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.

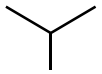
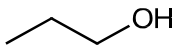
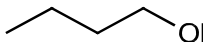
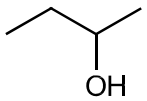
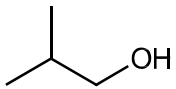
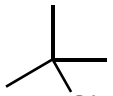
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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®, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

® IGCSE is a registered trademark.

© UCLES 2017

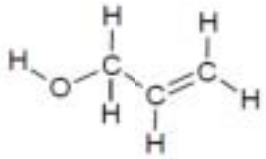
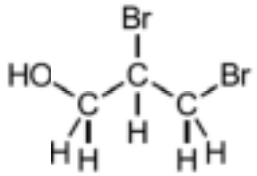
Question	Answer	Marks
1(a)	The mass of a molecule OR the (weighted) average / (weighted) mean mass of the molecules	**1**
	Relative / compared to $\frac{1}{12}$ (the mass) of <u>an atom</u> of carbon–12 OR on a scale in which a carbon–12 atom / isotope has a mass of (exactly) 12 (units)	**1**
1(b)(i)	**3**	**1**
1(b)(ii)	**8**	**1**
1(b)(iii)	$C_3H_8O + 4½O_2 \rightarrow 3CO_2 + 4H_2O$	**1**
1(b)(iv)	 **AND** propan–2–ol / 2–propanol	**1**
	 **AND** propan–1–ol / 1–propanol	**1**
	Alternative answers (any two):  **AND** butan–1–ol / 1–butanol  **AND** butan–2–ol / 2–butanol  **AND** (2–)methylpropan–1–ol / (2–)methyl–1–propanol  **AND** (2–)methylpropan–2–ol / (2–)methyl–2–propanol	

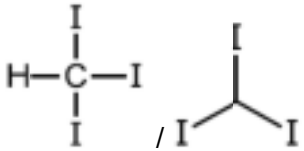
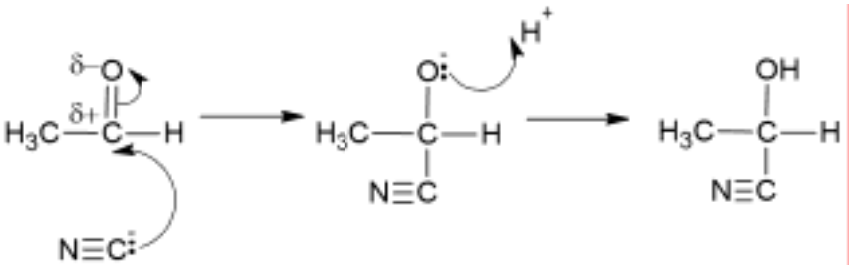
Question	Answer	Marks
1(b)(v)	correct conversions of data to SI/consistent units p = 100 000 ; V = 20×10^{-6} ; T = 393	1
	calculation of *n (= pVIRT)* from M1 values $n = \frac{100 \times 10^3 \times 20 \times 10^{-6}}{8.31 \times 393}$	1
	calculation of mass *m (= n × Mr)* **AND** answer correct to **3sf** *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
	Total:	10

Question	Answer			Marks
2(a)	substance	type of bonding	type of lattice structure	
	copper	metallic	giant/metallic	1
	ice	covalent OR hydrogen(-bonding) / H(–bonding)	hydrogen-bonded / simple / molecular	1
	silicon(IV) oxide	covalent	giant (molecular) / macromolecular	1
	iodine	covalent	simple / molecular	1
	sodium chloride	ionic	giant / ionic	1
2(b)(i)	hydrogen bonding			1

Question	Answer	Marks
2(b)(ii)	H-bond between O and H of different molecules	**1**
	minimum **three** partial charges (in a row) over **two** H_2O molecules, i.e.: either $^{\delta-}O—H^{\delta+}$ - - - - $^{\delta-}O$ or $H^{\delta+}$ - - - - $^{\delta-}O—H^{\delta+}$	**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 *owtte*	**1**
2(c)(iii)	energy given out / released forming bonds / forming bonds exothermic	**1**
	compensates for / counteracts heat loss / cooling *owtte*	**1**
	Total:	**15**

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) high activation energy	**1**
3(b)(ii)	white flame / white light / white smoke / white solid	**1**
3(b)(iii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(s) + H_2(g)$	**2**
3(c)(i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$	**1**
3(c)(ii)	$CaCO_3 \rightarrow CaO + CO_2$	**1**
	$CaO + H_2O \rightarrow Ca(OH)_2$	**1**
3(d)(i)	reduce acidity in soil / increase pH of soil	**1**
	(both) basic / base(s)	**1**
3(d)(ii)	$CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$ OR $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + H_2CO_3$	**1**
	Total:	**16**

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^2 overlap of (2)s with two (2)p (atomic) orbitals	**1**
	sp^3 overlap of (2)s with all three (2)p (atomic) orbitals	**1**
4(a)(iii)	$sp^2 = 116° – 124°$	**1**
	$sp^3 = 106° – 112°$	**1**
4(b)(i)		**1**
4(b)(ii)	(electrophilic) addition	**1**
	bromine decolourises / turns colourless / fades (from orange / brown)	**1**
4(b)(iii)	$HOCH_2CHBrCH_2Br$ OR 	**1**
4(b)(iv)	CO_2 / carbon dioxide	**1**
4(c)(i)	**P** = propanal	**1**
	Q = propanone	**1**

Question	Answer	Marks
4(c)(ii)	tr(i)iodomethane / 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 :C≡N to $C^{(\delta+)}$	**1**
	correct dipole on carbonyl $^{\delta+}C=O^{\delta-}$ AND curly arrow from bond to $O^{(\delta-)}$	**1**
	correct intermediate, including $C–O^-$ AND curly arrow from lone pair to H^+	**1**
	Total:	**19**