

Cambridge  
International  
AS & A Level

**Cambridge International Examinations**  
Cambridge International Advanced Subsidiary and Advanced Level

---

**CHEMISTRY**

**9701/21**

Paper 2 AS Level Structured Questions

**May/June 2017**

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.


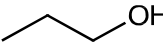
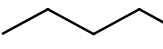
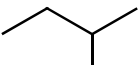
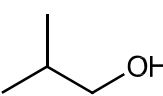

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2017 series for most Cambridge IGCSE<sup>®</sup>, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

---

© IGCSE is a registered trademark.

This document consists of **7** printed pages.

Question	Answer	Marks
1(a)	The mass of a molecule OR the (weighted) average / (weighted) mean mass of the molecules	1
	Relative / compared to $\frac{1}{12}$ (the mass) of <u>an atom</u> of carbon-12 OR on a scale in which a carbon-12 atom / isotope has a mass of (exactly) 12 (units)	1
1(b)(i)	<b>3</b>	1
1(b)(ii)	<b>8</b>	1
1(b)(iii)	$C_3H_8O + 4\frac{1}{2}O_2 \rightarrow 3CO_2 + 4H_2O$	1
1(b)(iv)	 OH <b>AND</b> propan-2-ol / 2-propanol	1
	 <b>AND</b> propan-1-ol / 1-propanol	1
	Alternative answers (any two):  OH <b>AND</b> butan-1-ol / 1-butanol	
	 OH <b>AND</b> butan-2-ol / 2-butanol	
	 <b>AND</b> (2-)methylpropan-1-ol / (2-)methyl-1-propanol	
 OH <b>AND</b> (2-)methylpropan-2-ol / (2-)methyl-2-propanol		

**PUBLISHED**

Question	Answer	Marks
1(b)(v)	correct conversions of data to SI/consistent units $p = 100\,000$ ; $V = 20 \times 10^{-6}$ ; $T = 393$	1
	calculation of $n (=pV/RT)$ from M1 values $n = \frac{100 \times 10^3 \times 20 \times 10^{-6}}{8.31 \times 393}$	1
	calculation of mass $m (=n \times Mr)$ <b>AND</b> answer correct to <b>3sf</b> $m = 6.12 \times 10^{-4} \times 60 = 0.0367$ (g)  Alternative answer for using $C_4H_{10}O$ : $m = 6.12 \times 10^{-4} \times 74 = 0.0453$ (g)	1
	<b>Total:</b>	<b>10</b>

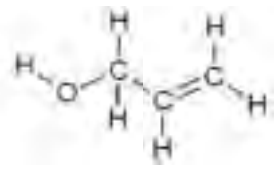
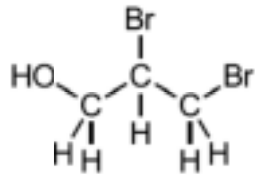
Question	Answer	Marks																		
2(a)	<table border="1"> <thead> <tr> <th>substance</th> <th>type of bonding</th> <th>type of lattice structure</th> </tr> </thead> <tbody> <tr> <td>copper</td> <td>metallic</td> <td>giant/metallic</td> </tr> <tr> <td>ice</td> <td>covalent OR hydrogen(-bonding) / H(-bonding)</td> <td>hydrogen-bonded / simple / molecular</td> </tr> <tr> <td>silicon(IV) oxide</td> <td>covalent</td> <td>giant (molecular) / macromolecular</td> </tr> <tr> <td>iodine</td> <td>covalent</td> <td>simple / molecular</td> </tr> <tr> <td>sodium chloride</td> <td>ionic</td> <td>giant / ionic</td> </tr> </tbody> </table>	substance	type of bonding	type of lattice structure	copper	metallic	giant/metallic	ice	covalent OR hydrogen(-bonding) / H(-bonding)	hydrogen-bonded / simple / molecular	silicon(IV) oxide	covalent	giant (molecular) / macromolecular	iodine	covalent	simple / molecular	sodium chloride	ionic	giant / ionic	1
	substance	type of bonding	type of lattice structure																	
	copper	metallic	giant/metallic																	
	ice	covalent OR hydrogen(-bonding) / H(-bonding)	hydrogen-bonded / simple / molecular																	
	silicon(IV) oxide	covalent	giant (molecular) / macromolecular																	
	iodine	covalent	simple / molecular																	
sodium chloride	ionic	giant / ionic																		
		1																		
		1																		
		1																		
		1																		
2(b)(i)	hydrogen bonding	1																		

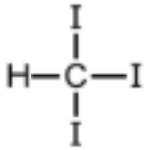
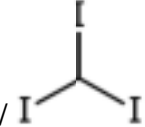
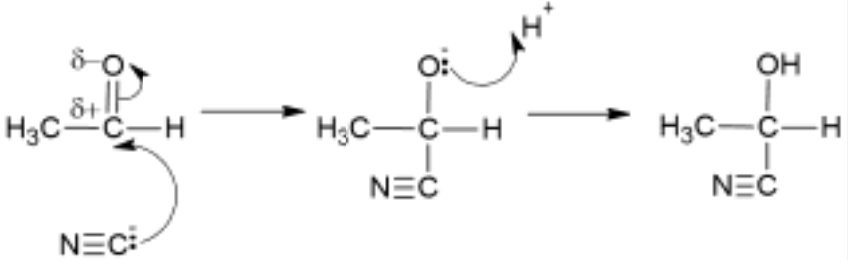
**PUBLISHED**

Question	Answer	Marks
2(b)(ii)	H-bond between O and H of different molecules	1
	minimum <b>three</b> partial charges (in a row) over <b>two</b> H <sub>2</sub> O molecules, i.e.: $\begin{array}{c} \text{either } \delta^- \text{O} - \text{H}^{\delta+} \text{ --- } \delta^- \text{O} \\ \text{or } \text{H}^{\delta+} \text{ --- } \delta^- \text{O} - \text{H}^{\delta+} \end{array}$	1
	lone pair of electrons on O of H-bond, in line with H-bond	1
2(c)(i)	X = liquid AND Z = solid	1
	Y = liquid and solid OR 'liquid / solid' OR 'liquid OR solid'	1
2(c)(ii)	(kinetic) energy reducing	1
	motion slowing <span style="float: right;"><i>owtte</i></span>	1
2(c)(iii)	energy given out / released forming bonds / forming bonds exothermic	1
	compensates for / counteracts heat loss / cooling <span style="float: right;"><i>owtte</i></span>	1
	<b>Total:</b>	<b>15</b>

Question	Answer	Marks
3(a)(i)	A	1
3(a)(ii)	H	1
3(a)(iii)	G	1
3(a)(iv)	B	1
3(a)(v)	F	1
3(b)(i)	(strong) heating	1
	(to provide / overcome) <u>high</u> activation energy	1
3(b)(ii)	<u>white</u> flame / <u>white</u> light / <u>white</u> smoke / <u>white</u> solid	1
3(b)(iii)	$\text{Mg(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Mg(OH)}_2\text{(s)} + \text{H}_2\text{(g)}$	2
3(c)(i)	$2\text{Mg(NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$	1
3(c)(ii)	$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$	1
	$\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$	1
3(d)(i)	reduce acidity in soil / increase pH of soil	1
	(both) basic / base(s)	1
3(d)(ii)	$\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ OR $\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{H}_2\text{CO}_3$	1
	<b>Total:</b>	<b>16</b>

**PUBLISHED**

Question	Answer	Marks
4(a)(i)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	1
	different structural / displayed formulae / arrangement of bonds	1
4(a)(ii)	sp <sup>2</sup> overlap of (2)s with two (2)p (atomic) orbitals	1
	sp <sup>3</sup> overlap of (2)s with all three (2)p (atomic) orbitals	1
4(a)(iii)	sp <sup>2</sup> = 116° – 124°	1
	sp <sup>3</sup> = 106° – 112°	1
4(b)(i)		1
4(b)(ii)	(electrophilic) addition	1
	bromine decolourises / turns colourless / fades (from orange / brown)	1
4(b)(iii)	HOCH <sub>2</sub> CHBrCH <sub>2</sub> Br    OR 	1
4(b)(iv)	CO <sub>2</sub> / carbon dioxide	1
4(c)(i)	<b>P</b> = propanal	1
	<b>Q</b> = propanone	1

Question	Answer	Marks
4(c)(ii)	 /  tr(i)iodomethane / $\text{CHI}_3$ /	1
4(d)(i)	(molecules / isomers with) the same (molecular and) structural formula	1
	Any two of: chiral centre / C attached to four different groups / atoms non-super(im)posable mirror images different spatial / 3D arrangement of atoms (owtte) different rotation of plane-polarised light	1
4(d)(ii)	 curly arrow from lone pair on $\text{:C}\equiv\text{N}$ to $\text{C}^{(\delta+)}$ correct dipole on carbonyl $\delta^+\text{C}=\text{O}^{\delta-}$ AND curly arrow from bond to $\text{O}^{(\delta-)}$ correct intermediate, including $\text{C}-\text{O}^-$ AND curly arrow from lone pair to $\text{H}^+$	1 1 1
	<b>Total:</b>	<b>19</b>