

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 $\Rightarrow$ weak; many particles per volume $\Rightarrow$ concentrated
2	C	$[\text{H}^+] = 1.0 \times 10^{-3} \text{ mol L}^{-1} \Rightarrow \text{pH } 3.0$
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	$^{79}\text{Br}/^{81}\text{Br} \approx 1:1$ 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 = $\text{HCO}_3^- + \text{H}^+ = \text{H}_2\text{CO}_3$
10	A	Hydrophobic tails into grease, hydrophilic heads to water
11	B	Heating favours the endothermic (forward) direction $\Rightarrow$ blue $[\text{CoCl}_4]^{2-}$
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	$K_{\text{sp}} = [\text{Ag}^+]^2[\text{CrO}_4^{2-}] = (2s)^2(s) = 4s^3$
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 $\text{OH}^- = 1.25 \text{ mmol} / 50.0 \text{ mL} = 0.025 \text{ mol L}^{-1}$; pOH 1.60; pH 12.40
20	A	K_a 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). $q = 250.0 \times 4.18 \times 20.0 = 20\,900 \text{ J} = 20.9 \text{ kJ}$; $n = 0.850/60.09 = 1.41 \times 10^{-2} \text{ mol}$; $\Delta cH = -20.9/0.01415 = -1.48 \times 10^3 \text{ kJ mol}^{-1}$.

(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-

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

Q23. $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$; $K_b = K_w/K_a = 5.6 \times 10^{-10}$; $x = \sqrt{(5.6 \times 10^{-10} \times 0.25)} = 1.18 \times 10^{-5}$ (approximation valid: $x/c \approx 0.005\% \ll 5\%$); $\text{pOH} = 4.93$; **pH = 9.07**.

Q24 (a). $[\text{N}_2\text{O}_4]$ continuous at t_1 (no step), rising with decreasing gradient to a higher plateau.

(b). Added NO_2 raises $[\text{NO}_2]$, so $\text{NO}_2\text{--NO}_2$ 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 $[\text{NO}_2]$ falls and $[\text{N}_2\text{O}_4]$ 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 $a = \text{mol I}_2$ added; shift forward by x : $1.40 + 2x = 1.60 \Rightarrow x = 0.100$. New $[\text{H}_2] = 0.100$; $K = 1.60^2/(0.100 \times (0.100 + a)) = 49.0 \Rightarrow 0.100 + a = 2.56/4.90 = 0.522 \Rightarrow \mathbf{a = 0.42 \text{ mol}}$ (concentrations, not moles, in K ; here $V = 1.00 \text{ L}$ so they coincide numerically — working must show the expression).

Q26 (a). $\text{Ba}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$. 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). $n(\text{H}_2\text{SO}_4) = 0.100 \times 0.0220 = 2.20 \times 10^{-3} \text{ mol} = n(\text{Ba}(\text{OH})_2)$; $c = 2.20 \times 10^{-3}/0.0250 = \mathbf{0.0880 \text{ mol L}^{-1}}$.

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

(b). $24 \text{ mg L}^{-1} \div 63.55 \text{ g mol}^{-1} = 3.8 \times 10^{-4} \text{ mol L}^{-1} > 8.0 \times 10^{-5} \text{ mol L}^{-1} (\approx 4.7 \times \text{the limit}) \Rightarrow \mathbf{\text{not compliant}}$.

Q28 (a). At half-equivalence (12.5 mL) $\text{pH} = \text{pK}_a = 4.87 \Rightarrow \mathbf{K_a = 10^{-4.87} = 1.3 \times 10^{-5}}$. Annotation of the half-equivalence volume required.

(b). At equivalence only the propanoate ion is present; $\text{CH}_3\text{CH}_2\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{CH}_2\text{COOH} + \text{OH}^-$ generates excess OH^- , so $\text{pH} > 7$.

Q29 (a). All three sulfates are insoluble or slightly soluble: $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4(\text{s})$, $\text{Pb}^{2+} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4(\text{s})$ (and CaSO_4 may also form), so a white precipitate does not distinguish the cations.

(b). Valid sequence, e.g.: (1) add $\text{NaCl}(\text{aq})$ or dilute HCl — white precipitate $\text{PbCl}_2(\text{s})$ only if Pb^{2+} : $\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$; $\text{Ba}^{2+}/\text{Ca}^{2+}$ give no precipitate. (2) If no precipitate, flame test: apple-green $\Rightarrow \text{Ba}^{2+}$, brick-red $\Rightarrow \text{Ca}^{2+}$ (or add $\text{F}^-/\text{SO}_4^{2-}$ 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.

Q31 (a). $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ and $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$.

(b). Titre 1 (20.10 mL) is an outlier — exclude; mean concordant titre = $(19.20 + 19.15 + 19.25)/3 = 19.20$ mL. $n(\text{NaOH}) = 1.920 \times 10^{-3} \text{ mol} = n(\text{excess HCl})$ per 25.00 mL aliquot; $\times 10 = 1.920 \times 10^{-2} \text{ mol}$ excess HCl total. Initial HCl = 0.02500 mol; reacted with tablet = $5.80 \times 10^{-3} \text{ mol}$; $n(\text{CaCO}_3) = 2.90 \times 10^{-3} \text{ mol}$; 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. $\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$. Added H^+ reacts with the large reservoir of CH_3COO^- (equilibrium shifts left), so $[\text{H}^+]$ 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 $[\text{SO}_4^{2-}] = 1.08 \times 10^{-10}/0.010 = 1.1 \times 10^{-8} \text{ mol L}^{-1}$; CaSO_4 at $4.93 \times 10^{-5}/0.010 = 4.9 \times 10^{-3} \text{ mol L}^{-1} \Rightarrow \text{BaSO}_4$ first (by $\sim 10^5$ times).

(b). When CaSO_4 just starts, $[\text{SO}_4^{2-}] = 4.93 \times 10^{-3} \Rightarrow [\text{Ba}^{2+}] = 1.08 \times 10^{-10}/4.93 \times 10^{-3} = \mathbf{2.2 \times 10^{-8} \text{ mol L}^{-1}}$ — essentially all Ba^{2+} (99.9998%) is removed before any CaSO_4 forms, so filtering at this point separates the ions.

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

(b). $\Delta G = 0$ at $T = 178/0.161 = \mathbf{1.11 \times 10^3 \text{ K} (\approx 833 \text{ °C})}$; 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, $(\text{CH}_3)_2\text{CHCOOCH}_2\text{CH}_3$.

(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 ($\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$) 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)**, $\text{CH}_3\text{COOCH}(\text{CH}_3)_2$, made from **propan-2-ol**. Justification: $M_r = 102$ matches $\text{C}_5\text{H}_{10}\text{O}_2$; base peak m/z 43 = CH_3CO^+ (acylium; C_3H_7^+ also accepted with reasoning), m/z 87 = $M - \text{CH}_3$, 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 $\Rightarrow$ 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 ($\text{CH}_3\text{C}=\text{O}$, 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).

Prediction provenance

Which consensus prediction each part of this paper realises. Full evidence panels:

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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)

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

Built by an AI panel and backtested against the hidden 2025 papers before publication — method at intuitioneducation.com.au/hsc-2026/how-we-did-it. Scored publicly in November 2026. Independent Intuition Education material from publicly available NESA documents; not affiliated with or endorsed by NESA.