Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **October/November 2016**

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.

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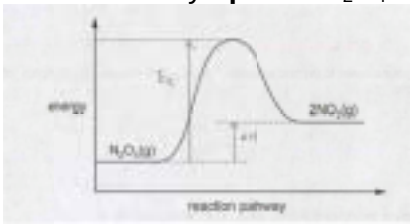
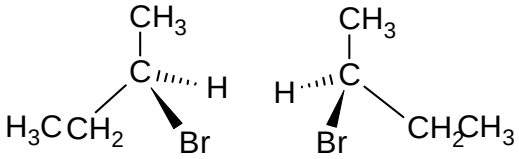
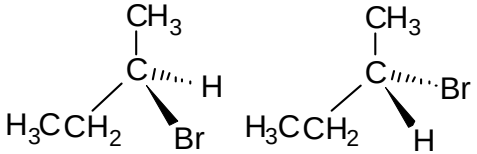
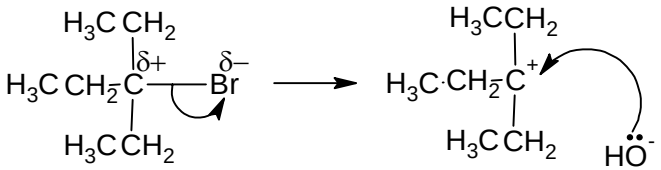
Question	Answer	Mark
1(a)	0.04 **OR** 4×10^{-2}	**1**
1(b)(i)	$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$	**1**
1(b)(ii)	0.00075 **OR** 7.5×10^{-4}	**1**
1(b)(iii)	0.0015 **OR** 1.5×10^{-3}	**1**
1(b)(iv)	0.015 **OR** 1.5×10^{-2}	**1**
1(b)(v)	0.025 **OR** 2.5×10^{-2}	**1**
1(b)(vi)	0.0125 **OR** 1.25×10^{-2} **OR** 0.013 **OR** 1.3×10^{-2}	**1**
1(b)(vii)	40 Ca / calcium	**1** **1**
	Total:	**9**

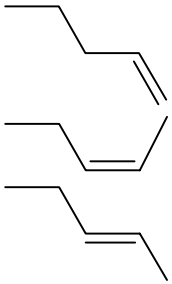
Question	Answer	Mark
2(a)	Arrow vertically **up** from N_2O_4 line to $2NO_2$ line labelled enthalpy change / ΔH Arrow vertically **up** from N_2O_4 line to dashed line from peak labelled activation energy / E_a 	**1** **1**
2(b)(i)	$M_r = \frac{m \times R \times T}{p \times V} \quad \left(= \frac{4.606 \times 8.31 \times 323}{1.68 \times 10^5 \times 1 \times 10^{-3}}\right)$ = 73.6	**1** **1**
2(b)(ii)	2n	**1**
2(b)(iii)	0.05 – n + 2n **OR** 0.05 + n	**1**
2(b)(iv)	$\frac{2n}{(0.05 + n)}$	**1**
2(b)(v)	N_2O_4 = 0.0375 NO_2 = 0.0250	**1** **1**
2(b)(vi)	$K_p = \frac{pNO_2^2}{pN_2O_4}$	**1**

Question	Answer	Mark
2(b)(vii)	$(0.4 \times 1.68 \times 10^5)^2/(0.6 \times 1.68 \times 10^5)$ **OR** $0.4^2 \times 1.68 \times 10^5/0.6$	**1**
	44800 **OR** 44.8	**1**
	Pa **OR** kPa	**1**
	Total:	**13**

Question	Answer	Mark
3(a)(i)	Increasing nuclear attraction	**1**
	Increasing nuclear charge / number of protons **AND** constant / similar shielding / same shell	**1**
3(a)(ii)	From 12 / Mg to 13 / A*l*: (Outer) electron in '13' / A*l* in (3)p (whereas outer electron in '12' / Mg in (3)s) (3p =) higher energy level / more shielded	 **1** **1**
	From 15 / P to 16 / S electron repulsion ('16' / S has a) pair of electrons in a (3)p orbital / a (3)p orbital is full ORA	 **1** **1**
3(a)(iii)	(decreasing IE down Group 0) due to decreasing nuclear attraction	**1**
	increasing shielding / increasing number of shells / energy levels / increasing distance of (outer) electrons (from nucleus)	**1**

Question	Answer	Mark
3(b)(i)	Increasing strength of / more energy needed to break (metallic) bonding / increasing strength of attraction between (cat)ion / nucleus and delocalised / free / sea of / cloud of electrons	1
	Increasing number of delocalised electrons / decreasing (cat)ion size / increasing charge / charge density of (cat)ion	1
3(b)(ii)	Attraction for electrons too strong to fully delocalise all 3 in A*l* **OR** difference in size between 12/Mg^{2+} and 13/Al^{3+} is less than difference in size between 11/Na^{+} and 12/Mg^{2+} **OR** magnitude of increase in charge is less from 2+ to 3+ than from 1+ to 2+	1
3(b)(iii)	Increase (15 / P to 16 / S) then decrease (to 17 / C*l* and 18 / Ar) **OR** general decrease (from 15 / P to 18 / Ar) with an increase from 15 / P to 16 / S **OR** $S_{(8)}$>$P_{(4)}$>C$l_{(2)}$>Ar	1
	(melting point depends on strength of) VdW / IMFs	1
	The greater the number of electrons in the molecule (atom for Ar) the greater the strength of VdW / IMFs **OR** the greater the melting point ora	1
3(b)(iv)	Giant covalent (structure) / many (strong) covalent bonds (need breaking)	1
	Total:	**15**

Question	Answer	Mark
4(a)(i)	2–bromobutane	**1**
4(a)(ii)	e.g. of mirror images  e.g. of swapped groups 	**1+1**
4(a)(iii)	$CH_3CH_2CH_2CH_2Br$ $(CH_3)_2CHCH_2Br$ $(CH_3)_3CBr$	**1** **1** **1**
4(b)(i)	3-bromo-3-ethylpentane	**1**
4(b)(ii)	 M1 = dipole and curly arrow from bond to (or just beyond) Br M2 = correct carbocation M3 = OH^- with curly arrow from lone pair <u>on O</u> to C(+)	**1** **1** **1**
4(b)(iii)	S_N1 / nucleophilic substitution	**1**

Question	Answer	Mark
4(c)(i)	Sodium / potassium hydroxide	**1**
	Ethanol / alcohol **AND** heat	**1**
4(c)(ii)	elimination	**1**
4(c)(iii)		**1** **1** **1**
	Total:	**17**

Question	Answer	Mark
5(a)(i)	C*l*● and ●CH_3	**1**
5(a)(ii)	Cl^- and $^+CH_3$ / CH_3^+	**1**
5(b)(i)	Oxidation **OR** reduction	**1**
5(b)(ii)	Condensation	**1**
5(b)(iii)	Reduction **OR** oxidation **OR** addition	**1**
5(b)(iv)	Addition	**1**
	Total:	**6**