INTUITION EDUCATION

HSC 2026 · PREDICTED PRACTICE PAPER

2026 HSC Chemistry

Answers & marking notes

Paper total: 100 marks

Sit the paper first. These are worked answers with the marking notes behind them — what earns the mark, and the traps the marking centre has flagged in past years. Where a note names a band, it describes what a top-band response does, not a guaranteed mark.

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Answers & marking notes

Section I — answer key

Q	Answer	Note
1	C	Mostly molecular ⇒ weak; many particles per volume ⇒ concentrated
2	C	$[H^+] = 1.0 \times 10^{-3}$ mol L^{-1} ⇒ pH 3.0
3	A	Lowest locant set {2,4}; substituents cited alphabetically (chloro before methyl)
4	B	Solids excluded; CO squared; products over reactants
5	D	Symmetry: four equivalent CH_3 carbons + two equivalent CH carbons = 2 environments
6	C	$Q = (2.0 \times 10^{-3})(2.0 \times 10^{-3})^2 = 8.0 \times 10^{-9} < 1.7 \times 10^{-5}$
7	B	$^{79}Br/^{81}Br \approx 1{:}1$ gives equal M and M+2 peaks (Cl would give 3:1)
8	D	Indicator range must span the equivalence pH of 8.9
9	B	Conjugate acid = $HCO_3^- + H^+ = H_2CO_3$
10	A	Hydrophobic tails into grease, hydrophilic heads to water
11	B	Heating favours the endothermic (forward) direction ⇒ blue $[CoCl_4]^{2-}$
12	D	$\Delta G = \Delta H - T\Delta S < 0$ only at high T requires $\Delta H > 0$ and $\Delta S > 0$
13	B	Alcohol gives the alkyl part (methyl), acid the -oate part (propanoate)
14	C	$K_{sp} = [Ag^+]^2[CrO_4^{2-}] = (2s)^2(s) = 4s^3$
15	C	AAS is the standard trace-metal technique
16	A	Acidic start (pH 2.9), buffer region, basic equivalence point
17	D	Polyester = diol + dicarboxylic acid condensation
18	A	CH_3 (3H) split by 2H into a triplet; CH_2 (2H) split by 3H into a quartet
19	C	Excess OH^- = 1.25 mmol / 50.0 mL = 0.025 mol L^{-1}; pOH 1.60; pH 12.40
20	A	Ka is temperature-dependent only; equilibrium shifts to ions on dilution

Section II — marking notes

Q21. X = dilute sulfuric acid (or H_3PO_4) catalyst; major product propan-2-ol (OH on the central carbon per Markovnikov).

Q22 (a). q = 250.0 × 4.18 × 20.0 = 20 900 J = 20.9 kJ; n = 0.850/60.09 = 1.41×10^{-2} mol; ΔcH = −20.9/0.01415 = **-1.48×10^3 kJ mol^{-1}**.

(b). Major heat losses to the surroundings, the can and by incomplete combustion mean not all released energy heats the water. Improvement: insulate/shield the apparatus or reduce the flame-

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to-can distance (any justified change that channels more heat into the water; "repeat trials" alone is reliability, not accuracy — no mark).

Q23. $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$; Kb = Kw/Ka = 5.6×10^{-10}; x = $\sqrt{(5.6 \times 10^{-10} \times 0.25)}$ = 1.18×10^{-5} (approximation valid: x/c ≈ 0.005% ≪ 5%); pOH = 4.93; **pH = 9.07**.

Q24 (a). $[N_2O_4]$ continuous at t_1 (no step), rising with decreasing gradient to a higher plateau.

(b). Added NO_2 raises $[NO_2]$, so NO_2–NO_2 collision frequency and hence forward rate rise immediately; the reverse rate is initially unchanged. Because forward rate > reverse rate, net conversion to N_2O_4 occurs; as $[NO_2]$ falls and $[N_2O_4]$ rises the forward rate falls and reverse rate rises until the rates are equal again. Le Chatelier alone (without rates) caps at 1 mark.

Q25. Check: K = $1.40^2/(0.200 \times 0.200)$ = 49.0 ✓. Let a = mol I_2 added; shift forward by x: 1.40 + 2x = 1.60 ⇒ x = 0.100. New $[H_2]$ = 0.100; K = $1.60^2/(0.100 \times (0.100 + a))$ = 49.0 ⇒ 0.100 + a = 2.56/4.90 = 0.522 ⇒ **a = 0.42 mol** (concentrations, not moles, in K; here V = 1.00 L so they coincide numerically — working must show the expression).

Q26 (a). $Ba^{2+}(aq) + 2OH^-(aq) + 2H^+(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$. Conductivity falls because the highly mobile OH^- ions are converted to water and Ba^{2+} is removed as insoluble $BaSO_4$ — the ions are removed without replacement; near zero at equivalence because almost no ions remain; rises after equivalence as excess H^+ (very high mobility) and SO_4^{2-} accumulate.

(b). $n(H_2SO_4) = 0.100 \times 0.0220 = 2.20 \times 10^{-3}$ mol = $n(Ba(OH)_2)$; c = $2.20 \times 10^{-3}/0.0250$ = **0.0880 mol L^{-1}**.

Q27 (a). From the calibration line: 0.264/0.110 = 2.4 mg L^{-1} in the diluted sample; dilution factor 250.0/25.00 = 10; undiluted = **24 mg L^{-1}**.

(b). 24 mg L^{-1} ÷ 63.55 g mol^{-1} = 3.8×10^{-4} mol L^{-1} > 8.0×10^{-5} mol L^{-1} (≈ 4.7 × the limit) ⇒ **not compliant**.

Q28 (a). At half-equivalence (12.5 mL) pH = pKa = 4.87 ⇒ **Ka = $10^{-4.87}$ = 1.3×10^{-5}**. Annotation of the half-equivalence volume required.

(b). At equivalence only the propanoate ion is present; $CH_3CH_2COO^- + H_2O \rightleftharpoons CH_3CH_2COOH + OH^-$ generates excess OH^-, so pH > 7.

Q29 (a). All three sulfates are insoluble or slightly soluble: $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$, $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4(s)$ (and $CaSO_4$ may also form), so a white precipitate does not distinguish the cations.

(b). Valid sequence, e.g.: (1) add NaCl(aq) or dilute HCl — white precipitate $PbCl_2(s)$ only if Pb^{2+}: $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$; Ba^{2+}/Ca^{2+} give no precipitate. (2) If no precipitate, flame test: apple-green ⇒ Ba^{2+}, brick-red ⇒ Ca^{2+} (or add F^-/SO_4^{2-} with correct solubility logic). Marks for correct order, observations for every cation, and net ionic equations with states.

Q30. At low temperature the equilibrium yield is high but the rate is far too slow to be economic (few molecules exceed the activation energy); raising the temperature increases the fraction of successful collisions and the rate, though it shifts the exothermic equilibrium backwards. 450 °C is a compromise between acceptable rate and acceptable yield.

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Q31 (a). $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ and $HCl + NaOH \rightarrow NaCl + H_2O$.

(b). Titre 1 (20.10 mL) is an outlier — exclude; mean concordant titre = (19.20 + 19.15 + 19.25)/3 = 19.20 mL. n(NaOH) = 1.920×10^{-3} mol = n(excess HCl) per 25.00 mL aliquot; × 10 = 1.920×10^{-2} mol excess HCl total. Initial HCl = 0.02500 mol; reacted with tablet = 5.80×10^{-3} mol; n($CaCO_3$) = 2.90×10^{-3} mol; mass = **0.290 g (290 mg)**.

(c). 290 mg is 3% below the 300 mg claim — a justified verdict either way scores (e.g. does not fully support the claim, or is within reasonable experimental uncertainty of it).

Q32. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$. Added H^+ reacts with the large reservoir of CH_3COO^- (equilibrium shifts left), so $[H^+]$ rises only slightly; added OH^- removes H^+ and the equilibrium shifts right, ethanoic acid ionising to replace it. Both components must be present in comparable, substantial amounts; both directions required for full marks.

Q33 (a). $BaSO_4$ begins at $[SO_4^{2-}] = 1.08 \times 10^{-10}/0.010 = 1.1 \times 10^{-8}$ mol L^{-1}; $CaSO_4$ at $4.93 \times 10^{-5}/0.010 = 4.9 \times 10^{-3}$ mol L^{-1} ⇒ $BaSO_4$ first (by ~10^5 times).

(b). When $CaSO_4$ just starts, $[SO_4^{2-}] = 4.93 \times 10^{-3}$ ⇒ $[Ba^{2+}] = 1.08 \times 10^{-10}/4.93 \times 10^{-3}$ = **2.2×10^{-8} mol L^{-1}** — essentially all Ba^{2+} (99.9998%) is removed before any $CaSO_4$ forms, so filtering at this point separates the ions.

Q34 (a). $\Delta G = 178 - 298 \times 0.161$ = **+130 kJ mol^{-1}** ⇒ not spontaneous at 25 °C.

(b). $\Delta G = 0$ at T = 178/0.161 = **1.11×10^3 K (≈ 833 °C)**; spontaneous above this temperature.

Q35 (a). B = 2-methylpropan-2-ol (tertiary, major by Markovnikov); C = 2-methylpropan-1-ol (primary); D = 2-methylpropanoic acid (primary alcohol fully oxidised by excess oxidant under reflux). Full structural formulae required.

(b). E = ethyl 2-methylpropanoate, $(CH_3)_2CHCOOCH_2CH_3$.

(c). B is a tertiary alcohol: the carbon bearing the OH has no hydrogen atom to be removed, so it cannot be oxidised by dichromate.

Q36. Neutralisation itself ($H^+ + OH^- \rightarrow H_2O$) releases the same energy per mole, but ethanoic acid is only partially ionised; part of the released energy is consumed breaking the O–H bonds ionising the remaining molecular acid as the equilibrium shifts, so the net measured enthalpy is less exothermic.

Q37. X = **propan-2-yl ethanoate (isopropyl ethanoate)**, $CH_3COOCH(CH_3)_2$, made from **propan-2-ol**. Justification: $M^+ = 102$ matches $C_5H_{10}O_2$; base peak m/z 43 = CH_3CO^+ (acylium; $C_3H_7^+$ also accepted with reasoning), m/z 87 = M − CH_3, m/z 59 = CH_3COO^+; IR 1743 cm^{-1} ester C=O with C–O at 1240/1050 and no O–H rules out acid/alcohol; ^{13}C: 4 environments for 5 carbons ⇒ two equivalent CH_3 (δ 170.7 C=O, δ 67.3 O–CH); ^1H: septet 1H at δ 4.99 (CH adjacent to 6H, deshielded by O), doublet 6H (two CH_3 adjacent to 1H), singlet 3H at δ 2.01 (CH_3C=O, no neighbours). Marks: correct structure + name (2), each spectrum explicitly linked (4), base-peak fragment identified (1), integration vs splitting used correctly (1), alcohol named (1).

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Prediction provenance

Which consensus prediction each part of this paper realises. Full evidence panels: intuitioneducation.com.au/hsc-2026

Paper item	Prediction	Agreement
Section I Q3	`chem-q12-iupac-naming-mc`	0.63 · 5 (fable, opus, gpt-5.6-sol, grok, deepseek)
Section I Q4	`topic-level consensus`	0.65 (fable) · 3 (fable, gpt-5.6-sol, opus-adjacent)
Section I Q5	`topic-level consensus`	0.6–0.7 · 3 (fable, opus, gpt-5.6-sol)
Section I Q6	`topic-level consensus`	0.55 (grok) · 2 (grok, opus)
Section I Q7	`topic-level consensus`	0.45 (fable) · 2 (fable, gpt-5.6-sol)
Section I Q8	`topic-level consensus`	0.85 (gemini-3.1-pro) · 3 (gemini-3.1-pro, grok, gpt-5.6-sol)
Section I Q10	`watch list`	0.35 (fable) · 1 (fable)
Section I Q18	`topic-level consensus`	0.62 (grok) · 3 (grok, fable, opus)
Section I Q19	`topic-level consensus`	0.42 (grok) · 2 (grok, gemini-3.1-pro)
Section I Q20	`topic-level consensus`	0.60 (fable) · 1 (fable)
Q21	`topic-level consensus`	— · —
Q22	`chem-q10-calorimetry-returns`	0.58 · 3 (fable, grok, opus)
Q23	`chem-q7-salt-hydrolysis-ph`	0.53 · 4 (fable, opus, grok, deepseek)
Q24	`chem-q6-collision-theory-disturbance`	0.56 · 6 (all)
Q25	`chem-q2-keq-ice-added-species`	0.56 · 5 (fable, opus, gpt-5.6-sol, grok, gemini-3.1-pro)
Q26	`chem-q11-conductometric-titration`	0.51 · 4 (fable, gpt-5.6-sol, gemini-3.1-pro, deepseek)
Q27	`chem-q8-calibration-curve-dilution`	0.55 · 5 (fable, opus, gpt-5.6-sol, grok, deepseek)
Q28	`watch list`	0.58 (gpt-5.6-sol), 0.45 (opus) · 2
Q29	`chem-q9-ion-testing-sequence`	0.55 · 6 (all)
Q30	`topic-level consensus`	P(examined) 0.65, 3/6 models rest it · —
Q31	`chem-q4-back-titration-consumer-claim`	0.61 · 5 (fable, opus, gpt-5.6-sol, grok, deepseek)
Q32	`watch list`	0.55 (fable), 0.65 (gemini-3.1-pro), 0.48 (grok) · 3
Q33	`chem-q3-competing-precipitation`	0.53 · 5 (fable, opus, gpt-5.6-sol, grok, deepseek)
Q34	`watch list`	0.60 (fable), 0.42 (opus) · 2
Q35	`chem-q5-reaction-pathway-flowchart`	0.57 · 6 (all)
Q36	`watch list`	0.35–0.42 · 3 (fable, gpt-5.6-sol, opus)

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Paper item	Prediction	Agreement
Q37	`chem-q1-spectroscopy-capstone`	0.72 · 6 (all)

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