

CIE A-Level Chemistry 9701 Paper 3 Practice

Paper (Advanced Practical Skills) - ANSWERS

Total: 40 marks · 2 h · 2 questions · 11 parts

Q	Part	Answer	Mark points	marks
1	(a)	The titres are 24.20, 24.70, 24.10 and 24.15 cm ³ . Titration 1 (24.70 cm ³) differs by 0.50 cm ³ from the rest, far outside 0.20 cm ³ , so it is not concordant and must be rejected; it is a rough titration only.	1 mark: all four titres correct (24.20 / 24.70 / 24.10 / 24.15) 1 mark: 24.70 cm ³ rejected, difference from the rest is more than 0.20 cm ³	2
1	(b)	The concordant titres are 24.20, 24.10 and 24.15 cm ³ ; the mean is (24.20+24.10+24.15)/3 = 24.15 cm ³ .	1 mark: only the three concordant titres used 1 mark: mean = 24.15 cm ³ to 2 d.p.	2
1	(c)	$n(\text{KMnO}_4) = 0.0200 \times 24.15 / 1000 = 4.83 \times 10^{-4} \text{ mol}$.	1 mark: $4.83 \times 10^{-4} \text{ mol}$ (accept 4.8×10^{-4})	1
1	(d)	$\text{MnO}_4^- + 5\text{Fe}^{2+} + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 5\text{Fe}^{3+} + 4\text{H}_2\text{O}$. The ratio is 1:5, so $n(\text{Fe}^{2+}) = 5 \times 4.83 \times 10^{-4} = 2.415 \times 10^{-3} \text{ mol}$.	1 mark: correct coefficients (5Fe ²⁺ , 8H ⁺ , 4H ₂ O) 1 mark: $2.415 \times 10^{-3} \text{ mol}$	2
1	(e)	$n(\text{Fe}^{2+}) = 2.415 \times 10^{-3} \times 10 = 2.415 \times 10^{-2} \text{ mol}$; $M_r = 9.45 / 2.415 \times 10^{-2} = 391.3$.	1 mark: $\times 10$ to give $2.415 \times 10^{-2} \text{ mol}$ 1 mark: $M_r = 391$ (accept 391.3)	2
1	(f)	$m(\text{Fe}) = 2.415 \times 10^{-2} \times 55.8 = 1.348 \text{ g}$ (1.35 g); percentage = $1.348 / 9.45 \times 100 = 14.26\%$.	1 mark: mass of iron 1.35 g 1 mark: 14.26% (accept 14.3%)	2

1	(g)	Mr 391.3 differs from 392.1 by 0.2%, and 14.26% differs from 14.23% by 0.03 percentage points; both are within experimental error, so the sample is essentially pure. Improvement: stand the conical flask on a white tile so the first permanent pale pink end-point is easier to see, and add the last drops one at a time with constant swirling to avoid overshooting.	1 mark: comparison of Mr (0.2% difference) 1 mark: comparison of iron percentage (0.03 points) 1 mark: sensible improvement with justification	3
2	(a)	1. A colourless solution forms. 2. With a little NaOH a white precipitate forms; it dissolves in excess to give a colourless solution; on warming a gas is given off that turns damp red litmus paper blue. 3. With BaCl ₂ (aq) a white precipitate forms that does not dissolve in excess dilute HCl. 4. With a little ammonia a white precipitate forms; it does not dissolve in excess ammonia.	1 mark each: colourless solution; white ppt soluble in excess with NH ₃ gas; white ppt insoluble in acid; white ppt insoluble in excess ammonia	4
2	(b)	NH ₄ ⁺ : warming with alkali gives a gas that turns damp red litmus blue (ammonia). Al ³⁺ : NaOH gives a white precipitate that dissolves in excess NaOH (amphoteric) but not in excess ammonia. SO ₄ (2-): BaCl ₂ (aq) gives a white precipitate that is insoluble in excess dilute HCl, unlike a carbonate or sulfite.	1 mark: NH ₄ ⁺ with evidence 1 mark: Al ³⁺ with evidence 1 mark: SO ₄ (2-) with evidence	3
2	(c)	NH ₄ = 18.0; Al = 27.0; SO ₄ = 32.1 + 64.0 = 96.1, x2 = 192.2; 12H ₂ O = 12 x 18.0 = 216.0. Mr = 18.0 + 27.0 + 192.2 + 216.0 = 453.2. Percentage water = 216.0 / 453.2 x 100 = 47.66%.	1 mark: correct parts for SO ₄ and 12H ₂ O 1 mark: Mr = 453.2 1 mark: 47.66% (accept 47.7%)	3
2	(d)	Both give a white precipitate with a little ammonia. In excess ammonia, Zn ²⁺ forms the soluble complex [Zn(NH ₃) ₄] ²⁺ and the precipitate dissolves, whereas Al ³⁺ does not form a stable ammine complex so its precipitate remains. A precipitate that is insoluble in excess ammonia therefore identifies Al ³⁺ .	1 mark: Zn ²⁺ dissolves as a soluble complex 1 mark: Al ³⁺ precipitate stays, so the two are distinguished	2
3	(a)	Maximum temperature 26.7 C, initial 20.0 C, so the rise is DT = 26.7 - 20.0 = 6.7 C. The maximum is the moment the reaction has just finished, before much heat is lost; the later readings fall as heat is lost to the surroundings, so the last reading (26.4 C) would underestimate DT.	1 mark: 26.7 C 1 mark: DT = 6.7 C 1 mark: maximum is before heat loss, last reading underestimates DT	3
3	(b)	Total volume = 25.0 + 25.0 = 50.0 cm ³ , mass = 50.0 x 1.00 = 50.0 g. q = mcDT = 50.0 x 4.18 x 6.7 = 1,400 J (1.40 kJ).	1 mark: mass 50.0 g from the total volume 1 mark: q = mcDT substituted correctly 1 mark: 1,400 J (1.40 kJ)	3

3	(c)	$n(\text{HCl}) = 1.00 \times 25.0 / 1000 = 0.0250 \text{ mol}$ and $n(\text{NaOH})$ is also 0.0250 mol, so 0.0250 mol of water is formed. $\text{DH} = -q/n = -1,400 / 0.0250 = -56,000 \text{ J/mol} = -56.0 \text{ kJ/mol}$.	1 mark: 0.0250 mol of water 1 mark: $q/n = 56,000 \text{ J/mol}$ 1 mark: -56.0 kJ/mol with the negative sign explained	3
3	(d)	(1) Heat is lost to the cup and the surroundings, so the measured DT is too small. (2) The heat capacity of the cup is ignored and the density and specific heat capacity of the solution are taken as those of pure water, so q is underestimated.	1 mark: heat loss 1 mark: heat capacity of the cup ignored / properties taken as water	2
3	(e)	Improvements: use a polystyrene cup with a lid and pass the thermometer through the lid to cut heat loss and evaporation; plot temperature against time and extrapolate back to the moment of mixing (cooling correction), or use more concentrated solutions so DT is larger and the relative error smaller. The magnitude is smaller because some heat is lost between mixing and reading, so DT is too small and DH is underestimated; the Data Booklet value assumes perfect insulation.	1 mark: lid / better insulation 1 mark: cooling correction or larger DT 1 mark: heat loss makes DT and DH too small	3