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**CHEMISTRY**

**9701/21**

Paper 2 AS Structured Questions

**October/November 2019**

MARK SCHEME

Maximum Mark: 60

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**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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This document consists of **9** 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 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.

**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 <b>OR</b> <u>green</u> gas formed <b>OR</b> solid dissolves / disappears / soluble	1
1(b)	<b>M1:</b> decreases (down the group) <b>M2:</b> increasing induced dipoles <b>M3:</b> greater number of electrons	3
1(c)(i)	<b>M1:</b> $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$ <b>M2:</b> chlorine is oxidised and reduced	2
1(c)(ii)	$\text{NaClO}_3$ / sodium chlorate(V)	1
1(d)	<b>M1:</b> chloric(I) acid / hypochlorous acid / $\text{HClO}$ <b>M2:</b> kills bacteria / micro-organisms / microbes	2
1(e)(i)	ultra-violet (light) / sunlight	1
1(e)(ii)	$\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$	1

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Question	Answer	Marks															
2(a)	<table border="1" style="width: 100%; text-align: center;"> <tr> <td><b>Na<sub>2</sub>O</b></td> <td><b>MgO</b></td> <td><b>Al<sub>2</sub>O<sub>3</sub></b></td> <td><b>SiO<sub>2</sub></b></td> <td><b>SO<sub>3</sub></b></td> </tr> <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> <p>Award one mark for each correct row.</p>	<b>Na<sub>2</sub>O</b>	<b>MgO</b>	<b>Al<sub>2</sub>O<sub>3</sub></b>	<b>SiO<sub>2</sub></b>	<b>SO<sub>3</sub></b>	ionic	ionic	ionic	covalent	covalent	giant	giant	giant	giant / macro-molecular	simple / molecular	<b>2</b>
<b>Na<sub>2</sub>O</b>	<b>MgO</b>	<b>Al<sub>2</sub>O<sub>3</sub></b>	<b>SiO<sub>2</sub></b>	<b>SO<sub>3</sub></b>													
ionic	ionic	ionic	covalent	covalent													
giant	giant	giant	giant / macro-molecular	simple / molecular													
2(b)(i)	<p><b>M1</b> SiO<sub>2</sub> has a <b>network</b> of strong bonds / SiO<sub>2</sub> has <b>many</b> strong bonds</p> <p><b>M2</b> SO<sub>3</sub> has weak intermolecular forces <b>OR</b> weak VdW forces (between molecules)</p> <p><b>M3</b> high(er) / more energy required to break <b>bonds</b> than overcome <b>forces</b> (between molecules)</p>	<b>3</b>															
2(b)(ii)	<p><b>M1:</b> reacts with both acid and base / alkali</p> <p><b>M2:</b> use any equation with Al<sub>2</sub>O<sub>3</sub> and an acid, e.g. Al<sub>2</sub>O<sub>3</sub> + 6HCl → 2AlCl<sub>3</sub> + 3H<sub>2</sub>O</p> <p><b>M3:</b> use any equation with Al<sub>2</sub>O<sub>3</sub> and a base / alkali, e.g. Al<sub>2</sub>O<sub>3</sub> + 2NaOH + 3H<sub>2</sub>O → 2NaAl(OH)<sub>4</sub></p>	<b>3</b>															
2(b)(iii)	<p>solid dissolves / disappears <b>OR</b> gets warm / hot</p>	<b>1</b>															
2(c)(i)	octahedral	<b>1</b>															

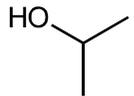
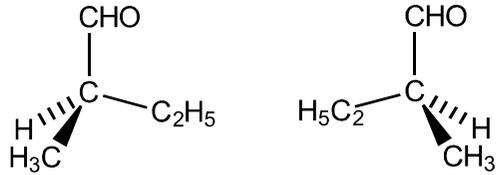
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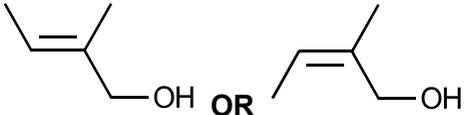
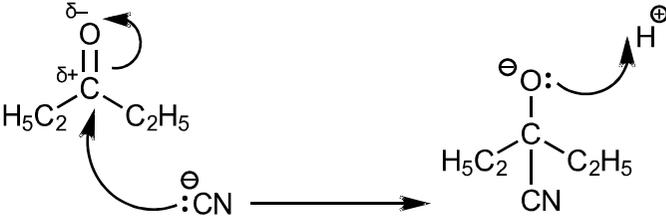
Question	Answer	Marks
2(c)(ii)	<p><b>M1:</b> use of the correct expression in terms of specific bond energies. (<math>514 - xE_{\text{Se-O}} = -346</math>)</p> <p><b>M2:</b> use of correct stoichiometry AND correct processing of expression given in M1. Provided the values 514 and 346 are used. (<math>514 - 2E_{\text{Se-O}} = -346</math>)</p> <p>= (+)430 (kJ mol<sup>-1</sup>)</p>	2
2(c)(iii)	$\text{SeO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SeO}_3 + \text{H}_2\text{O}$	1

Question	Answer	Marks
3(a)(i)	cracking	1
3(a)(ii)	enthalpy change of combustion / $\Delta H_c$ is high / large energy release (per mole / per unit mass) <b>OR</b> combust / burn easily	1
3(a)(iii)	$\text{C}_4\text{H}_8 + 4\text{O}_2 \rightarrow 4\text{CO} + 4\text{H}_2\text{O}$	1
3(a)(iv)	<p><b>M1:</b> infrared spectroscopy</p> <p><b>M2:</b> Compare / measure (characteristic) wavelengths</p>	2
3(b)(i)	<p><math>\text{C}_4\text{H}_4\text{S(l)} + 6\text{O}_2\text{(g)} \rightarrow 4\text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)} + \text{SO}_2\text{(g)}</math></p> <ul style="list-style-type: none"> <li>• correct species</li> <li>• balancing</li> <li>• state symbols</li> </ul> <p>Award one mark for two correct bullet points, award two marks for all three correct.</p>	2

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

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

Question	Answer	Marks								
4(b)(iv)	 <p><b>M1:</b> / CH<sub>3</sub>CH(OH)CH<sub>3</sub></p> <p><b>M2:</b> H<sub>2</sub>SO<sub>4</sub> / sulfuric acid</p>	2								
4(c)(i)	<ul style="list-style-type: none"> <li>orange / red / yellow precipitate</li> <li>orange / red / yellow precipitate</li> </ul>	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)	 <p><b>M1:</b> Correct 3D representation</p> <p><b>M2:</b> Correct 3D representation of drawn enantiomer</p>	2								
4(c)(v)	<table border="1" data-bbox="347 1013 1075 1372"> <thead> <tr> <th>principal absorptions in the infra-red spectrum</th> <th>bond responsible</th> </tr> </thead> <tbody> <tr> <td>3200–3600 cm<sup>-1</sup></td> <td>RO-H / O-H</td> </tr> <tr> <td>1630 cm<sup>-1</sup></td> <td>C=C</td> </tr> <tr> <td>1050 cm<sup>-1</sup></td> <td>C—O</td> </tr> </tbody> </table>	principal absorptions in the infra-red spectrum	bond responsible	3200–3600 cm <sup>-1</sup>	RO-H / O-H	1630 cm <sup>-1</sup>	C=C	1050 cm <sup>-1</sup>	C—O	1
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1050 cm <sup>-1</sup>	C—O									

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