, } N_A=6.022 \times 10^{23})$$

$$n = V/22.4 \quad (V \text{ in litres, at STP: } 0^\circ\text{C, } 101.3 \text{ kPa})$$

- Molar mass (M): mass of one mole of a substance, numerically equal to its atomic/molecular mass in g/mol
- Avogadro's number ($N_A = 6.022 \times 10^{23}$): number of particles in one mole
- At STP: one mole of ANY gas occupies 22.4 L

2. Mole Ratios from Balanced Equations

A balanced chemical equation tells us the MOLE RATIO in which reactants combine and products form. This is the stoichiometric ratio.

Example: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \Rightarrow 2\text{NH}_3(\text{g})$

Ratio: 1 mol N_2 : 3 mol H_2 : 2 mol NH_3

If 2 mol N_2 reacts: need 6 mol H_2 , produce 4 mol NH_3

3. Percentage Composition and Empirical Formula

$$\% \text{ by mass of element} = (\text{mass of element} / \text{molar mass of compound}) \times 100$$

Empirical formula: simplest whole-number ratio of atoms

Example: Find empirical formula of compound: 40% C, 6.7% H, 53.3% O

Assume 100 g: C=40g, H=6.7g, O=53.3g

Moles: $\text{C}=40/12=3.33$, $\text{H}=6.7/1=6.7$, $\text{O}=53.3/16=3.33$

Ratio: C:H:O = 1:2:1

Empirical formula: CH_2O

4. Limiting Reagent and Excess

The LIMITING REAGENT is the reactant that is used up first, thereby limiting the amount of product formed.

- Step 1: Calculate moles of each reactant available
- Step 2: Divide each by its stoichiometric coefficient from the balanced equation
- Step 3: The SMALLER result indicates the limiting reagent

Step 4: Calculate product using moles of limiting reagent

5. Concentration of Solutions

$$c = n/V \text{ (c in mol/L or mol.dm}^{-3}\text{), n in mol, V in litres/dm}^3\text{)}$$

$$\text{OR } c = m/(M \times V)$$

KEY: 1 dm³ = 1 litre = 1000 mL = 1000 cm³. Always convert volume to litres when using $c = n/V$.

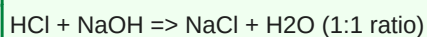
6. Titration Calculations

Titration is used to find the concentration of an unknown solution by reacting it with a standard solution of known concentration.

$$\text{At equivalence point: } n_1/n_2 = c_1V_1/(c_2V_2)$$

From balanced equation: $n(\text{acid})/n(\text{base})$ ratio is used

Example: 25 cm³ of NaOH is neutralised by 18.5 cm³ of 0.2 mol/L HCl. Find [NaOH].



$$n(\text{HCl}) = 0.2 \times 0.0185 = 0.0037 \text{ mol}$$

$$n(\text{NaOH}) = 0.0037 \text{ mol (1:1)}$$

$$[\text{NaOH}] = 0.0037/0.025 = 0.148 \text{ mol/L}$$