Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/21**

Paper 2 AS Structured Questions **October/November 2019**

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 2019 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.

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Question	Answer	Marks
1(a)(ii)	It oxidises chlorine from –1 to 0	**1**
1(a)(ii)	effervescence / fizzing / bubbling **OR** green gas formed **OR** solid dissolves / disappears / soluble	**1**
1(b)	**M1:** decreases (down the group) **M2:** increasing induced dipoles **M3:** greater number of electrons	**3**
1(c)(i)	**M1:** $Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$ **M2: chlorine** is oxidised and reduced	**2**
1(c)(ii)	$NaClO_3$ / sodium chlorate(V)	**1**
1(d)	**M1:** chloric(I) acid / hypochlorous acid / HClO **M2:** kills bacteria / micro-organisms / microbes	**2**
1(e)(i)	ultra-violet (light) / sunlight	**1**
1(e)(ii)	$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>Na_2O MgO Al_2O_3 SiO_2 SO_3
<table><tr><td>ionic</td><td>ionic</td><td>ionic</td><td>covalent</td><td>covalent</td></tr><tr><td>giant</td><td>giant</td><td>giant</td><td>giant / macro-molecular</td><td>simple / molecular</td></tr></table>Award one mark for each correct row.</td><td>2</td></tr>
<tr><td>2(b)(i)</td><td>M1 SiO_2 has a network of strong bonds / SiO_2 has many strong bonds

M2 SO_3 has weak intermolecular forces
OR
weak VdW forces (between molecules)

M3 high(er) / more energy required to break bonds than overcome forces (between molecules)</td><td>3</td></tr>
<tr><td>2(b)(ii)</td><td>M1: reacts with both acid and base / alkali

M2: use any equation with Al_2O_3 and an acid, e.g. $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

M3: use any equation with Al_2O_3 and a base / alkali, e.g. $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$</td><td>3</td></tr>
<tr><td>2(b)(iii)</td><td>solid dissolves / disappears
OR
gets warm / hot</td><td>1</td></tr>
<tr><td>2(c)(i)</td><td>octahedral</td><td>1</td></tr>
</table>

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Question	Answer	Marks
2(c)(ii)	**M1:** use of the correct expression in terms of specific bond energies. (514 – xE$_{Se—O}$ = –346) **M2:** use of correct stoichiometry AND correct processing of expression given in M1. Provided the values 514 and 346 are used. (514 – 2E$_{Se—O}$ = –346) = (+)430 (kJ mol^{-1})	**2**
2(c)(iii)	$SeO_2 + 2NaOH \rightarrow Na_2SeO_3 + H_2O$	**1**

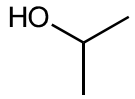
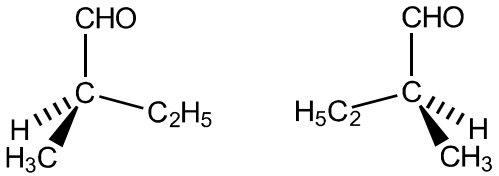
Question	Answer	Marks
3(a)(i)	cracking	**1**
3(a)(ii)	enthalpy change of combustion / ΔH_c is high / large energy release (per mole / per unit mass) **OR** combust / burn easily	**1**
3(a)(iii)	$C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$	**1**
3(a)(iv)	**M1**: infrared spectroscopy **M2:** Compare / measure (characteristic) wavelengths	**2**
3(b)(i)	$C_4H_4S(l) + 6O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l) + SO_2(g)$ • correct species • balancing • state symbols Award one mark for two correct bullet points, award two marks for all three correct.	**2**

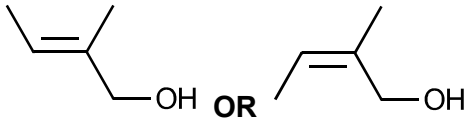
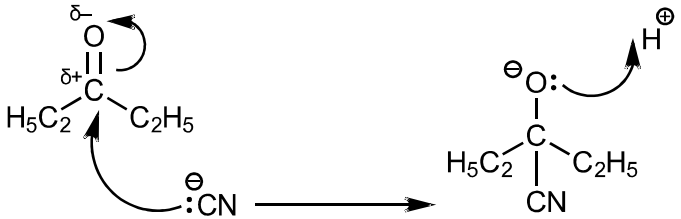
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Question	Answer	Marks
3(b)(ii)	**M1** (enthalpy change when) 1 mol of a substance **M2** EITHER burns / combusts / reacts in excess air / oxygen OR completely burns / combusts / reacts in air / oxygen	**2**
3(b)(iii)	**M1** m = 200 and ΔT = 37.5–18.5 **M2** $Q = mc\,\Delta T = 200 \times 4.18 \times (37.5 - 18.5) = 15\,884$ (J)	**2**
3(b)(iv)	**M1** mol of thiophene used = 0.63 / 84.1 OR 7.49(1 082 045) $\times 10^{-3}$ **M2** calculation ÷ 1000 AND negative sign $\Delta H_c = \frac{-\textbf{(iii)}}{\textbf{1000}} \div n = \frac{-\textbf{(iii)}}{\textbf{21000}} \div (0.63 / 84.1)$ = **–**2120 (–2120.39) (kJ mol^{-1})	**2**

Question	Answer	Marks
4(a)(i)	(2,2–)dimethylpropanal	**1**
4(a)(ii)	sp^2	**1**
4(b)(i)	acidified potassium dichromate**[(VI)] AND** heat under reflux	**1**
4(b)(ii)	**M1: A** has **H-bonding** (between molecules) **M2: B** only has dipole–dipole / **VdW** forces (between molecules) **M3:** H-bonding is stronger / requires more energy to overcome	**3**
4(b)(iii)	$(CH_3)_3CCHO + 2[H] \rightarrow (CH_3)_3CCH_2OH$	**1**

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Question	Answer	Marks
4(b)(iv)	 / $CH_3CH(OH)CH_3$ **M1:** **M2:** H_2SO_4 / sulfuric acid	**2**
4(c)(i)	• orange / red / yellow precipitate • orange / red / yellow precipitate	**1**
4(c)(ii)	Aldehyde	**1**
4(c)(iii)	has a carbon / atom attached / bonded to four different atoms / groups / groups of atoms / chains	**1**
4(c)(iv)	 **M1:** Correct 3D representation **M2:** Correct 3D representation of drawn enantiomer	**2**
4(c)(v)	principal absorptions in the infra-red spectrum / bond responsible 3200–3600 cm^{-1} / RO-H / O-H 1630 cm^{-1} / C=C 1050 cm^{-1} / C—O	**1**

Question	Answer	Marks
4(c)(vi)	 **OR** **M1:** skeletal alkene group **AND** C5 structure **M2: one** alcohol group **M3:** branched chain **AND** capable of geometrical isomerism	**3**
4(c)(vii)	**M1:** Correct structure of **X** and correct dipole on C=O **M2:** curly arrow from C=O bond to O AND intermediate with CN attached and –ve charge on the O **M3:** curly arrow from lone pair on CN^- to C(=O) in **X** **AND** curly arrow from lone pair in the intermediate to H^+ 	**3**
4(c)(viii)	catalyst	**1**