Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 2021**

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 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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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 descriptors 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.

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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.

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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.

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Question	Answer	Mark
1(a)	**M1** cream	**1**
	M2 AgBr	**1**
1(b)	(1)$\mathbf{M}Br_2 + 2AgNO_3 \rightarrow 2AgBr + \mathbf{M}(NO_3)_2$	**1**
1(c)	**M1** *calculate Mr of* $\mathbf{M}Br_2$ *using* 8.415×10^{-4} *mol* $\mathbf{M}Br_2$ *in 0.250 g* M_r = ……. = 297(.1)……	**1**
	M2 *calculate the atomic mass of* ***M*** *using* M_r *calculated in M1* $297.1 - (2 \times 79.9) = 137(.4)$	**1**
	M3 *identify group 2 element from* A_r *in M2* Ba / barium	**1**
1(d)(i)	(solution / mixture / liquid) turns (colourless to) orange or brown	**1**
1(d)(ii)	displacement	**1**
1(e)	**M1** *reagent:* concentrated sulfuric acid	**1**
	M2 *observation:* brown vapour / gas (forms)	**1**
1(f)(i)	*explain* ***how the action of heat*** *is used to identify the 3 samples* **M1** nitrate AND carbonate lose mass / less than 1 g	**1**
	M2 nitrate produces brown (NO_2) fumes	**1**
	M3 MgO no reaction / MgO no change	**1**
1(f)(ii)	*electronic configuration of* Mg^{2+} ($1s^2$) $2s^2 2p^6$	**1**

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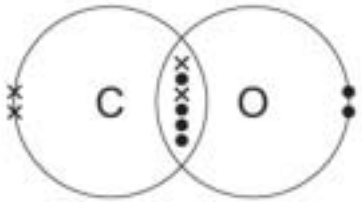
Question	Answer	Mark
1(g)	*One similarity* **M1** solid(s) disappear(s)	**1**
	One difference **M2** $MgCO_3$ fizzes (due to CO_2) OR no fizzing with $Mg(OH)_2$	**1**

Question	Answer	Marks
2(a)(i)	Li^+ AND S^{2-}	**1**
2(a)(ii)	**M1** giant	**1**
	M2 (many) strong force(s) of attraction between oppositely charged ions OR (many) strong ionic bond(s)	**1**
2(b)(i)	(covalent) bond with both electrons are provided from the same / one species OR shared pair (of electrons) are provided from the same species / one atom *owtte*	**1**
2(b)(ii)	3 bonding pairs between C and O, 4 •'s AND 2×'s 1 lone pair on C, ××, AND 1 lone pair on O, ••. 	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>2(c)(i)</td><td>Any two assumptions about the behaviour of particles in an ideal gas from
• (particles / molecules have mass but) negligible size / volume (compared to total volume of gas / container)
• no / negligible forces / interactions (between particles / molecules)
• collisions are elastic</td><td>2</td></tr>
<tr><td rowspan="2">2(c)(ii)</td><td>M1 IMF become larger / more significant</td><td>1</td></tr>
<tr><td>M2 volume of <u>molecules / particles</u> becomes significant / no longer negligible</td><td>1</td></tr>
<tr><td>2(c)(iii)</td><td><table><tr><td>$N_2(g)$</td><td>CO(g)</td></tr><tr><td>instantaneous dipole–induced dipole ✓</td><td>instantaneous dipole–induced dipole
(and)
permanent dipole–permanent dipole ✓</td></tr></table></td><td>2</td></tr>
<tr><td>2(c)(iv)</td><td>O is more electronegative than C</td><td>1</td></tr>
</table>

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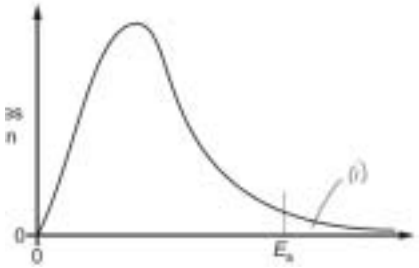
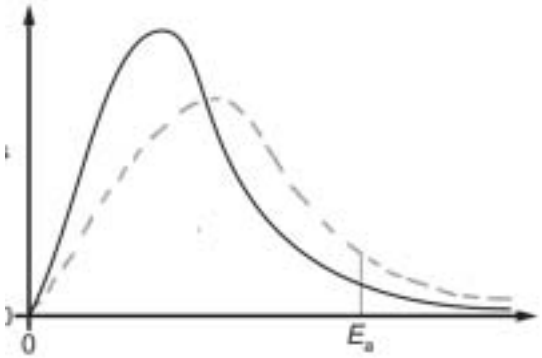
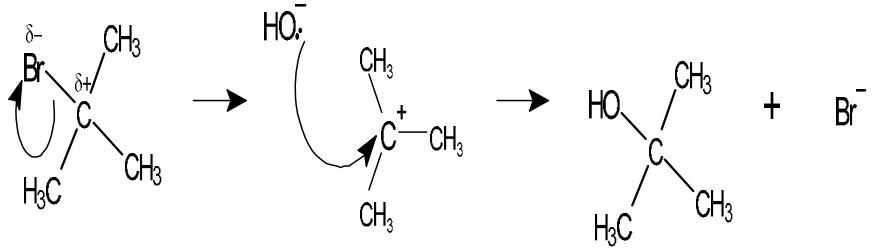
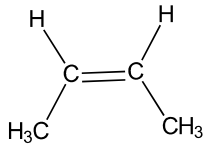
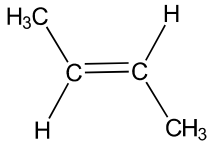
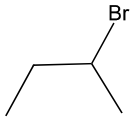
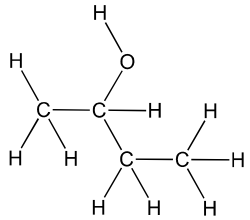
Question	Answer	Mark
3(a)	change in amount of substance with time	**1**
3(b)(i)	label **area** under the original curve to the right of E_a.  	**1**
3(b)(ii)	**M1** *curve starts at the origin but peak lies to the right of original.*	**1**
	M2 *peak at higher temperature is lower than the original AND graph crosses the original once only – beyond the peak of original*  	**1**
3(b)(iii)	no change / none	**1**

Question	Answer	Mark
3(c)(i)	 **M1** correct dipole on haloalkane AND arrow from bond to Br or just beyond	**1**
	M2 correct intermediate	**1**
	M3 arrow from lone pair on <u>O</u> of OH^- / ^-OH to central C of their intermediate shown in M2 OR arrow from lone pair on <u>O</u> of OH^- / ^-OH to central C of 2-bromo 2-methylpropane if S_N2 mechanism shown	**1**
3(c)(ii)	nucleophilic substitution	**1**
3(d)	**M1** more time (because the rate is lower)	**1**
	M2 C-C*l* (bond) is stronger (than C-Br)	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th></th><th>structural formula</th><th>name</th></tr>
<tr><td>A</td><td>$CH_3CH_2CH=CH_2$</td><td>but-1-ene
OR
1-butene</td></tr>
<tr><td>B</td><td></td><td>cis / Z but-2-ene
OR
cis / Z 2-butene</td></tr>
<tr><td>C</td><td></td><td>trans / E but-2-ene
OR
trans / E 2-butene</td></tr>
<tr><td>D</td><td>$CH_2=C(CH_3)_2$</td><td>(2) methyl prop(-1-)ene</td></tr>
</table>
M1 correct identification of but-1-ene (for A)
M2 correct identification of but-2-ene for B and C
M3 identification of cis / trans (Z / E) for B and C (in correct order)
M4 correct name of D
</td><td>4</td></tr>
<tr><td>4(a)(ii)</td><td>(molecules with the) same structural formula (and same molecular formula) with different arrangement of atoms / groups in space</td><td>1</td></tr>
<tr><td>4(b)(i)</td><td>A</td><td>1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td rowspan="3">4(b)(ii)</td><td>

M1 skeletal formula only</td><td>**1**</td></tr>
<tr><td>**M2** *explanation in terms of increased / greater stability of intermediate / carbocation*
intermediate / (secondary) carbocation / $CH_3C^+(H)(CH_2CH_3)$ is (more) stable</td><td>**1**</td></tr>
<tr><td>**M3** *reason for increased stability of intermediate in terms of greater number of alkyl groups showing largest inductive (electron releasing) effect*
greater (positive) inductive effect due to two alkyl groups
OR
greater electron donation of two alkyl groups</td><td>**1**</td></tr>
<tr><td>4(c)</td><td>dehydrating agent / cause dehydration</td><td>**1**</td></tr>
<tr><td>4(d)(i)</td><td>oxidation</td><td>**1**</td></tr>
<tr><td>4(d)(ii)</td><td><table><tr><td>functional group</td><td>present in **Z**</td></tr><tr><td>aldehyde</td><td>✓</td></tr><tr><td>ketone</td><td></td></tr><tr><td>carboxylic acid</td><td></td></tr></table></td><td>**1**</td></tr>
</table>

Question	Answer	Mark
5(a)	*displayed formula of butan-2-ol structure with O—H shown* 	**1**
5(b)(i)	2-bromobutane	**1**
5(b)(ii)	substitution	**1**
5(b)(iii)	*reagent* **M1** NaCN or KCN	**1**
	conditions **M2** ethanolic AND heat (under reflux)	**1**
5(b)(iv)	(1)C_4H_9CN + (1)H^+ + 2H_2O → (1)$C_4H_9CO_2H$ + (1)NH_4^+ ✓✓ *correct organic product showing carboxylic acid functional group* **M1** $C_4H_9CO_2H$ / C_4H_9COOH	**1**
	M2 balanced equation with a $C_5H_{10}O_2$ or equivalent structure as product	**1**
5(b)(v)	2200–2250 (cm^{-1} due to) C≡N / triple bond between C and N.	**1**