

Cambridge International AS & A Level

CHEMISTRY**9701/21**

Paper 2 AS Structured Questions

October/November 2025**MARK SCHEME**Maximum Mark: 60

Published

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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.

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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.

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Question	Answer	Marks
1(a)(i)	24 protons 28 neutrons 24 electrons	1
1(a)(ii)	(⁵⁴ Cr has two) more neutrons (than ⁵² Cr)	1
1(a)(iii)	(relative) abundance (of each isotope)	1
1(a)(iv)	The fourth isotope has any value of RIM less than 51.996	1
1(b)(i)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ (3d ⁵ 4s ¹)	1
1(b)(ii)	6	1
1(c)(i)	Cr / Cr ₂ O ₇ ²⁻ AND it gains electrons	1
1(c)(ii)	(+)4	1
1(c)(iii)	<i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i>	N/A
1(c)(iv)	M1 CO₂ has only instantaneous / temporary dipole–induced dipole forces AND methanal has permanent dipole–permanent dipole (and id-id) forces M2 IMF's in methanal are stronger than IMF's in CO₂	2

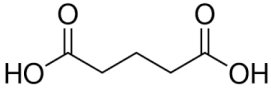
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1(d)(i)	rate of forward and backward (reaction) are the same / equal OR concentrations of reactants and products are constant	1
1(d)(ii)	closed system	1
1(d)(iii)	M1 (mixture becomes more) orange M2 forward reaction is endothermic M3 (mixture becomes more) orange M4 equilibrium moves (forwards/right) to compensate for extra acid / H ⁺	4
1(e)	M1 hydrolysis M2 $\text{CrF}_4 + 2\text{H}_2\text{O} \rightarrow \text{CrO}_2 + 4\text{HF}$	2

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Question	Answer						Marks	
2(a)(i)	M1 nuclear charge increases (across period) AND similar shielding M2 greater / stronger attraction to nucleus						2	
2(a)(ii)	M1 Al loses (3) electrons / Al is 3+, and P gains (3) electrons / P is 3– M2 Al ⁽³⁺⁾ has (one) fewer shell (than P ^(3–))						2	
2(b)(i)	M1	(+)1	(+)2	(+)3	(+)4	(+)5	(+)6	2
	M2	12-14	8-10	—	—	0-4	0-4	
2(b)(ii)	they are insoluble						1	
2(c)(i)	Na ₂ O + 2HCl → 2NaCl + H ₂ O						1	
2(c)(ii)	Al ₂ O ₃ + 2NaOH → 2NaAlO ₂ + H ₂ O						1	
2(d)(i)	(thermal stability) increases (down the group)						1	
2(d)(ii)	NO ₂ AND O ₂						1	

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Question	Answer	Marks
3(a)	simplest /lowest (whole number / integer) ratio of atoms (of each element) in a compound / molecule	1
3(b)	two of: 	2
3(c)(i)	homolytic	1
3(c)(ii)	M1 $\text{C}_5\text{H}_{10} + \text{Cl}\cdot \rightarrow \text{C}_5\text{H}_9\cdot + \text{HCl}$ M2 $\text{C}_5\text{H}_9\cdot + \text{Cl}_2 \rightarrow \text{C}_5\text{H}_9\text{Cl} + \text{Cl}\cdot$	2
3(c)(iii)	termination	1
3(d)(i)	HCl (g)	1
3(d)(ii)	M1 (reaction 1): $-3115 - 286 + 3292 = -109 \text{ (kJ mol}^{-1}\text{)}$ M2 $\Delta H_2 = -53 - (-109) = (+)56 \text{ (kJ mol}^{-1}\text{)}$	2
3(e)(i)		1
3(e)(ii)	M1 absorption labelled at approx. 3000 cm^{-1} identified as O—H M2 absorption labelled at approx. 1720 cm^{-1} identified as C=O	2

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Question	Answer	Marks
4(a)(i)	reduction	1
4(a)(ii)	PCl_5 / PCl_3 / SOCl_2 OR KCl / NaCl AND conc. H_2SO_4 / conc. H_3PO_4	1
4(a)(ii)	M1 $\text{C}_2\text{H}_5\text{CH}_2\text{Cl} + \text{NaOH} \rightarrow \text{C}_3\text{H}_6 + \text{H}_2\text{O} + \text{NaCl}$ M2 ethanol (solvent) AND heat / reflux	2
4(a)(iv)	conc. H_2SO_4 OR conc. H_3PO_4 OR Al_2O_3 AND heat	1
4(b)(i)	addition	1
4(b)(ii)	M1 (molecules that have the) same structural formula (and same molecular formula) M2 but different 3D / spatial arrangement of atoms / groups	2
4(b)(iii)	$\begin{array}{cccc} \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 \\ & & & \\ \text{---C---} & \text{C---} & \text{C---} & \text{C---} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ M1 M2 optical isomerism M3 the methylated carbon has four different groups attached	3
4(b)(iv)	M1 non-biodegradability M2 harmful combustion products	2
4(c)(i)	2,3-dimethylbut-1-ene	1

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Question	Answer	Marks
4(c)(ii)	(The spectrum is of) X AND 41 is $[\text{CH}_2=\text{CCH}_3]^+$ / 41 is C_3H_5^+ OR 43 is $[\text{CH}_3\text{CHCH}_3]^+$ / 43 is C_3H_7^+ OR X would NOT have significant peak at 54 / $[(\text{CH}_3)_2\text{C}=\text{C}^+]$ / C_4H_6^+ OR X would NOT have significant peak at 42 due to $[(\text{CH}_3)_2\text{C}^+]$ / C_3H_6^+	1
4(c)(iii)	$([\text{M}+1]^+ / 34.7 \times 100 / 1.1 = 6)$ $[\text{M}+1]^+ = 2.29$	1

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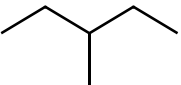
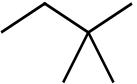
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Question	Answer	Marks
1(a)(i)	25 protons 30 neutrons 25 electrons	1
1(a)(ii)	(atoms of an element) with the same number of protons and different number of neutrons	1
1(a)(iii)	M1 (relative) isotopic mass. OR (relative isotopic) mass of Mn-55 and Mn-53 M2 (relative) abundance of each isotope	2
1(b)(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 (3d^5 4s^2)$	1
1(b)(ii)	5	1
1(c)(i)	Mn / MnO ₂ AND it gains electrons	1
1(c)(ii)	(+) ₄	1
1(c)(iii)	<i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i>	N/A

Question	Answer	Marks
2(a)(i)	delocalised electrons move (through the structure / between layers)	1
2(a)(ii)	P / S / Cl have no charge carriers OR (no ions and) no delocalised electrons OR no mobile / moving ions	1
2(b)	M1 Si has (lots of) strong covalent bonds broken M2 P / S / Cl (only) has weak Van der Waals' (forces) broken	2

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Question	Answer						Marks
2(c)	M1	+1	+2	+3	+4	+5	4
	M2	7	6.5	0–4	0–4	0–4	
	M3	I	I	I	C	C	
	M4	G	G	G	S	S	
2(d)(i)	$2Al + 3Cl_2 \rightarrow 2AlCl_3$						1
2(d)(ii)	$PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$						1
2(e)(i)	rate of forward and backward (reaction) are the same / equal OR (ratio of) concentrations of reactants and products are constant						1
2(e)(ii)	closed system						1
2(e)(iii)	M1 (mixture / solution becomes more) yellow M2 (forward) reaction is exothermic (equilibrium shifts left) OR equilibrium / reaction shifts (left) to absorb (additional) heat / energy M3 (mixture / solution becomes more) red M4 fewer moles of gas on right-hand side OR (gas on left and) no gas on the right						4
2(f)(i)	$MgCl_2(aq) + Na_2CO_3(aq) \rightarrow MgCO_3(s) + 2NaCl(aq)$ M1 formulae in balanced equation M2 state symbols						2
2(f)(ii)	MgO / magnesium oxide AND CO ₂ / carbon dioxide						1
2(f)(iii)	(thermal stability) increases (down the group)						1

Question	Answer	Marks
3(a)	M1 (family of molecules / compounds / series with) same general formula OR (family of molecules where) molecular formula differs (only) by (units of) $\text{CH}_2(n)$. M2 similar chemical properties / reactions	2
3(b)	M1 strong C—H (bonds) M2 non-polar (C—H / molecule / bonds)	2
3(c)	cracking	1
3(d)(i)	M1  M2 	2
3(d)(ii)	M1 $\text{B} < \text{A} < \text{hexane}$. M2 hexane / unbranched has stronger / more IMFs M3 hexane / unbranched requires most / more energy	3
3(e)(i)	H_2 ((g)) OR hydrogen (gas)	1
3(e)(ii)	M1 $+215 + (-156) - (+48) =$ M2 $+11 \text{ kJ mol}^{-1}$	2
3(e)(iii)	$\text{C}_6\text{H}_{14} + 9\frac{1}{2}\text{O}_2 \rightarrow 6\text{CO}_2 + 7\text{H}_2\text{O}$	1
4(a)(i)	free-radical substitution	1

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Question	Answer	Marks
4(a)(ii)	M1 $\text{C}_3\text{H}_8 + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{HCl}$ OR $\text{C}_3\text{H}_8 + \text{Cl}^\bullet \rightarrow \text{C}_3\text{H}_7^\bullet + \text{HCl}$ M2 $\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{Cl}^\bullet$ OR $\text{C}_3\text{H}_7^\bullet + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{Cl}^\bullet$ etc M3 $\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ OR $\text{C}_3\text{H}_7^\bullet + \text{Cl}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$	3
4(a)(iii)	homolytic	1
4(a)(iv)	1,2-dichloropropane	1
4(a)(v)	M1 (type of structural isomerism) positional M2 (type of stereoisomerism) optical	2
4(b)	sodium hydroxide AND water	1
4(c)(i)	orange to green	1
4(c)(ii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{COOH} + \text{H}_2\text{O}$	1
4(d)(i)	condensation	1
4(d)(ii)	M1 absorption labelled at approx. 1750 cm^{-1} identified as C=O M2 absorption labelled at approx. 1650 cm^{-1} identified as C=C M3 absorption labelled at approx. 1170 cm^{-1} identified as C—O	3
4(d)(iii)	$(0.31 / 4.7 \times 100 / 1.1) = 6$ carbon atoms	1

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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

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Annotations

Annotation	Meaning
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	Incorrect point or mark not awarded
	Unclear
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	Contradiction in response otherwise markworthy, mark not given
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	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error

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

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Question	Answer	Marks
1(a)(i)	24 protons 28 neutrons 24 electrons	1
1(a)(ii)	(⁵⁴ Cr has two) more neutrons (than ⁵² Cr)	1
1(a)(iii)	(relative) abundance (of each isotope)	1
1(a)(iv)	The fourth isotope has any value of RIM less than 51.996	1
1(b)(i)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ (3d ⁵ 4s ¹)	1
1(b)(ii)	6	1
1(c)(i)	Cr / Cr ₂ O ₇ ²⁻ AND it gains electrons	1
1(c)(ii)	(+) ⁴	1
1(c)(iii)	<i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i>	N/A
1(c)(iv)	M1 CO ₂ has only instantaneous / temporary dipole–induced dipole forces AND methanal has permanent dipole–permanent dipole (and id-id) forces M2 IMF's in methanal are stronger than IMF's in CO ₂	2

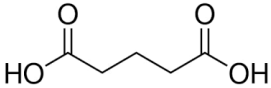
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Question	Answer	Marks
1(d)(i)	rate of forward and backward (reaction) are the same / equal OR concentrations of reactants and products are constant	1
1(d)(ii)	closed system	1
1(d)(iii)	M1 (mixture becomes more) orange M2 forward reaction is endothermic M3 (mixture becomes more) orange M4 equilibrium moves (forwards/right) to compensate for extra acid / H ⁺	4
1(e)	M1 hydrolysis M2 $\text{CrF}_4 + 2\text{H}_2\text{O} \rightarrow \text{CrO}_2 + 4\text{HF}$	2

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Question	Answer						Marks	
2(a)(i)	M1 nuclear charge increases (across period) AND similar shielding M2 greater / stronger attraction to nucleus						2	
2(a)(ii)	M1 Al loses (3) electrons / Al is 3+, and P gains (3) electrons / P is 3– M2 Al ⁽³⁺⁾ has (one) fewer shell (than P ^(3–))						2	
2(b)(i)	M1	(+)1	(+)2	(+)3	(+)4	(+)5	(+)6	2
	M2	12-14	8-10	—	—	0-4	0-4	
2(b)(ii)	they are insoluble						1	
2(c)(i)	Na ₂ O + 2HCl → 2NaCl + H ₂ O						1	
2(c)(ii)	Al ₂ O ₃ + 2NaOH → 2NaAlO ₂ + H ₂ O						1	
2(d)(i)	(thermal stability) increases (down the group)						1	
2(d)(ii)	NO ₂ AND O ₂						1	

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Question	Answer	Marks
3(a)	simplest /lowest (whole number / integer) ratio of atoms (of each element) in a compound / molecule	1
3(b)	two of: 	2
3(c)(i)	homolytic	1
3(c)(ii)	M1 $\text{C}_5\text{H}_{10} + \text{Cl}\cdot \rightarrow \text{C}_5\text{H}_9\cdot + \text{HCl}$ M2 $\text{C}_5\text{H}_9\cdot + \text{Cl}_2 \rightarrow \text{C}_5\text{H}_9\text{Cl} + \text{Cl}\cdot$	2
3(c)(iii)	termination	1
3(d)(i)	HCl (g)	1
3(d)(ii)	M1 (reaction 1): $-3115 - 286 + 3292 = -109 \text{ (kJ mol}^{-1}\text{)}$ M2 $\Delta H_2 = -53 - (-109) = (+)56 \text{ (kJ mol}^{-1}\text{)}$	2
3(e)(i)		1
3(e)(ii)	M1 absorption labelled at approx. 3000 cm^{-1} identified as O—H M2 absorption labelled at approx. 1720 cm^{-1} identified as C=O	2

Question	Answer	Marks
4(a)(i)	reduction	1
4(a)(ii)	PCl_5 / PCl_3 / SOCl_2 OR KCl / NaCl AND conc. H_2SO_4 / conc. H_3PO_4	1
4(a)(ii)	M1 $\text{C}_2\text{H}_5\text{CH}_2\text{Cl} + \text{NaOH} \rightarrow \text{C}_3\text{H}_6 + \text{H}_2\text{O} + \text{NaCl}$ M2 ethanol (solvent) AND heat / reflux	2
4(a)(iv)	conc. H_2SO_4 OR conc. H_3PO_4 OR Al_2O_3 AND heat	1
4(b)(i)	addition	1
4(b)(ii)	M1 (molecules that have the) same structural formula (and same molecular formula) M2 but different 3D / spatial arrangement of atoms / groups	2
4(b)(iii)	$\begin{array}{cccc} \text{H} & \text{CH}_3 & \text{H} & \text{CH}_3 \\ & & & \\ \text{---C---} & \text{C---} & \text{C---} & \text{C---} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ M1 M2 optical isomerism M3 the methylated carbon has four different groups attached	3
4(b)(iv)	M1 non-biodegradability M2 harmful combustion products	2
4(c)(i)	2,3-dimethylbut-1-ene	1

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Question	Answer	Marks
4(c)(ii)	(The spectrum is of) X AND 41 is $[\text{CH}_2=\text{CCH}_3]^+$ / 41 is C_3H_5^+ OR 43 is $[\text{CH}_3\text{CHCH}_3]^+$ / 43 is C_3H_7^+ OR X would NOT have significant peak at 54 / $[(\text{CH}_3)_2\text{C}=\text{C}^+]$ / C_4H_6^+ OR X would NOT have significant peak at 42 due to $[(\text{CH}_3)_2\text{C}^+]$ / C_3H_6^+	1
4(c)(iii)	$([\text{M}+1]^+ / 34.7 \times 100 / 1.1 = 6)$ $[\text{M}+1]^+ = 2.29$	1

Cambridge International AS & A Level

CHEMISTRY**9701/24**

Paper 2 AS Level Structured Questions

October/November 2025**MARK SCHEME**Maximum Mark: 60

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 October/November 2025 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'.

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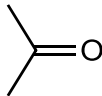
Question	Answer				Marks																
1(a)(i)	(halogens can) remove electron(s) (from a reactant)				1																
1(a)(ii)	$2Al + 3Cl_2 \rightarrow 2AlCl_3$				1																
1(a)(iii)	purple (gas) disappears				1																
1(b)(i)	M1 Br—Br is weaker (than Cl—Cl) AND Br atoms are larger M2 less (significant) overlap of orbitals (in Br-Br)				2																
1(b)(ii)	HCl is more thermally stable				1																
1(b)(iii)	M1 (enthalpy change / energy change) when one mole of a compound / substance is formed M2 from its (constituent) elements in their standard state(s)				2																
1(b)(iv)	M1 $(6 \times -92) - (2 \times -46) =$ M2 $-460 \text{ (kJ mol}^{-1}\text{)}$				2																
1(b)(v)	M1 (trigonal) pyramidal M2 three bonding pairs AND one lone pair (of electrons)				2																
1(c)(i)	<table><tr><td></td><td>NaCl</td><td>NaBr</td><td>NaI</td></tr><tr><td>with Ag⁺(aq)</td><td>white precipitate</td><td>M1 cream / off-white ppt</td><td>M2 yellow ppt</td></tr><tr><td>with conc. H₂SO₄</td><td>acid – base</td><td>acid – base, then redox</td><td>acid – base, then redox</td></tr><tr><td>observations with conc. H₂SO₄</td><td>M3 steamy fumes OR fizzing</td><td>M4 brown liquid OR fizzing</td><td> • black solid • yellow solid • effervescence </td></tr></table>					NaCl	NaBr	NaI	with Ag ⁺ (aq)	white precipitate	M1 cream / off-white ppt	M2 yellow ppt	with conc. H ₂ SO ₄	acid – base	acid – base, then redox	acid – base, then redox	observations with conc. H ₂ SO ₄	M3 steamy fumes OR fizzing	M4 brown liquid OR fizzing	• black solid • yellow solid • effervescence	4
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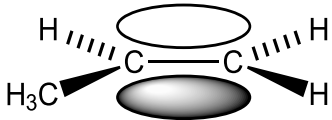
Question	Answer	Marks
1(c)(ii)	M1 black solid = iodine / I_2 AND yellow solid = sulfur / $S_{(8)}$ M2 effervescence = hydrogen sulfide / $H_2S(g)$	2
1(d)(i)	M1 $MgCl_2$ (is ionic and) has mobile ions M2 $SiCl_4$ is covalent AND no charge carriers OR (no ions and) no delocalised electrons OR no mobile / moving ions	2
1(d)(ii)	M1 $MgCl_2$ pH = 7 M2 $SiCl_4$ pH 0 – 4	2

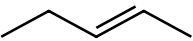
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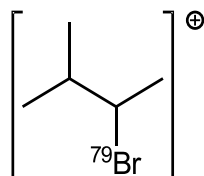
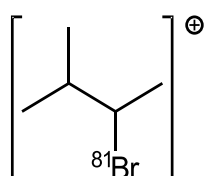
Question	Answer	Marks
2(a)	M1 Al_2O_3 is ionic M2 P_4O_{10} is a (simple) molecule M3 ionic bonds are stronger than intermolecular forces	3
2(b)(i)	$\text{mol}^{-2} \text{ dm}^6$	1
2(b)(ii)	M1 at equilibrium: moles of $\text{CO} = 0.120$ AND moles of $\text{H}_2 = 0.240$ M2 $[\text{CH}_3\text{OH}] = 0.056$ AND $[\text{CO}] = 0.024$ AND $[\text{H}_2] = 0.048$ M3 use of K_c with correct evaluation = 1.01×10^3	3
2(b)(iii)	no effect AND K_c is not affected by pressure	1
2(c)(i)	increases rate by providing a different mechanism with a lower activation energy	1
2(c)(ii)	$2\text{CH}_3\text{OH} \rightarrow \text{CH}_3\text{OCH}_3 + \text{H}_2\text{O}$	1
2(c)(iii)	$\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$	1

Question	Answer	Marks
3(a)(i)		1
3(a)(ii)	yellow precipitate	1
3(a)(iii)	elimination	1

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Question	Answer	Marks
3(a)(iv)		1
3(b)(i)	$(\text{CH}_3)_2\text{CHOH} + \text{Na} \rightarrow (\text{CH}_3)_2\text{CHO}^{\ominus}\text{Na}^{\oplus} + \frac{1}{2} \text{H}_2$	1
3(b)(ii)	M1 correct dipole on $\delta^+\text{C}-\text{Br}\delta^-$ AND curly arrow from C—Br bond to Br M2 intermediate  M3 curly arrow from lone pair of $(\text{CH}_3)_2\text{CHO}^-$ to C^+	3
3(b)(iii)	M1 rate would decrease M2 C—Br is weaker (than C—Cl, so breaks more easily)	2
3(b)(iv)	$\text{C}_6\text{H}_{14}\text{O} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 7\text{H}_2\text{O}$	1

Question	Answer	Marks
4(a)(i)	M1 (molecules with the) same molecular formula / same number of atoms of each element M2 different structural formulae/structures	2
4(a)(ii)	M1  M2 restricted / lack of / no rotation about C=C	2
4(a)(iii)	electrophilic addition	1

Question	Answer	Marks								
4(a)(iv)	M1 $\text{CH}_3\text{COCH}_3 + \text{CH}_3\text{COOH}$ as products M2 $(\text{CH}_3)_2\text{C} = \text{CHCH}_3 + 3[\text{O}] \rightarrow \text{CH}_3\text{COCH}_3 + \text{CH}_3\text{COOH}$	2								
4(a)(v)	M1 (reaction proceeds via a) more stable intermediate / carbocation M2 because of greater positive inductive effect of more alkyl groups	2								
4(a)(vi)	M1  M2 	2								
4(b)(i)	KCN in ethanol (and heat)	1								
4(b)(ii)	$(\text{C}_2\text{H}_5)_2\text{CHCN} + 2\text{H}_2\text{O} + \text{HCl} \rightarrow (\text{C}_2\text{H}_5)_2\text{CHCOOH} + \text{NH}_4\text{Cl}$	1								
4(b)(iii)	<table><tr><td></td><td>reaction of V with propan-2-ol</td></tr><tr><td>type of reaction</td><td>M1 condensation</td></tr><tr><td>functional group formed</td><td>M2 ester</td></tr><tr><td>molecular formula of organic product W</td><td>M3 $\text{C}_9\text{H}_{18}\text{O}_2$</td></tr></table>		reaction of V with propan-2-ol	type of reaction	M1 condensation	functional group formed	M2 ester	molecular formula of organic product W	M3 $\text{C}_9\text{H}_{18}\text{O}_2$	3
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