

Cambridge International AS & A Level

CHEMISTRY**9701/21**

Paper 2 AS Level Structured Questions

May/June 2025

MARK SCHEME

Maximum Mark: 60

Published

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This document consists of **12** printed pages.

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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
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- 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***.
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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

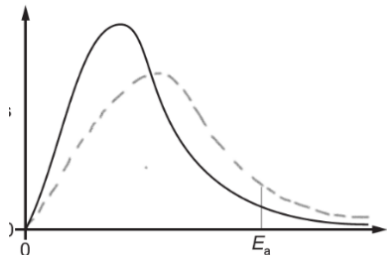
Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Unclear
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Part of the correct answer has been seen. Full credit has not been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

Annotation	Meaning
RE	Rounding error
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)	sodium – metallic AND sodium oxide – ionic	1									
1(a)(ii)	delocalised electrons move (through the structure)	1									
1(a)(iii)	(sodium and oxide) ions move (through the liquid)	1									
1(b)(i)	$2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$	1									
1(b)(ii)	$\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$	1									
1(b)(iii)	<table border="1"> <tr> <td></td><td>sodium</td><td>sodium oxide</td></tr> <tr> <td>one similarity</td><td colspan="2">(both) solids disappear OR (both produce) colourless solutions</td></tr> <tr> <td>one difference</td><td>effervescence</td><td>no effervescence</td></tr> </table>		sodium	sodium oxide	one similarity	(both) solids disappear OR (both produce) colourless solutions		one difference	effervescence	no effervescence	2
	sodium	sodium oxide									
one similarity	(both) solids disappear OR (both produce) colourless solutions										
one difference	effervescence	no effervescence									
1(c)	M1 $\text{NaCl} + 1$ AND $\text{PCl}_5 + 5$ M2 Na has only 1 valence (shell) electrons AND P has 5	2									
1(d)	<i>All three for two marks:</i> - false - comparison or statement of oxidation number - correct link to melting point from their comparison or statement	2									

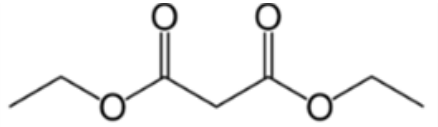
Question	Answer	Marks
2(a)	atoms (of an element) with same number of protons and different number of neutrons	1

Question	Answer	Marks						
2(b)(i)	M1 method showing each abundance multiplied by m/e value • (5.9×54) and (91.9×56) and (2.2×57) OR • (0.59×54) and (9.19×56) and (0.22×57) M2 the three values from M1 expressed as a percentage and added together correctly with final answer to 1 d.p $\frac{5.9}{100} \times 54 + \frac{91.9}{100} \times 56 + \frac{2.2}{100} \times 57 = 55.9$	2						
2(b)(ii)	<table><tr><td>particle</td><td>number of particles in one atom of ^{56}Fe</td></tr><tr><td>protons</td><td>26</td></tr><tr><td>nucleons</td><td>56</td></tr></table>	particle	number of particles in one atom of ^{56}Fe	protons	26	nucleons	56	2
particle	number of particles in one atom of ^{56}Fe							
protons	26							
nucleons	56							
2(c)	5	1						
2(d)	$\text{Fe(g)} \rightarrow \text{Fe}^{\text{+}}\text{(g)} + \text{e}^{\text{(-)}}$	1						
2(e)	M1 same electronic configuration OR same shielding M2 same number of protons OR same nuclear charge M3 so same nuclear attraction to outer shell electron M4 no change / will not be affected	4						

Question	Answer	Marks
3(a)(i)	 Two correct for one mark, all four for two marks: • start at origin • peak sits below the original • peak sits to the right-hand side of the original • new line crosses the original once only AND to the right of the original peak	2
3(a)(ii)	M1 greater proportion of (H_2) molecules have energy greater than or equal to the activation energy / $\geq E_A$ M2 increase in frequency of successful collisions (between H_2 and C_6H_{12})	2
3(a)(iii)	catalyst	1
3(a)(iv)	annotation to show new E_A (nickel / catalyst) further to the left than original E_A	1
3(b)	M1 (if a change is made at a system is dynamic equilibrium) the equilibrium moves M2 to minimise the change in conditions	2
3(c)	(forward) reaction is exothermic $(a + b) > c$	2

Question	Answer	Marks
4(a)	$\text{C}_3\text{H}_4\text{O}_3$	1
4(b)(i)	$(28.40 / 1000 \times 0.0005) = 1.42 \times 10^{-5} \text{ mol}$	1

Question	Answer	Marks															
4(b)(ii)	$(1.42 \times 10^{-5} \times 176 \times 200 / 5) = 0.099968$ M1 correct method to deduce mass of vit C in 5 cm ³ sample $(1.42 \times 10^{-5} \times 176) = 2.49 \times 10^{-3}$ M2 correct calculation for mass of vit C in original solution $(2.49 \times 10^{-3} \times 200 / 5) = 0.099968$ OR M1 correct method to deduce amount, mol, vit C in 5 cm ³ sample $(1.42 \times 10^{-5} \times 200 / 5) = 5.68 \times 10^{-4}$ M2 correct calculation for mass of vit C in original solution = M1 $\times$ 176 $(5.68 \times 10^{-4}) \times 176 = 0.099968$	2															
4(b)(iii)	oxidising agent	1															
4(b)(iv)	M1 (also) oxidises / reacts with (primary and / or secondary) alcohol groups M2 (also) breaks the sigma and pi bond in C=C	2															
4(c)	<i>Any two complete rows from:</i> <table border="1"> <thead> <tr> <th>wavenumber</th><th>bond</th><th>functional group</th></tr> </thead> <tbody> <tr> <td>1040 – 1300</td><td>C–O</td><td>ester / hydroxy</td></tr> <tr> <td>3200 – 3650</td><td>O–H</td><td>hydroxy / alcohols</td></tr> <tr> <td>2850 – 2950</td><td>C–H</td><td>alkane</td></tr> <tr> <td>1710 – 1750</td><td>C=O</td><td>ester</td></tr> </tbody> </table>	wavenumber	bond	functional group	1040 – 1300	C–O	ester / hydroxy	3200 – 3650	O–H	hydroxy / alcohols	2850 – 2950	C–H	alkane	1710 – 1750	C=O	ester	2
wavenumber	bond	functional group															
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1710 – 1750	C=O	ester															

Question	Answer	Marks
5(a)	M1 two ester links M2 rest of structure correct 	2
5(b)	(acid) hydrolysis	1
5(c)(i)	$\text{HOOCCH}_2\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow \text{NaOOCCH}_2\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$	1
5(c)(ii)	C is not as strong an acid as B	1
5(d)(i)	M1 NaOH(aq) AND heat M2 acidified AND potassium dichromate(VI) AND heat under reflux	2
5(d)(ii)	oxidation	1
5(e)(i)	LiAlH ₄	1
5(e)(ii)	M1 correct unambiguous organic product M2 correct balanced equation $\text{HOOCCH}_2\text{COOH} + 8[\text{H}] \rightarrow \text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH} + 2\text{H}_2\text{O}$	2
5(e)(iii)	1,3-dichloropropane	1

Question	Answer	Marks
6(a)	carbonyl	1
6(b)	M1 (2,4)-dinitrophenylhydrazine / (2,4)-DNPH M2 orange / red / yellow precipitate	2

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Question	Answer	Marks
6(c)(i)	F = propanone G = ethanal H = propanal	2
6(c)(ii)	tri-iodomethane OR CHI_3	1
6(c)(iii)	$\text{CH}_3\text{CH}(\text{OH})\text{-R}$ where R is represented as H or any alkyl group	1

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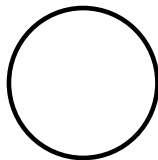
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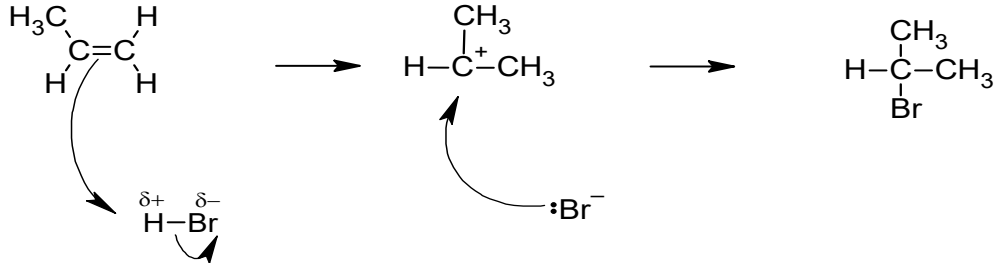
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1(a)(i)	(both) giant molecular	1															
1(a)(ii)	delocalised electrons move through the structure OR delocalised electrons move through / between the layers	1															
1(a)(iii)	no delocalised electrons (to carry charge through the structure) OR <u>all</u> (4) outer electrons are used in bonding	1															
1(b)(i)	$\text{PCl}_5 + 4\text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 + 5\text{HCl}$	1															
	$\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$	1															
1(b)(ii)	M1 phosphorus(V) chloride white / yellow solid M2 silicon(IV) chloride colourless liquid	2															
1(b)(iii)	M1 (phosphorus(V) chloride) produces colourless solution M2 silicon(IV) chloride produces white suspension / white precipitate (in a colorless liquid / mixture / solution)	2															
1(c)(i)	species behaves as acid and base OR species reacts with (both) acid and base	1															
1(c)(ii)	Al_2O_3	1															
1(d)(i)	<table border="1"> <tbody> <tr> <td>SO_2</td><td>–73</td><td>pd</td></tr> <tr> <td>H_2O</td><td>0</td><td>H</td></tr> <tr> <td>SiO_2</td><td>1600</td><td>C</td></tr> <tr> <td>Na_2O</td><td>1132</td><td>I</td></tr> <tr> <td>MgO</td><td>2852</td><td>I</td></tr> </tbody> </table>	SO_2	–73	pd	H_2O	0	H	SiO_2	1600	C	Na_2O	1132	I	MgO	2852	I	3
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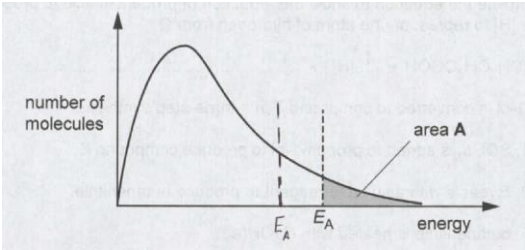
Question	Answer	Marks
1(d)(ii)	<i>Evaluate hypotheses based on the information candidates have given in the table</i> M1 not enough information M2 SO₂ and / or H₂O break intermolecular forces OR SO₂ and / or H₂O does not break covalent bonds OR only SiO₂ breaks covalent bonds	2

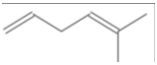
Question	Answer	Marks
2(a)(i)	route 1 M1 average (weighted) mass of (an) atom(s) (of an element) OR average (weighted) mass of the isotope(s) (of an element) M2 compared to the mass of the unified atomic mass unit OR on a scale in which a carbon-12 atom / isotope has a mass of exactly 12 (units) OR on a scale in which the mass of a carbon-12 atom/isotope is exactly 12 (units) OR compared to $\frac{1}{12}$ mass of one atom of C-12 route 2 M1 average mass of one mol of isotopes / atoms (of an element) M2 relative / compared to $\frac{1}{12}$ of the mass of one mol of C-12 atoms/isotopes OR when the mass of one mol C-12 atoms / isotopes is exactly 12 (000) g	2
2(a)(ii)	M1 relative abundance of unknown isotope = $(100 - 91.9 - 6.0) = 2.1\%$ M2 $55.8 = (53.9 \times 6.0 + 55.9 \times 91.9 + ? \times M1) / 100 = 56.9$	2
2(b)	1 (pair)	1

Question	Answer	Marks						
2(c)		1						
2(d)	<table><tr><td>species present in an ion of 56-Fe^{3+}</td><td>number</td></tr><tr><td>electrons</td><td>M1 23</td></tr><tr><td>M2 neutrons</td><td>30</td></tr></table>	species present in an ion of 56-Fe^{3+}	number	electrons	M1 23	M2 neutrons	30	2
species present in an ion of 56-Fe^{3+}	number							
electrons	M1 23							
M2 neutrons	30							
2(e)	M1 smaller / decreases M2 loss of outer / valence shell (of electrons) OR loss of electrons so increase in (force of) attraction from nucleus OR loss of electrons so increase nuclear attraction	2						

Question	Answer	Marks
3(a)(i)	two (or more) reactants / molecules react to make (only) one product	1

Question	Answer	Marks
3(a)(ii)	 M1 curly arrow from = of C=C to H (of HBr) M2 curly arrow from bond of H^{δ+}—Br^{δ-} to Br^{δ-} (dipole is essential) M3 correct intermediate M4 curly arrow from lone pair of Br⁻ to C⁺ of intermediate drawn	4
3(a)(iii)	M1 (2-bromopropane is made from the) more stable intermediate / carbocation M2 (due to positive) inductive effect of more alkyl groups (attached to the C⁺ / central carbon atom) OR (due to) greater (positive) inductive effect of 2 methyl groups (rather than 1 ethyl group)	2
3(b)(i)	H ₂ / hydrogen AND some X / alkene left(over) / remains (at the end of this reaction)	1
3(b)(ii)	link the significance of gradient values to rate AND describe either the decrease in rate or the decrease in gradient as the gradient decreases the rate decreases OR rate decreases until the reaction stops when gradient = 0	1

Question	Answer	Marks
3(c)	method 1 – breaking all bonds in molecules $(2 \times 610) + (2 \times 436) + (10 \times 410) + (3 \times 350) - (14 \times 410) - (5 \times 350)$ - energy involved when all bonds are broken = (7242) - energy involved when all bonds are made = (7490) - energy to break bonds – energy to make bonds $= (7242 - 7490) = -248$ method 2 – ignore any bonds that do not change from reactants to products $(2 \times 610) + (2 \times 436) - (4 \times 410) - (2 \times 350)$ - energy involved when all bonds are broken = (2092) - energy involved when all bonds are made = (2340) - energy to break bonds – energy to make bonds $(2092 - 2340) = -248$	2
3(d)(i)	E_A shown on Fig. 3.3 to the left of original (on the x axis) 	1

Question	Answer	Marks
3(d)(ii)	M1 it / (area) B larger AND rate (reaction / hydrogenation) increases OR (area) B identified by shading or labelling on Fig 3.3 AND rate (reaction / hydrogenation) increases in prose M2 increase in the frequency of effective / successful collisions OR increase in rate of effective / successful collisions	2
3(e)	$\text{H}_2\text{C}=\text{CHCH}_2\text{CH}=\text{C}(\text{CH}_3)_2$ ✓✓  ✓✓ $\text{H}_2\text{CCHCH}_2\text{CHC}(\text{CH}_3)_2$ ✓✓ M1 $\text{H}_2\text{C}=\text{C}\dots$ on one end of their molecule OR $\dots\text{C}=\text{C}(\text{CH}_3)_2$ on one end of their molecule OR $\dots\text{C}=\text{CHCH}_2\text{CH}=\text{C}\dots$ in the middle of their molecule M2 correct structure	2

Question	Answer	Marks
4(a)(i)	LiAlH_4	1
4(a)(ii)	$\text{CH}_3\text{CH}_2\text{CO}_2\text{H} + 4[\text{H}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{H}_2\text{O}$	1
4(b)(i)	substitution	1
4(b)(ii)	KCN / potassium cyanide in ethanol / $\text{C}_2\text{H}_5\text{OH}$ AND heat	1
4(b)(iii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CN} + \text{NaOH} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{NH}_3$ OR $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN} + \text{NaOH} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na} + \text{NH}_4\text{OH}$ M1 correct organic product (as molecule or anion) M2 rest of equation is correct	2
4(b)(iv)	(alkaline) hydrolysis	1
4(c)(i)	sp^3	1

Question	Answer	Marks
4(c)(ii)	hydrogen / H ₂	1
4(c)(iii)	(It / Na) reduces A / B / C / the alcohol (group) OR (it / Na behaves as) reducing agent OR (it / Na) donates electrons to A / B / C / the alcohol (group)	1
4(d)(i)	(CH ₃) ₃ COH	1
4(d)(ii)	butan-1-ol OR (2) methylpropan-1-ol	1
4(d)(iii)	butan-2-ol OR CH ₃ CH ₂ CH(OH)CH ₃ .	1

Question	Answer	Marks
5(a)	C ₃ H ₄ O ₃	1
5(b)(i)	$5.00 \times 10^{-3} \times 36.65 / 1000$ $= 1.833 \times 10^{-4} / 1.8325 \times 10^{-4}$	1
5(b)(ii)	M1 expression and / or correct calculation to show how the amount of vitamin C in 150 g of lemon peel is calculated $1.8325 \times 10^{-4} \text{ mol} \times 176 \times 4$ M2 correct calculation based on $(\text{M1} / 150) \times 100 = 0.086(\%)$ Using 1.8325×10^{-4} for M1 , M2 = 0.086 OR 0.087(%) Alternative answer using 7.65×10^{-4} : M1 $7.65 \times 10^{-4} \times 176 \times 4 = 0.5386 / 0.539$ M2 correct calculation based on $(\text{M1} / 150) \times 100 = 0.359 / 0.36 (\%)$	2

Question	Answer			Marks
5(b)(iii)	absorption / cm^{-1}	present in spectrum of vitamin C	present in spectrum of M	1
	1500–1680	✓	✗ / – / blank	
	2850–2950	✓	✓	
	3200–3650	✓	✓	

Cambridge International AS & A Level

CHEMISTRY**9701/23**

Paper 2 AS Level Structured Questions

May/June 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 May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **11** printed pages.

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
	Benefit of the doubt not applied in this instance

Annotation	Meaning
RE	Rounding error
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)	$1s^2 2s^2 2p^5$	1
1(a)(ii)	2 (pairs)	1
1(a)(iii)		1
1(b)(i)	$S(g) \rightarrow S^+(g) + e^{-}$ OR $S(g) - e^{-} \rightarrow S^+(g)$	1
1(b)(ii)	M1 pair of electrons in a 3p orbital (in S) repel each other M2 outweighs the effect of increase in nuclear charge	2
1(b)(iii)	M1 $Na^+ < Ne < F^-$ M2 (all have) same number of electrons / isoelectronic M3 larger species has smaller nuclear charge / fewer protons M4 (so) smaller nuclear attraction (to outer electrons)	4

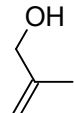
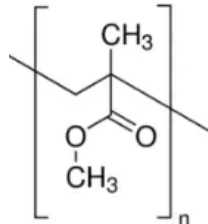
Question	Answer	Marks
2(a)	Na_2O	1
2(b)	$P_4O_{10} + 12NaOH \rightarrow 4Na_3PO_4 + 6H_2O$	1
2(c)(i)	SO_3	1
2(c)(ii)	- false Al_2O_3 melting point is lower than MgO (but) charge on Al ion is greater than that on Mg Any 2 points = 1 mark , all 3 points = 2 marks	2
2(d)	it / ZnO accepts protons	1
2(e)(i)	$NaAl(OH)_4$	1

Question	Answer	Marks
2(e)(ii)	$Al_2(SO_4)_3$	1
3(a)(i)	Al_2O_3 / aluminium oxide	1
3(a)(ii)	- unburned hydrocarbons - react with NO / NO_2 (to) produce PAN (– a component of photochemical smog) Any 2 points = 1 mark, all 3 points = 2 marks	2
3(b)(i)	nickel / platinum	1
3(b)(ii)	minimum energy required for a collision to be effective	1
3(b)(iii)	M1 • area under the curve with energy $\geq E_A$ using a catalyst is larger so • greater proportion of particles with sufficient energy to react M2 rate faster because higher frequency of successful collisions	2

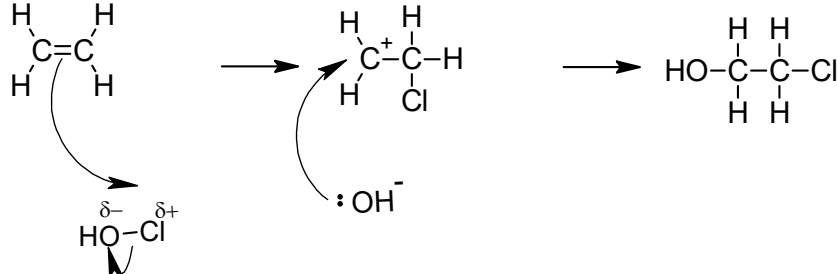
Question	Answer	Marks
4(a)(i)	Check final graph for range of acceptable answers $\pm(1-0.5) / 100 = \pm 0.005$ 0 $\text{mol dm}^{-3} \text{s}^{-1}$ for both Any 2 points = 1 mark, all 3 points = 2 marks	2
4(a)(ii)	$Na_2S_2O_3$ because reaction stops before all the HCl is used up. OR $Na_2S_2O_3$ because there is still HCl remaining (when the reaction has stopped)	1
4(a)(iii)	the frequency of effective collisions decreases as concentration of $HCl(aq)$ and / or $Na_2S_2O_3$ decreases	1

Question	Answer	Marks
4(a)(iv)	M1 0.001(00) mol sulfur produced M2 $M1 \times 6.02 \times 10^{23}$ $= 6.02 \times 10^{20}$	2
4(a)(v)	It reacts with water (to produce H_2SO_3)	1
4(b)(i)	M1 non-linear M2 bond angle – $120^\circ > x \geq 116^\circ$	2
4(b)(ii)	M1 weaker dipole moment (in SO_2) M2 electronegativity (difference) is larger (/ 1.4) for H and O than for S and O (/ 0.9) OR S=O bond is less polar than H—O OR stronger dipoles in S=O / SO_2	2

Question	Answer	Marks									
5(a)(i)	C_2H_3O	1									
5(a)(ii)	<table border="1"> <tr> <th>reagent</th><th>observation when reagent is added to W</th><th>structural formula of organic product when reagent is added to W</th></tr> <tr> <td>Na</td><td>fizz / bubbles etc / OR solid / Na disappears / dissolves</td><td>$CH_2C(CH_3)CO_2Na$ OR $CH_2C(CH_3)CO_2^- Na^+$</td></tr> <tr> <td>Br_2 in the dark</td><td>brown to colourless / decolourise</td><td>$CH_2BrCBr(CH_3)CO_2H$</td></tr> </table>	reagent	observation when reagent is added to W	structural formula of organic product when reagent is added to W	Na	fizz / bubbles etc / OR solid / Na disappears / dissolves	$CH_2C(CH_3)CO_2Na$ OR $CH_2C(CH_3)CO_2^- Na^+$	Br_2 in the dark	brown to colourless / decolourise	$CH_2BrCBr(CH_3)CO_2H$	4
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Br_2 in the dark	brown to colourless / decolourise	$CH_2BrCBr(CH_3)CO_2H$									
5(b)(i)	number of σ bonds = 14 number of π bonds = 2	2									

Question	Answer	Marks
5(b)(ii)		1
5(b)(iii)	reducing agent	1
5(b)(iv)	methanol / CH ₃ OH AND conc(entrated) (sulfuric) acid (catalyst)	1
5(b)(v)	• A C–H alkane • B C=O ester • C C=C alkene • D C–O ester 2 points = 1 mark, all 4 points = 2 marks	2
5(b)(vi)		1
5(c)	ethene pi bond is a region of (high) electron density (above and below the C-C (sigma) bond)	1

Question	Answer	Marks
6(a)(i)	two or more reactants / molecules react to make (only) one product	1
6(a)(ii)	mix / add Cl ₂ into water	1

Question	Answer	Marks
6(a)(iii)	water purification / killing bacteria or microbes	1
6(b)	 M1 correct arrow for HO-Cl M2 arrow from double bond of C=C to Cl M3 correct intermediate M4 arrow from lone pair on O of :OH⁻ to the appropriate C	4
6(c)(i)	KCN/potassium cyanide in ethanol AND heat	1
6(c)(ii)	(acid) hydrolysis	1
6(c)(iii)	$\text{HOCH}_2\text{CH}_2\text{CN} + 2\text{H}_2\text{O} + \text{HCl} \rightarrow \text{HOCH}_2\text{CH}_2\text{COOH} + \text{NH}_4\text{Cl}$	1

Cambridge International AS & A Level

CHEMISTRY**9701/24**

Paper 2 AS Level Structured Questions

May/June 2025**MARK SCHEME**Maximum Mark: 60

Published

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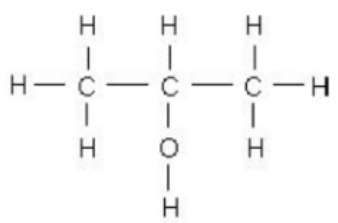
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SF	Error in number of significant figures
TE	Transcription error

Question	Answer	Marks						
1(a)	<table border="1"> <tr> <td><i>Mg</i></td><td><i>Si</i></td><td><i>P</i></td></tr> <tr> <td>M1 Giant metallic</td><td>M2 Giant molecular</td><td>M3 Simple molecular</td></tr> </table>	<i>Mg</i>	<i>Si</i>	<i>P</i>	M1 Giant metallic	M2 Giant molecular	M3 Simple molecular	3
<i>Mg</i>	<i>Si</i>	<i>P</i>						
M1 Giant metallic	M2 Giant molecular	M3 Simple molecular						
1(b)	M1 Na to Al have (delocalised) electrons that can move (through the structure / lattice) AND (P / S / Cl) do not (have delocalised electrons / mobile charge carriers) M2 Na to Al increasing number of delocalised electrons	2						
1(c)(i)	$\text{Ar}^{2+}(\text{g}) \rightarrow \text{Ar}^{3+}(\text{g}) + \text{e}^{(-)}$ M1 a correct equation which represents an ionisation process e.g. $\text{X}^{n+} \rightarrow \text{X}^{(n+1)+} + \text{e}^{(-)}$ M2 correct equation to show third ionisation energy of Ar including (g) state symbols	2						
1(c)(ii)	M1 nuclear charge M2 distance of outer electron(s) from nucleus OR ionic radius OR shielding (by inner shells and / or sub-shells)	2						
1(c)(iii)	M1 (most significant factor) = distance of outer electron(s) from nucleus OR ionic radius OR shielding OR shells M2 (3rd IE) value for (Na and) Mg is (much) greater than Al (to Ar) OR (Na and) Mg has electron(s) removed from a shell that is closer to the nucleus / less shielding OR (Na and) Mg has electron(s) removed from a shell that is lower in energy	2						
1(c)(iv)	1s 2s 2p 3s 3p	1						
1(d)(i)	$\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$	1						
1(d)(ii)	$\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4$	1						

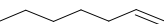
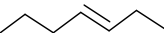
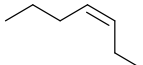
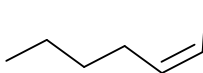
Question	Answer	Marks
2(a)(i)	non-linear	1
2(a)(ii)	104.5°	1
2(b)(i)	<i>In any order:</i> M1 (solution / liquid) (red) to colourless M2 yellow solid appears	2
2(b)(ii)	oxidation number of S in $\text{SCl}_2 = (+) 2 / (+) \text{II}$ oxidation number of S in $\text{H}_2\text{SO}_3 = (+) 4 / (+) \text{IV}$	2
2(b)(iii)	hydrolysis	1

Question	Answer	Marks
3(a)(i)	0.00658(0) mol	1
3(a)(ii)	M1 I_2 in 25.0 cm^3 $0.00658 / 2 = 0.00329 \text{ (mol)}$ M2 $0.00329 \times 1000 / 25.0 = 0.132 \text{ (mol)}$ alternative answer using 9.42×10^{-3} : M1 0.00471 M2 0.1884	2
3(b)	M1 $0.2 - 0.154 = 0.046 \text{ (mol H}_2 \text{ and / or I}_2 \text{ reacts)}$ M2 mol H_2 at equilibrium $0.1 - 0.046 = 0.054$ M3 mol HI at equilibrium $0.3 + (0.046 \times 2) = 0.392$	3
3(c)	2.46	1
3(d)(i)	(electrostatic) attraction between the nuclei (of two atoms) and a shared pair of electrons	1

Question	Answer	Marks
3(d)(ii)	M1 HCl is more stable AND (because) Cl atom is smaller / less distance between electron pair and nucleus / shorter (H-X) bond length M2 (In HCl) stronger attraction between nucleus and shared pair of electrons OR (In HCl) (fewer shells of electrons so) less shielding OR (In HCl) greater orbital overlap so stronger interaction	2
3(d)(iii)	any value or range of values for K_c between $5.50 \times 10^{-34} < K_c < 1.26 \times 10^{-3}$	1

Question	Answer	Marks
4(a)	$\text{C}_5\text{H}_{10}\text{O}_2$	1
4(b)	propyl ethanoate	1
4(c)(i)	condensation	1
4(c)(ii)	$\text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$	1
4(c)(iii)	propan-1-ol	1
4(d)(i)	$\text{CH}_3\text{CN} + \text{HCl} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{NH}_4\text{Cl}$	1
4(d)(ii)		2

Question	Answer	Marks
4(d)(iii)	M1 step 1 PCl_3 and heat OR HCl(g) OR PCl_5 OR SOCl_2 OR NaCl / KCl and conc. H_2SO_4 / conc. H_3PO_4 M2 step 2 reagent KCN M3 conditions for step 2 dissolved in ethanol AND heat	3

Question	Answer	Marks
5(a)	M1  M2  OR 	2
5(b)(i)	no rotation / restricted rotation of $\text{C}=\text{C}$ / pi bond	1
5(b)(ii)	(W / it has two) different groups bonded to each C of the double bond	1
5(c)		1
5(d)(i)	oxidising agent	1
5(d)(ii)	hot concentrated acidified KMnO_4	1

Question	Answer	Marks
6(a)(i)	simplest (whole number) ratio of atoms (of the elements) in a compound	1
6(a)(ii)	C : H M1 $\frac{85.7}{12}$ or 7.14 : $\frac{14.3}{1}$ or 14.3 1 : 2 M2 CH₂	2
6(a)(iii)	alkene(s)	1
6(b)	M1 convert temp to 373 K (and use) M2 correct rearrangement and use $7.15 = n \cdot 8.31(4) \times T$ to find n AND Mr = 0.194 / n Mr = 84.1	2
6(c)(i)	M1 $\frac{100}{1.1} \times \frac{11}{100}$ M2 10	2
6(c)(ii)	C ₁₀ H ₁₈	1
6(c)(iii)	(C ₄ H ₉) ⁺	1