

Markscheme

May 2026

Chemistry

Higher level

Paper 2

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Subject Details: Chemistry Higher Level Paper 2 Markscheme

Candidates are required to answer **ALL** questions. Maximum total = **[90 marks]**.

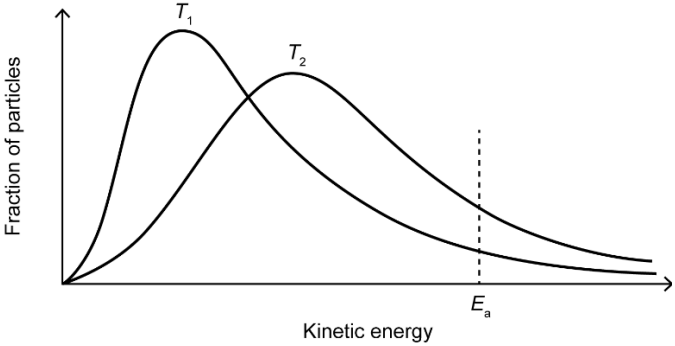
1. Each row in the “Question” column relates to the smallest subpart of the question.
2. The maximum mark for each question subpart is indicated in the “Total” column.
3. Each marking point in the “Answers” column is shown by means of a tick (✓) at the end of the marking point.
4. A question subpart may have more marking points than the total allows. This will be indicated by “**max**” written after the mark in the “Total” column. The related rubric, if necessary, will be outlined in the “Notes” column.
5. An alternative word is indicated in the “Answers” column by a slash (/). Either word can be accepted.
6. An alternative answer is indicated in the “Answers” column by “**OR**”. Either answer can be accepted.
7. An alternative markscheme is indicated in the “Answers” column under heading **ALTERNATIVE 1** etc. Either alternative can be accepted.
8. Words inside chevrons « » in the “Answers” column are not necessary to gain the mark.
9. Words that are underlined are essential for the mark.
10. The order of marking points does not have to be as in the “Answers” column, unless stated otherwise in the “Notes” column.
11. If the candidate’s answer has the same “meaning” or can be clearly interpreted as being of equivalent significance, detail and validity as that in the “Answers” column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect) in the “Notes” column.
12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.
14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the “Notes” column.
15. If a question specifically asks for the name of a substance, do not award a mark for a correct formula unless directed otherwise in the “Notes” column. Similarly, if the formula is specifically asked for, do not award a mark for a correct name unless directed otherwise in the “Notes” column.
16. If a question asks for an equation for a reaction, a balanced symbol equation is usually expected, do not award a mark for a word equation or an unbalanced equation unless directed otherwise in the “Notes” column.
17. Ignore missing or incorrect state symbols in an equation unless directed otherwise in the “Notes” column.

Question			Answers	Notes	Total
1.	(a)	(i)	Li $1s^2 2s^1$ AND Cl $1s^2 2s^2 2p^6 3s^2 3p^5$ ✓ Li loses AND Cl gains $1e^-$ OR Li⁺ AND Cl⁻ formed OR $1s^2$ AND $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓ «oppositely charged» ions are electrostatically attracted ✓	Accept condensed electron configurations.	3
1.	(a)	(ii)	«observed electron configuration is» [Ar]4s¹3d⁵ ✓ promoting 4s electron to 3d level is more stable configuration OR half-occupied d-orbitals/d-sublevel more stable ✓	Accept full electron configuration OR orbital diagram for M1.	2
1.	(b)	(i)	«$0.0350 \text{ dm}^3 \times 0.550 \text{ mol dm}^{-3} =$» 0.0193 «mol LiOH» AND «$0.0350 \text{ dm}^3 \times 0.250 \text{ mol dm}^{-3} =$» 0.00875 «mol Fe(NO₃)₃» ✓ «3:1 ratio hence» LiOH is limiting reactant ✓ «$\frac{0.0193 \text{ mol}}{3} \times 106.88 \text{ g mol}^{-1} =$» 0.688 «g Fe(OH)₃» ✓	Award [3] for correct final answer with working. Do not award M2 without justification.	3
1.	(b)	(ii)	«$\frac{0.542 \text{ g}}{0.688 \text{ g}} \times 100 =$» 78.8% ✓	If 0.763 is used, the answer is 71.0%.	1

Question			Answers	Notes	Total
1.	(c)	(i)	Acid: hydrochloric acid AND Base: ammonia ✓	Accept hydrogen chloride (for acid) and ammonium hydroxide/carbonate/hydrogen carbonate (for base). Do not accept formulas only.	1
1.	(c)	(ii)	less than 7 ✓	Accept any value in range 3.5 - 6.9. Do not accept a range that includes pH = 7.	1
1.	(c)	(iii)	ALTERNATIVE 1: $\ll K_a = 10^{-4.76} = \frac{[H^+][A^-]}{[HA]} \gg$ $\ll [H^+] = \frac{10^{-4.76} \times 0.350}{0.455} = \gg 1.34 \times 10^{-5} \ll \text{mol dm}^{-3} \gg \checkmark$ $\ll \text{pH} = -\log 1.34 \times 10^{-5} = \gg 4.87 \checkmark$ ALTERNATIVE 2: $\ll \text{pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]} = \gg$ $\ll \text{pH} = \gg 4.76 + \log \frac{0.455}{0.350} / 4.76 + 0.114 \checkmark$ $\ll \text{pH} = \gg 4.87 \checkmark$	Award [2] for correct final answer.	2

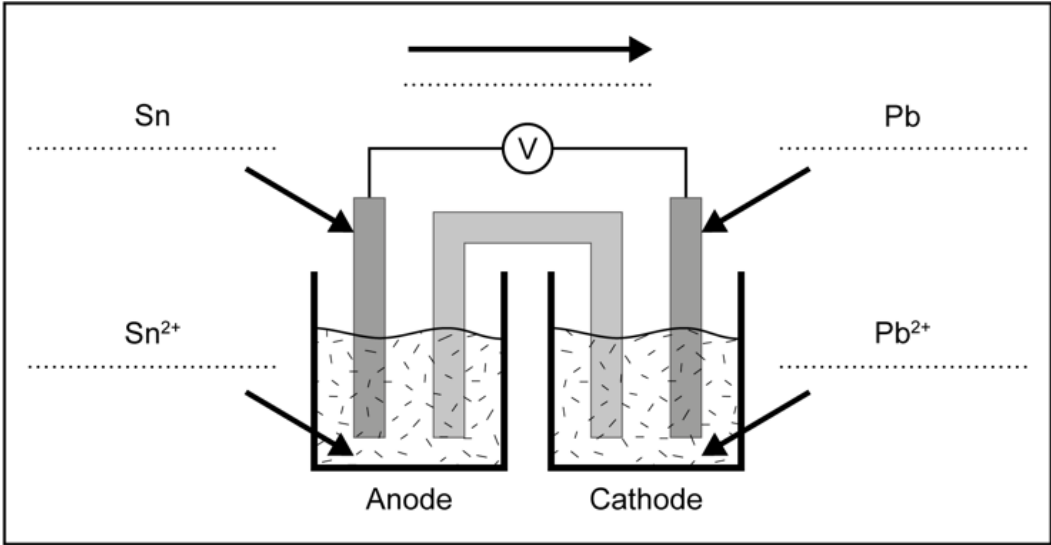
Question			Answers	Notes	Total
2.	(a)	(i)	$\frac{\llcorner+ \gg 285.4}{2} / \llcorner+ \gg 142.7 \text{ «kJ mol}^{-1}\gg \textbf{AND} \frac{\llcorner- \gg 498.0}{2} / \llcorner- \gg 249.0 \text{ «kJ mol}^{-1}\gg \checkmark$ $\llcorner+ 142.7 + (-249.0) + (-199.9) = \gg -306.2 \text{ «kJ mol}^{-1}\gg \checkmark$	Award [2] for final correct answer.	2
2.	(a)	(ii)	<i>Bond angle:</i> $110^\circ \leq \text{bond angle} < 120^\circ \checkmark$ <i>Molecular geometry:</i> bent / V-shaped / angular $\checkmark$	Accept any value in the range $110^\circ - 119^\circ$ (actual value is 116.8°).	2
2.	(a)	(iii)	$\llcorner V = \frac{1.75 \text{ mol} \times 8.31 \text{ J K}^{-1} \text{ mol}^{-1} \times 348 \text{ K}}{115 \text{ kPa}} = \gg 44.0 \text{ «dm}^3\gg \checkmark$		1
2.	(a)	(iv)	«gases under» high pressures AND molecular volume cannot be ignored OR «gases» with strong IMF / at low temperature / at high pressure AND molecular attractions/IMFs cannot be ignored $\checkmark$		1

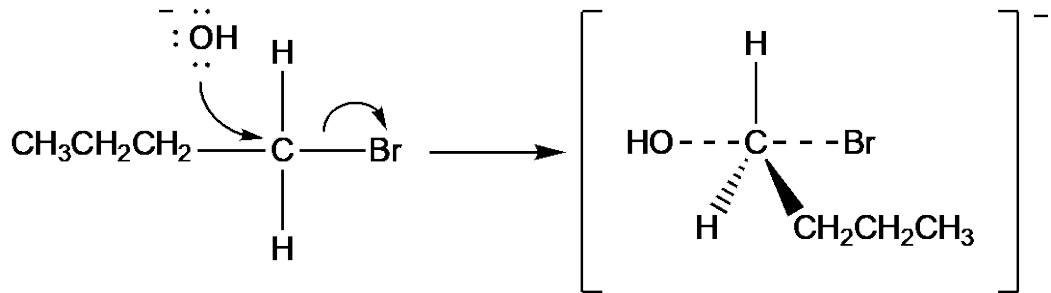
Question			Answers	Notes	Total				
2.	(a)	(v)	$\begin{array}{ccc} \text{:}\ddot{\text{O}}=\ddot{\text{O}}-\ddot{\text{O}}\text{:} \\ 0 \qquad +1/+ \qquad -1/- \checkmark \end{array}$	All three must be correct for the mark.	1				
2.	(b)	(i)	$\llcorner K = \llcorner \frac{[\text{NO}]^2[\text{O}_2]}{[\text{NO}_2]^2} \checkmark$		1				
2.	(b)	(ii)	<table><tr><td>Equilibrium position</td><td>shift to left/reactants AND fewer moles «of gas» ✓</td></tr><tr><td>Value of equilibrium constant</td><td>same AND only changes with temperature ✓</td></tr></table>	Equilibrium position	shift to left/reactants AND fewer moles «of gas» ✓	Value of equilibrium constant	same AND only changes with temperature ✓	Award [1 max] for correct effects without explanations.	2
Equilibrium position	shift to left/reactants AND fewer moles «of gas» ✓								
Value of equilibrium constant	same AND only changes with temperature ✓								
2.	(b)	(iii)	K calculated using equilibrium «concentrations» AND Q calculated «in the same way as K but» using non-equilibrium «concentrations» ✓ proceeds to the left / reverse reaction AND to use up excess products OR proceeds to the left / reverse reaction AND to decrease the value of Q «until it reaches equilibrium» ✓		2				
2.	(b)	(iv)	more particles will possess the necessary activation energy OR more particles/collisions with $E \geq E_a$ ✓ more «successful» collisions per unit time OR the frequency of «successful» collisions increases OR greater proportion of collisions are successful per unit time ✓		2				

Question			Answers	Notes	Total
2.	(b)	(v)	 T_2 curve starting at origin and asymptotic to x-axis with maximum lower AND to the right of T_1 maximum ✓		1
2.	(b)	(vi)	no effect ✓		1
2.	(c)	(i)	mechanism agrees with balanced/overall equation ✓ rate-determining step must be Step 2 AND based on rate equation ✓	Accept “rate law” for “rate equation”. Accept Step 1 is not the rate determining step AND based on rate equation for M2.	2
2.	(c)	(ii)	$\frac{1.5 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}}{[1.6 \times 10^{-1} \text{ mol dm}^{-3}]^2 [2.4 \times 10^{-1} \text{ mol dm}^{-3}]} = \gg 0.024 \quad \checkmark$ $\text{mol}^{-2} \text{ dm}^6 \text{ s}^{-1} \quad \checkmark$		2
3.	(a)	(i)	$190.96x + 192.96(1 - x) = 192.22$ OR $\frac{190.96x + 192.96(100 - x)}{100} = 192.22 \quad \checkmark$ <i>Ir-191</i>: 37% AND <i>Ir-193</i>: 63% ✓	Award [2] for correct final answer. Award [1 max] for 0.37 and 0.63.	2

Question			Answers	Notes	Total								
3.	(a)	(ii)	<table><tr><th>Subatomic Particle</th><th>Number</th></tr><tr><td>Protons</td><td>77</td></tr><tr><td>Neutrons</td><td>116</td></tr><tr><td>Electrons</td><td>73</td></tr></table>	Subatomic Particle	Number	Protons	77	Neutrons	116	Electrons	73	All 3 must be correct for mark.	1
			Subatomic Particle	Number									
			Protons	77									
			Neutrons	116									
			Electrons	73									
✓													
3.	(b)	(i)	Any two of: aluminium has smaller «ionic» radius ✓ aluminium has more delocalized electrons ✓ aluminium has greater «ionic» charge ✓	Accept “Al has more valence electrons” for M2.	2 max								
3.	(b)	(ii)	2Na(s) + 2H ₂ O(l) → H ₂ (g) + 2NaOH(aq). correct products AND state symbols ✓ correct balancing ✓		2								
3.	(b)	(iii)	Na has fewer occupied energy levels / lower shielding effect «than Cs» OR Na has valence electrons closer to the nucleus «than Cs» ✓	Accept Na has a smaller «atomic» radius.	1								

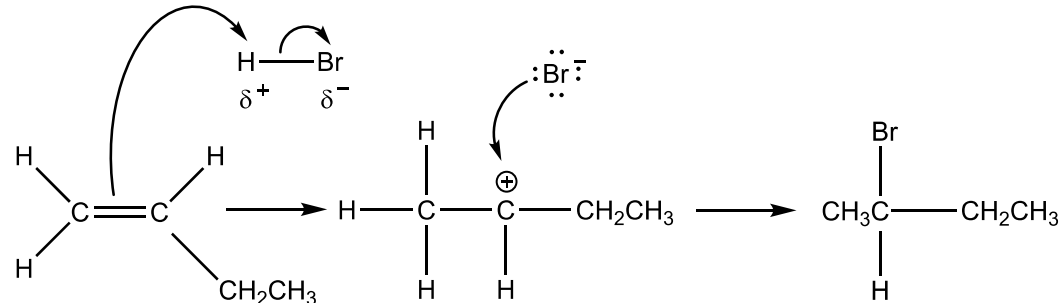
Question			Answers	Notes	Total
3.	(b)	(iv)	<i>Wavelength:</i> $\llcorner E = \frac{376000 \text{ J mol}^{-1}}{6.02 \times 10^{23} \text{ mol}^{-1}} = \gg 6.25 \times 10^{-19} \llcorner J \gg \checkmark$ $\llcorner \lambda = \frac{6.63 \times 10^{-34} \text{ J s} \times 3.00 \times 10^8 \text{ m s}^{-1}}{6.25 \times 10^{-19} \text{ J}} = \gg 3.18 \times 10^{-7} \llcorner m \gg \checkmark$ <i>Region:</i> ultraviolet/UV $\checkmark$		3
3.	(c)	(i)	ions/atoms of different radii/sizes AND layers cannot slide easily OR ions/atoms «added to the metal» disrupt lattice structure AND layers cannot slide easily $\checkmark$		1
3.	(c)	(ii)	<i>Any one of:</i> resistance to corrosion $\checkmark$ melting point $\checkmark$ density $\checkmark$ electrical conductivity $\checkmark$ magnetic behaviour $\checkmark$	Accept “wear resistance” or “boiling point”. Ignore malleability, ductility, strength, toughness, lustre or colour.	1 max

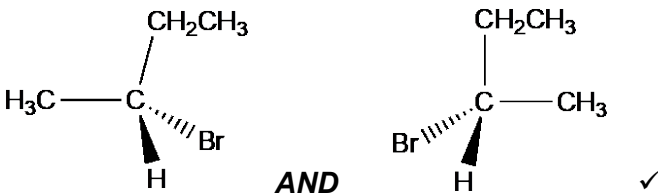
Question			Answers	Notes	Total
3.	(d)	(i)	 all 4 species labeled correctly ✓ arrow showing electron flow from anode to cathode in external circuit ✓	<i>Do not accept arrow through the salt bridge.</i>	2
3.	(d)	(ii)	«replace voltmeter with external» battery/power supply ✓ force/change/reverse direction of electron flow/current ✓ rebuilds/increases mass of Sn/anode OR rebuilds/increases «concentration of» Pb²⁺ ions ✓	<i>Accept diagrams for M1 and M2.</i>	3

Question			Answers	Notes	Total
3.	(e)	(i)	absorbs yellow light/575 – 585 «nm» ✓ complementary colour «violet» seen/transmitted ✓	Accept any wavelength value within the given range for M1. Do not accept violet light is “emitted” for M2.	2
3.	(e)	(ii)	coordination bond ✓	Accept dative/coordinate «covalent» bond.	1
4.	(a)	(i)	 CH₃CH₂CH₂CH₂OH + Br⁻ curly arrow from lone pair/negative charge on O in ⁻OH to carbon attached to Br ✓ curly arrow from C—Br to Br ✓ transition state showing negative charge AND partial bonds ✓	Award [2 max] for correctly drawn S_N1 mechanism. For M2, accept curly arrow in the transition state. For M3, do not penalize if HO and Br are not at 180° or the square bracket is missing. Penalize bond connectivity (e.g. OH---C in the transition state) only once. Penalize missing charges only once.	3
4.	(a)	(ii)	butan-1-ol ✓	Accept 1-butanol. Do not accept structural formula.	1

Question			Answers	Notes	Total						
4.	(b)	(i)	$\llbracket \Sigma(\Delta H_{\text{f}}^{\ominus} \text{ products}) \rrbracket 4 \times (-394) + 5 \times (-286) / -3006 \text{ «kJ mol}^{-1}\text{»}$ AND $\llbracket \Sigma(\Delta H_{\text{f}}^{\ominus} \text{ reactants}) \rrbracket -126 \text{ «kJ mol}^{-1}\text{»} \checkmark$ $\llbracket \Sigma(\Delta H_{\text{f}}^{\ominus} \text{ products}) - \Sigma(\Delta H_{\text{f}}^{\ominus} \text{ reactants}) \rrbracket = -3006 - (-126) = -2880 \text{ «kJ mol}^{-1}\text{»} \checkmark$	Award [2] for correct final answer.	2						
4.	(b)	(ii)	$\llbracket T = \rrbracket 298 \text{ «K»} \textbf{AND} \llbracket \Delta S^{\ominus} = \rrbracket -0.4375 \text{ «kJ K}^{-1} \text{ mol}^{-1}\text{»} \checkmark$ $\llbracket \Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus} \rrbracket$ $\llbracket \Delta G^{\ominus} = -2880 \text{ kJ mol}^{-1} - (-0.4375 \text{ kJ K}^{-1} \text{ mol}^{-1} \times 298 \text{ K}) \rrbracket = -2750 \text{ «kJ mol}^{-1}\text{»} \checkmark$	Award [2] for correct final answer. If -2400 is used, the answer is – 2270 «kJ mol ⁻¹ ».	2						
4.	(b)	(iii)	<table><tr><td>Compound</td><td>Oxidation State</td></tr><tr><td>CH₃CH₂CH₂CH₃</td><td>-3 ✓</td></tr><tr><td>CO₂</td><td>+4 ✓</td></tr></table>	Compound	Oxidation State	CH₃CH₂CH₂CH₃	-3 ✓	CO ₂	+4 ✓	Do not accept III or 3- for –3. Accept IV for +4 but do not accept 4+ or 4.	2
Compound	Oxidation State										
CH₃CH₂CH₂CH₃	-3 ✓										
CO ₂	+4 ✓										
4.	(c)	(i)	propanoic acid ✓ methanol ✓	Accept propanoyl chloride OR propanoic anhydride for M1. Award [1 max] for CH ₃ CH ₂ COOH AND CH ₃ OH.	2						

Question			Answers	Notes	Total
4.	(c)	(ii)	water ✓	<i>The by-product must match the reactants suggested in part (i). If the acid chloride was used the by-product is hydrochloric acid/hydrogen chloride, and if the anhydride was used the by-product is propanoic acid.</i> <i>Do not accept structural formula.</i>	1
4.	(c)	(iii)	prop-2-en-1-ol has hydrogen bonding «between molecules» AND propanone has dipole-dipole «forces between molecules» ✓ hydrogen bonds stronger «IMF» ✓		2
4.	(d)	(i)	provides energy for Cl—Cl/Cl ₂ bond fission/breaking OR produces Cl«•» radicals ✓		1
4.	(d)	(ii)	<i>Propagation:</i> CH ₄ + Cl• → •CH ₃ + HCl ✓ •CH ₃ + Cl ₂ → CH ₃ Cl + Cl• ✓ <i>Termination:</i> Cl• + Cl• → Cl ₂ OR Cl• + •CH ₃ → CH ₃ Cl OR •CH ₃ + •CH ₃ → CH ₃ CH ₃ ✓	<i>Penalize missing radicals once.</i> <i>Do not penalize location of radical dot on species.</i>	3

Question			Answers	Notes	Total
4.	(e)	(i)	but-1-ene: one carbon at C=C bond has two hydrogens/identical groups OR but-2-ene: both carbons at C=C bond have different groups attached ✓	<i>A structural drawing can be used as part of the explanation.</i>	1
4.	(e)	(ii)	sp ³ AND sp ² ✓		1
4.	(e)	(iii)	Number of signals: 2 ✓ Relative areas: 1:3 ✓	Accept relative areas in any order. Accept relative areas 2:6. Award [1 max] for 4 AND 1:1:3:3.	2
4.	(e)	(iv)	 curly arrow from C=C bond to H of HBr AND curly arrow showing H—Br bond breaking ✓ carbocation with charge on correct atom ✓ curly arrow from lone pair/negative charge on Br⁻ to C⁺ ✓	Do not penalize missing partial charges on H—Br for M1.	3

Question			Answers	Notes	Total
4.	(e)	(v)		Do not accept structures without wedge-dash representation. Do not accept structures with 90° angles.	1
4.	(e)	(vi)	«rotate plane of» polarized light OR «use a» polarimeter ✓ «plane of polarized» light is rotated in opposite directions ✓		2
4.	(e)	(vii)	aromatic ring / «clouds of» delocalized electrons ✓ «addition would» disrupt stabilizing effect of delocalised electrons/resonance OR resonance energy must be overcome OR breaking aromatic ring requires more energy than breaking one pi-bond «in alkene» ✓	Accept resonance structure for M1.	2
4.	(f)	(i)	«bonds broken» $4\text{C—H} + 2\text{O=O} / 4 \times 414 + 2 \times 498 / 2652 \text{ «kJ mol}^{-1}\text{»}$ AND «bonds formed» $2\text{C=O} + 4\text{O—H} / 2 \times 804 + 4 \times 463 / 3460 \text{ «kJ mol}^{-1}\text{»}$ ✓ «$\Delta H = 2652 - 3460 =$» $-808 \text{ «kJ mol}^{-1}\text{»}$ ✓	Award [2] for correct final answer.	2

Question			Answers	Notes	Total
4.	(f)	(ii)	zero AND element in the standard state ✓	Accept $O_2(g)$ does not have an enthalpy of formation as it is an element in the standard state.	1
4.	(f)	(iii)	Any two of: carbon «in CO» not fully oxidized ✓ one «triple» bond in CO weaker than two «double» bonds in CO_2 ✓ CO flammable OR combustion of CO exothermic ✓	Accept fewer/weaker bonds formed in CO than in forming CO_2 for M2.	2 max