

3.4 Concentrations in mol/dm³

Name: _____ Class: _____ Date: _____

Total: 16 marks

KEY WORDS titration • concentration

Objective

Use mol/dm³ concentrations and titration calculations. Chemistry only, HT. Original questions for spec statement 4.3.4.

1 Key knowledge and worked examples

Concentration (mol/dm³): moles of solute per dm³ of solution.

$$\text{moles} = C \times V(\text{dm}^3) \quad C = \frac{\text{moles}}{V} \quad V = \frac{\text{moles}}{C}$$

Remember $1000 \text{ cm}^3 = 1 \text{ dm}^3$. Link with mass: $\text{moles} = \text{mass} \div \text{Mr}$.

Titration logic: at neutralisation the moles of acid and alkali are in the **equation ratio**. Compute the known side's moles, scale by the ratio, divide by the other volume.

Worked example (4 marks). 25.0 cm³ of NaOH is neutralised by 20.0 cm³ of 0.150 mol/dm³ HCl. Find the NaOH concentration.

Moles HCl = $0.150 \times 0.0200 = 3.00 \times 10^{-3}$; HCl : NaOH is 1 : 1, so moles NaOH = 3.00×10^{-3} ; volume NaOH = 0.0250 dm³; $C = 3.00 \times 10^{-3} \div 0.0250 = 0.120 \text{ mol/dm}^3$.

2 Practice

2.1 How many moles are in 500 cm³ of 0.200 mol/dm³ solution? [2]

2.2 Convert 0.005 mol in 25.0 cm³ into a concentration. [2]

2.3 In $\text{H}_2\text{SO}_4 + 2 \text{NaOH}$, one mole of acid neutralises how many moles of alkali? [1]

3 Exam-style questions

3.1 (*HT*) 23.50 cm³ of 0.100 mol/dm³ barium hydroxide neutralises 25.00 cm³ of hydrochloric acid: $\text{Ba}(\text{OH})_2 + 2 \text{HCl} \rightarrow \text{BaCl}_2 + 2 \text{H}_2\text{O}$. Calculate the acid concentration. [4]

3.2 (*HT*) A student makes 250 cm³ of sodium carbonate solution containing 13.25 g of Na₂CO₃ (Mr = 106). Calculate the concentration in mol/dm³. [3]

3.3 (*HT*) The final trial overshoot the end point and its recorded result must be excluded. The trials read 21.10, 21.20, 21.15 and 24.60 cm³. Give the mean titre, and the moles of 0.100 mol/dm³ acid it represents. [4]

Solutions

2.1 $0.500 \text{ dm}^3 \times 0.200 = 0.100 \text{ mol}$.

2.2 $0.005 \div 0.0250 \text{ dm}^3 = 0.200 \text{ mol/dm}^3$.

2.3 Two.

3.1 Moles $\text{Ba}(\text{OH})_2 = 0.100 \times 0.02350 = 2.35 \times 10^{-3}$; ratio 1 : 2, so moles $\text{HCl} = 4.70 \times 10^{-3}$; volume acid = 0.02500 dm^3 ; $C = 4.70 \times 10^{-3} \div 0.02500 = 0.188 \text{ mol/dm}^3$.

3.2 Moles = $13.25 \div 106 = 0.125$; volume = 0.250 dm^3 ; $C = 0.125 \div 0.250 = 0.500 \text{ mol/dm}^3$.

3.3 Exclude the recorded overshoot, 24.60; mean = $(21.10 + 21.15 + 21.20) \div 3 = 21.15 \text{ cm}^3$; = 0.02115 dm^3 ; moles = $0.100 \times 0.02115 = 2.115 \times 10^{-3} \approx 2.12 \times 10^{-3} \text{ mol}$.