CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **February/March 2026**

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2026 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

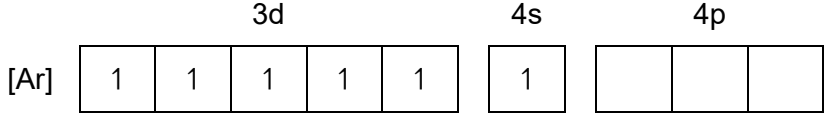
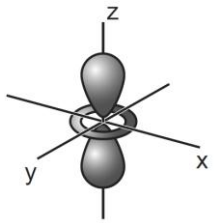
We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

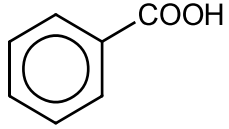
Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Unclear
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Part of the correct answer has been seen. Full credit has not been awarded.
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error

Annotation	Meaning
REP	Repetition
SEEN	Blank page or part of script seen
SF	Error in number of significant figures
TE	Transcription error

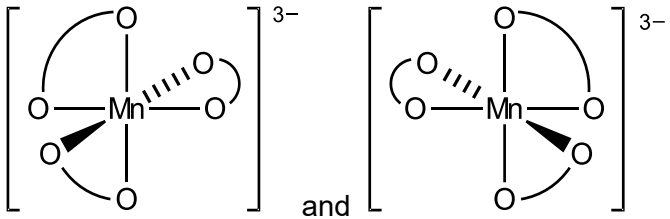
Question	Answer	Marks
1(a)(i)	(d-block element which forms one or more) stable ions/compounds with an incomplete d orbital(s)/d sub-shell	**1**
1(a)(ii)		**1**
1(a)(iii)		**1**
1(a)(iv)	more than one (stable) oxidation state / exist in variable oxidation states vacant/empty (d) orbitals are energetically accessible **OR** vacant/empty (d) orbitals can form dative bonds with ligands **OR** vacant/empty (d) orbitals can accept lone pair to bond with ligands	**2**
1(b)(i)	**M1**: emf / potential / voltage of an electrode / half-cell compared / connected to SHE / hydrogen half-cell **M2**: 1 mol dm^{-3}, 1 atm, 298 K	**2**

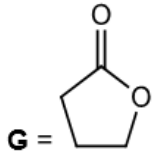
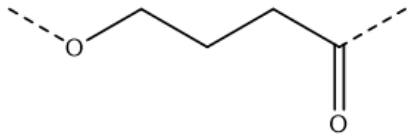
Question	Answer	Marks
1(b)(ii)	**M1**: (Cr^{2+} ions) can be oxidised to Cr^{3+} **M2**: by O_2 in acidic conditions / O_2 with H^+ because $E^{\ominus}_{cell}$ =(+)1.64 (V) **OR** by O_2 in acidic conditions / O_2 with H^+ as $E^{\ominus}$ O_2 / H^+ is more positive than Cr^{3+} / Cr^{2+} **OR** by O_2 in alkaline conditions / O_2 with OH^- because $E^{\ominus}_{cell}$ = (+) 1.66 (V) **OR** +0.81 V **OR** by O_2 in alkaline conditions / O_2 with OH^- as $E^{\ominus}$ O_2 / OH^- is more positive than Cr^{3+} / Cr^{2+}	**2**
1(b)(iii)	*for green solid* $Cr^{3+}(aq) + 3OH^-(aq) \rightarrow Cr(OH)_3(s)$	**1**
1(b)(iv)	*for yellow solution* $4Cr(OH)_3(s) + 8OH^-(aq) + 3O_2(g) \rightarrow 4CrO_4^{2-}(aq) + 10H_2O(l)$ correct species [1] correct balancing [1]	**2**
1(c)(i)	gaseous products are formed **OR** increase in moles / molecules of gas	**1**
1(c)(ii)	$915 = 192 + 81 + 4S - 114$ $\therefore S = ¼ \times 756 =$ (+) 189 ($J\,K^{-1}\,mol^{-1}$)	**2**
1(c)(iii)	ΔG always / needs / is to be negative / <0 because $\Delta H < 0$ / negative / exothermic $\Delta S > 0$ / positive / $-T\Delta S$ is negative high activation energy / E_a prevents reaction	**2**
1(d)(i)	(enthalpy change/energy released when) • 1 mole of • gaseous atoms accept • one mole of e^- any two [1], all three [2]	**2**

Question	Answer	Marks
1(d)(ii)	**M1**: (2 × 398 + 3×248 + 2 × 5233 + 3 × 702) **M2**: –1128 – 14112 = –15240 (kJ mol^{-1}) min 4 sf	**2**
1(d)(iii)	● Cr_2O_3 less exothermic / less negative ● Cr^{3+} (has same charge but) larger radius / is less charge dense ● less attraction between Cr^{3+} and O^{2-} / the different ions **OR** weaker bond between Cr^{3+} and O^{2-} any two [1], all three [2]	**2**

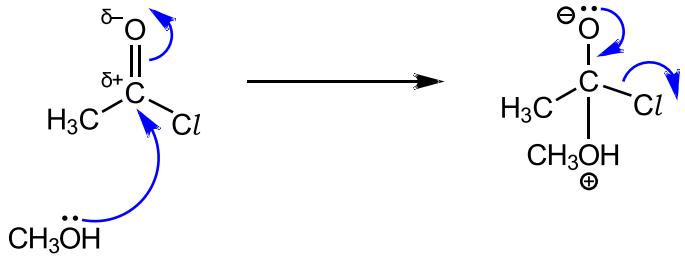
Question	Answer	Marks
2(a)(i)	**M1**: moles of manganate = 23.80 / 1000 × 0.0500 **OR** 1.19×10^{-3} mol **OR** initial moles of Fe^{2+} = 17.70 ÷ 277.9 **OR** 6.37×10^{-2} mol **M2**: moles of Fe^{2+} in aliquot = $5 \times 1.19 \times 10^{-3}$ **OR** 5.95×10^{-3} mol **AND** total moles of Fe^{2+} = $5.95 \times 10^{-3} \times 10$ **OR** 5.95×10^{-2} mol **OR** mass of $FeSO_4 \cdot 7H_2O$ left = $5.95 \times 10^{-3} \times 277.9$ **OR** 1.6535 g (in 25 cm^3) **M3**: mass of $FeSO_4 \cdot 7H_2O$ left = 1.6535 g × 10 = 16.535 g (in 250 cm^3) **OR** mass of $FeSO_4 \cdot 7H_2O$ left = $277.9 \times 5.95 \times 10^{-2}$ = 16.535 g percentage oxidised = 100% × (17.70 – 16.535) / 17.70 = 100% × 1.165 / 17.70 = 6.58 % min 2sf	**3**
2(a)(ii)	MnO_4^- / manganate is a (self-)indicator **OR** MnO_4^- / manganate changes colour / purple to colourless / decolourises **OR** solution changes (from colourless) to pink / purple at the end-point	**1**
2(b)(i)		**1**
2(c)	manganese is both oxidised and reduced (to a single oxidation state) from +VII / +7 to +III / +3 **AND** +II / +2 to +III / +3	**2**
2(d)(i)	$K_{sp} = [Mn^{2+}] [OH^-]^2$	**1**

Question	Answer	Marks
2(d)(ii)	$[Mn^{2+}(aq)] = 3.20 \times 10^{-3} / 88.9$ **OR** 3.60×10^{-5} mol dm^{-3} $K_{sp} = 3.60 \times 10^{-5} \times (2 \times 3.60 \times 10^{-5})^2 = 4 \times (3.60 \times 10^{-5})^3$ $= 1.87 \times 10^{-13}$ min 2sf mol^3 dm^{-9}	**3**
2(e)(i)	**M1**: d orbital(s) of two different energies / d-d splitting occurs **OR** d orbital(s)/d (sub)-shell splits / d-d gap **M2**: electron(s) promoted / excited **OR** electron(s) moves to higher (d–) orbital **M3**: wavelength / frequency / light / photon / hν / hf absorbed **OR** radiation / energy from <u>visible</u> (region) absorbed **AND** colour (seen) is complementary **OR** wavelength / frequency / colour / light not absorbed is transmitted / reflected / seen	**3**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(e)(ii)</td><td>
<table>
<tr><td>formula</td><td>$[Mn(C_2O_4)_3]^{3-}$</td></tr>
<tr><td>formula of ligand</td><td>$C_2O_4^{2-}$</td></tr>
<tr><td>shape</td><td>octahedral</td></tr>
<tr><td>coordination number</td><td>6</td></tr>
<tr><td>type of stereoisomerism</td><td>optical</td></tr>
<tr><td>structures</td><td>  and </td></tr>
</table>
</td><td>4</td></tr>
</table>

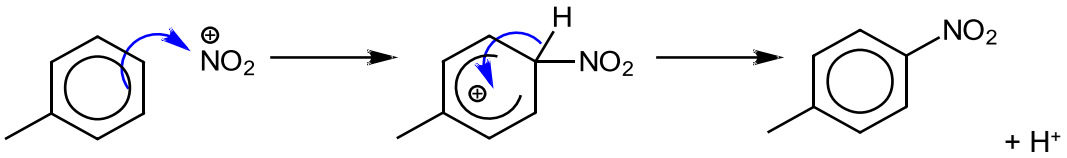
Question	Answer	Marks
3(a)	**G** =  **H** = 	2
3(b)	$HO(CH_2)_3COOH + 2PCl_5 \rightarrow Cl(CH_2)_3COCl + 2POCl_3 + 2HCl$ organic product $Cl(CH_2)_3COCl$ [1] rest of equation [1]	2

Question	Answer	Marks
3(c)(i)	$[H^+] = (K_a \times [HA])^{½}$ $= (1.91 \times 10^{-5} \times 0.150)^{½}$ **OR** 1.69×10^{-3} (mol dm^{-3}) pH = –log $[H^+]$ = 2.77 min 2sf	**2**
3(c)(ii)	(a solution that) resists / opposes / minimises changes in pH when small (amounts / volumes) of acid / H^+ and base / alkali / OH^- are added to it	**2**
3(c)(iii)	$HO(CH_2)_3COO^-$	**1**
3(c)(iv)	**M1**: moles of HA initially = $(0.150 \times 25.0 / 1000)$ **OR** 3.75×10^{-3} mol **AND** moles of NaOH / moles of A^- = $(0.200 \times 10.0 / 1000)$ **OR** 2.00×10^{-3} mol **M2**: remaining moles of HA = $3.75 \times 10^{-3} - 2.00 \times 10^{-3}$ **OR** 1.75×10^{-3} mol **M3**: $[H^+] = K_a[HA]/[A^-]$ $= 1.91 \times 10^{-5} \times \frac{(1.75 \times 10^{-3} \div 0.035)}{(2.00 \times 10^{-3} \div 0.035)} = 1.67 \times 10^{-5}$ **AND** pH = $-\log_{10} 1.67 \times 10^{-5}$ = 4.78 min 2sf	**3**
3(d)	(an excess of) acidified $K_2Cr_2O_7$ / $KMnO_4$ **AND** heat / boil / hot / reflux	**1**
3(e)(i)	(the) ratio of the concentrations of a solute between two solvents at equilibrium	**1**
3(e)(ii)	**M1**: [acid(ether)] = 0.0375 mol dm^{-3} **AND** [acid(aq)] = 0.2775 mol dm^{-3} **M2**: K_{pc} = [acid(ether)] / [acid(aq)] = 0.135	**2**

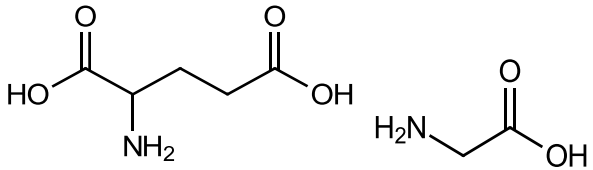
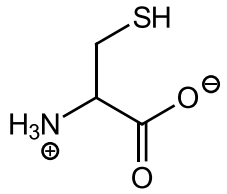
Question	Answer	Marks
4(a)(i)	two separate half-life readings quoted $t_{½} \cong 6000$ (s) ±250 same / constant half-life (∴ first order with respect to [ester])	**2**
4(a)(ii)	tangent seen at t = 0 **AND** initial rate (from gradient of tangent) ≅ 0.24 / 8750 = 2.74×10^{-5} (mol dm^{-3} s^{-1}) min 2sf	**1**
4(a)(iii)	rate = k [CH_3COOCH_3] [H^+] mol^{-1} dm^3 s^{-1}	**2**
4(b)(i)	• reaction 6 / CH_3COCl goes to completion / non-reversible • reaction 7 / CH_3COOH is an equilibrium (reaction) / reversible • reaction 6 has a gas formed **AND** has a greater ΔS / entropy is increased (so more feasible) any two [2]	**2**
4(b)(ii)	 **M1**: correct arrow from lone pair on O (in CH_3OH) to C (of C=O) **M2**: correct dipole on C=O **AND** correct arrow from the C=O bond to O atom **M3**: correct intermediate (both charges present) **M4**: arrow from (lone pair on) $O^{(-)}$ to C–O bond **AND** arrow from C-Cl bond to Cl	**4**

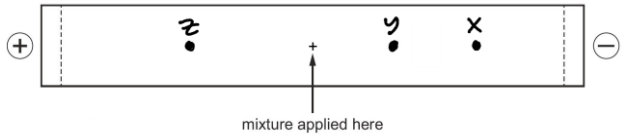
Question	Answer	Marks
4(c)	**M1**: chlorobenzene < chloroethane < ethanoyl chloride **M2 & M3**: Any two from: *(acyl chlorides easier than alkyl chlorides)* • has two electronegative atom groups/an extra electronegative atom / an electronegative oxygen / electron withdrawing C=O **AND** so C (of C=O) highly / more electron deficient / C-C*l* bond weak(est) *(aryl chlorides hardest)* • LP / lone pair / p-orbital on C*l*/chlorine **AND** overlaps / delocalised with ring / π system **AND** (C-C*l*) bond is strengthened / has partial double bond character *(alkyl chlorides easier than aryl chlorides)* • carbon is bonded to an electronegative atom / C*l* / not bonded to electronegative O **AND** so has less electron deficient carbon **OR** • C-C*l* bond strengthened **AND** by positive inductive effect of alkyl / R group	**3**

Question	Answer	Marks
5(a)(i)	$HNO_3 + H_2SO_4 \rightarrow {}^{+}NO_2 + H_2O + HSO_4^-$ **OR** $HNO_3 + 2H_2SO_4 \rightarrow {}^{+}NO_2 + H_3O^+ + 2HSO_4^-$	**1**

Question	Answer	Marks
5(a)(ii)	 **M1**: curly arrow 1 from touching / inside the hexagon to <u>nitrogen</u> of NO_2^+ **M2**: correct intermediate **M3**: curly arrow 2 from C-H bond into hexagon (touching / inside) **AND** H^+	**3**
5(a)(iii)	$CH_3C_6H_4NO_2 + 6[H] \rightarrow CH_3C_6H_4NH_2 + 2H_2O$	**1**
5(a)(iv)	Stage 1 **M1**: HNO_2 **OR** $NaNO_2$ with (dilute strong) acid **AND** $\leqslant$ 10 °C Stage 2 **M2**: warming with H_2O / aqueous	**2**
5(a)(v)	CH_3Cl **AND** $AlCl_3$ NO_2 directs to the meta / 3(,5)-position (in the ring so 4-methylation unlikely)	**2**
5(b)(i)	it is inert / unreactive	**1**
5(b)(ii)	a high-boiling point / non-volatile **AND** (non-polar) liquid / solvent	**1**
5(b)(iii)	it is the least polar **OR** it is more attracted to the stationary phase **OR** forms a strong IMF to the stationary phase **OR** attracted to the stationary phase for a longer time **OR** it is the least volatile / highest bp	**1**

Question	Answer	Marks
5(b)(iv)	% = 100% × 22 / (29 + 34 + 22) = 25.88 % = 25.9 **OR** 26 min 2sf	**1**
5(c)	**M1**: weakest = ethanol … water … phenol = strongest **M2**: *why acids are stronger or weaker* strongest acid has weakest O—H **OR** H^+ more easily lost **OR** anion stabilised / conjugate base stabilised **M3**: *for phenol:* as p-orbital / lone pair on oxygen overlaps / delocalised into the ring / π system / delocalised system **M4**: *for ethanol:* positive inductive effect/electron donating of alkyl / R group	**4**

Question	Answer	Marks
6(a)(i)		**2**
6(a)(ii)	pH at which a molecule is neutral / has no overall charge / charge of zero / no net charge	**1**
6(a)(iii)		**1**

Question	Answer	Marks
6(b)	**M1**:  **M2**: *direction in terms of charge of species* **Z** moves towards positive (pole) **AND** is negatively charged **OR** **X** / **Y** move towards negative (pole) **AND** is positively charged **M3**: *distance in terms of size* **X** moves farther / faster (than **Y**) because of lower M_r / smaller molecular size	**3**
6(c)(i)	**M1**: species with / has two lone pairs / LP (of electrons) **M2**: that form dative (covalent) / co-ordinate bond(s) to a (central) transition-element / metal AND atom / ion **OR** donates electron pair(s) to a (central) transition-element / metal AND atom / ion	**2**
6(c)(ii)	 **AND**	**1**
6(c)iii)	better / improved biological activity **OR** reduction of dosage **OR** the other isomer may have other / different / unwanted biological activity **OR** the other isomer may have different / unwanted side effects / be toxic / be harmful	**1**
6(c)(iv)	$[Cu(H_2O)_6]^{2+} + 2\mathbf{Z}^- \rightarrow [Cu(\mathbf{Z})_2(H_2O)_2] + 4H_2O$	**1**