2226 – 4233M

Markscheme

May 2026

Chemistry

Standard level

Paper 2

11 pages

Subject Details: Chemistry Standard Level Paper 2 Markscheme

Candidates are required to answer **ALL** questions. Maximum total = **[50 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.

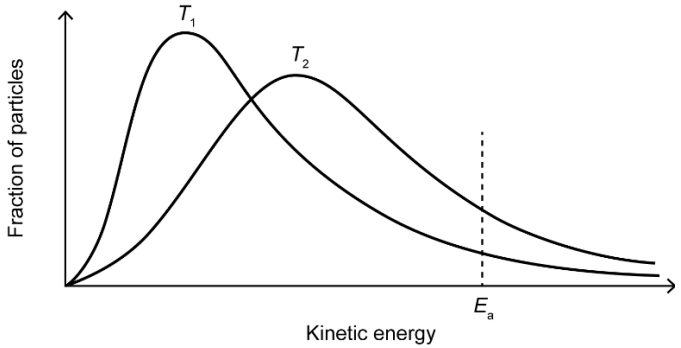
16. If a question asks for an equation for a reaction, a balanced symbol equation is usually expected, do not award a mark for a word equation or an unbalanced equation unless directed otherwise in the "Notes" column.

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» $[Ar]4s^1 3d^5$ ✓ 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)	«$0.0350\ dm^3 \times 0.550\ mol\ dm^{-3}$ =» 0.0193 «mol LiOH» ***AND*** «$0.0350\ dm^3 \times 0.250\ mol\ dm^{-3}$ =» 0.00875 «mol $Fe(NO_3)_3$» ✓ «3:1 ratio hence» LiOH is limiting reactant ✓ «$\frac{0.0193\ mol}{3} \times 106.88\ g\ mol^{-1}$ =» 0.688 «g $Fe(OH)_3$» ✓	*Award **[3]** for correct final answer with working.* *Do **not** award M2 without justification.*	**3**
1.	(b)	(ii)	«$\frac{0.542\ g}{0.688\ g} \times 100$ =» 78.8% ✓	*If 0.763 is used, the answer is 71.0%.*	**1**

Question			Answers	Notes	Total
2.	(a)	(i)	$\frac{«+»285.4}{2}$ / «+»142.7 «kJ mol^{-1}» ***AND*** $\frac{«-»498.0}{2}$ / «–»249.0 «kJ mol^{-1}» ✓ «+142.7 + (–249.0) + (–199.9) =» –306.2 «kJ mol^{-1}» ✓	*Award **[2]** for final correct answer.*	**2**
2.	(a)	(ii)	*Bond angle:* 110˚ ≤ bond angle < 120° ✓ *Molecular geometry:* bent / V–shaped / angular ✓	*Accept any value in the range 110˚ – 119˚ (actual value is 116.8˚).*	**2**
2.	(a)	(iii)	«$V = \frac{1.75\ mol \times 8.31\ J\ K^{-1} mol^{-1} \times 348\ K}{115\ kPa}$ = » 44.0 «dm^3» ✓		**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 ✓		**1**
2.	(b)	(i)	«K =»$\frac{[NO]^2[O_2]}{[NO_2]^2}$ ✓		**1**

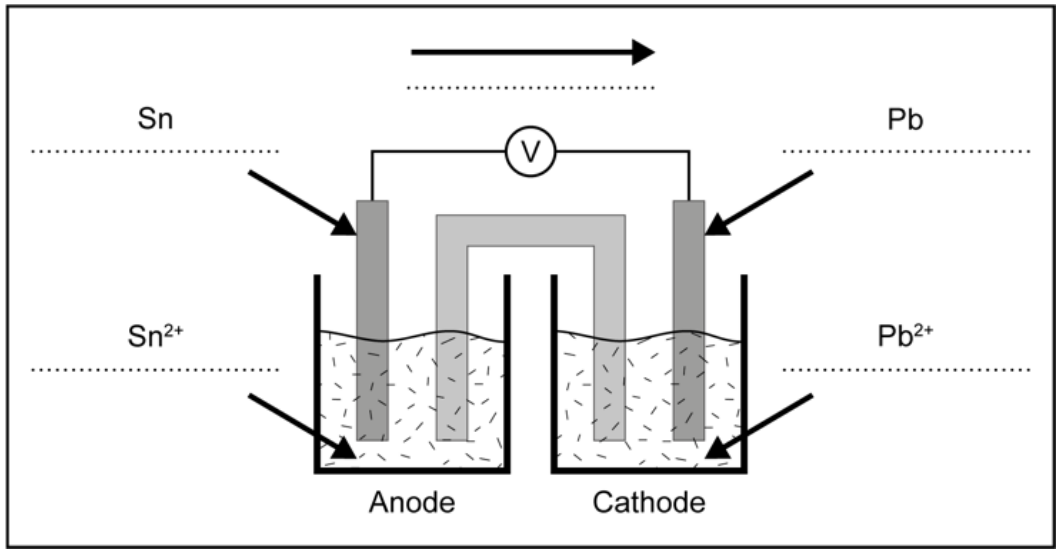
<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>2.</td><td>(b)</td><td>(ii)</td><td>
<table>
<tr><td>Equilibrium position</td><td>shift to left/reactants AND fewer moles «of gas» ✓</td></tr>
<tr><td>Value of equilibrium constant</td><td>same AND only changes with temperature ✓</td></tr>
</table>
</td><td>Award [1 max] for correct effects without explanations.</td><td>2</td></tr>
<tr><td>2.</td><td>(b)</td><td>(iii)</td><td>more particles will possess the necessary activation energy
OR
more particles/collisions with $E \geq E_a$ ✓

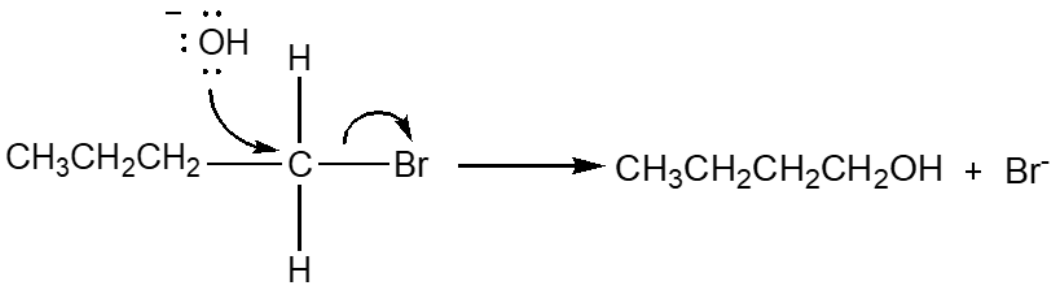
more «successful» collisions per unit time
OR
the frequency of «successful» collisions increases
OR
greater proportion of collisions are successful per unit time ✓</td><td></td><td>2</td></tr>
<tr><td>2.</td><td>(b)</td><td>(iv)</td><td> 

T_2 curve starting at origin and asymptotic to x-axis with maximum lower AND to the right of T_1 maximum ✓</td><td></td><td>1</td></tr>
</table>

Question			Answers	Notes	Total
2.	**(b)**	**(v)**	no effect ✓		**1**
3.	**(a)**	**(i)**	$190.96x + 192.96(1 - x) = 192.22$ ***OR*** $\frac{190.96\,x+192.96(100-x)}{100} = 192.22$ ✓ *Ir-191:* 37% ***AND*** *Ir-193:* 63% ✓	*Award **[2]** for correct final answer.* *Award **[1 max]** for 0.37 and 0.63.*	**2**
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>✓	*All 3 must be correct for mark.*	**1**
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)**	$2Na(s) + 2H_2O(l) \rightarrow H_2(g) + 2NaOH(aq)$. correct products ***AND*** state symbols ✓ *correct balancing* ✓		**2**

Question			Answers	Notes	Total
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**
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 ✓		**1**
3.	**(c)**	**(ii)**	*Any one of:* resistance to corrosion ✓ melting point ✓ density ✓ electrical conductivity ✓ magnetic behaviour ✓	*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 ✓	*Do **not** accept arrow through the salt bridge.*	**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*** regenerates/increases «concentration of» Pb^{2+} ions ✓	*Accept diagrams for M1 and M2.*	**3**

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>4.</td><td>(a)</td><td></td><td> 

curly arrow from lone pair/charge of hydroxide ion to carbon attached to Br ✓

curly arrow from C–Br to Br ✓

butan-1-ol AND Br⁻ ✓</td><td>Accept more detailed mechanism (S_N1 or S_N2) if drawn, although not required.

Penalize missing charges only once.

Do not award M3 if incorrect isomer.</td><td>3</td></tr>
<tr><td>4.</td><td>(b)</td><td>(i)</td><td>Bonds broken:
«3 C–C + 10 C–H + 6.5 O=O»
3 × 346 «kJ mol^{–1}» + 10 × 414 «kJ mol^{–1}» + 6.5 × 498 «kJ mol^{–1}» / 8415 «kJ mol^{–1}» ✓

Bonds formed:
«8 C=O + 10 O–H»
8 × 804 «kJ mol^{–1}» + 10 × 463 «kJ mol^{–1}» / 11062 «kJ mol^{–1}» ✓

ΔH «= Σbonds broken − Σbonds formed = (8415 kJ mol^{–1} − 11062 kJ mol^{–1})»
= –2647«kJ mol^{–1}» ✓</td><td>Award [3] for correct final answer.

Award [2 max] for final answer of «+»2647 «kJ mol⁻¹».</td><td>3</td></tr>
<tr><td>4.</td><td>(b)</td><td>(ii)</td><td><table><tr><th>Compound</th><th>Oxidation State</th></tr><tr><td>CH₃CH₂CH₂CH₃</td><td>–3 ✓</td></tr><tr><td>CO₂</td><td>+4 ✓</td></tr></table></td><td>Do not accept III or 3- for –3.

Accept IV for +4 but do not accept 4+ or 4.</td><td>2</td></tr>
</table>

Question			Answers	Notes	Total
4.	**(c)**		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)**		*Initiation:* Cl_2 «+ hf/UV » $\rightarrow$ 2Cl• ✓ *Propagation:* $CH_4 + Cl\bullet \rightarrow \bullet CH_3 + HCl$ ✓ $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ ✓	*Penalize missing radicals once.* *Do **not** penalize location of radical dot on species.* *Do **not** accept hydrogen radical.*	**3**