

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

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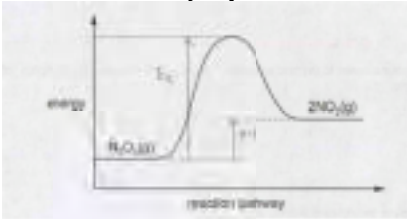
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This document consists of **8** printed pages.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2016	9701	22

Question	Answer	Mark
1(a)	0.04 OR 4×10^{-2}	1
1(b)(i)	$\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$	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	1
	Ca/calcium	1
	Total:	9

Page 3	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
2(a)	Arrow vertically up from N ₂ O ₄ line to 2NO ₂ line labelled enthalpy change / ΔH	1
	Arrow vertically up from N ₂ O ₄ line to dashed line from peak labelled activation energy / E _a	1
		
2(b)(i)	$M_r = \frac{m \times R \times T}{p \times V} \left(= \frac{4.606 \times 8.31 \times 323}{1.68 \times 10^5 \times 1 \times 10^{-3}} \right)$ $= 73.6$	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 ₂ O ₄ = 0.0375 NO ₂ = 0.0250	1 1
2(b)(vi)	$K_p = \frac{p\text{NO}_2^2}{p\text{N}_2\text{O}_4}$	1

Page 4	Mark Scheme	Syllabus	Paper
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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/Al: (Outer) electron in '13'/Al 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

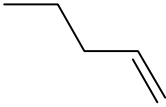
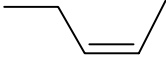
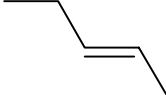
Page 5	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
3(b)(i)	Increasing strength of / more energy needed to break (metallic) bonding / increasing strength of attraction between (cat)ion / nucleus and delocalised / free / sea of / cloud of electrons Increasing number of delocalised electrons / decreasing (cat)ion size / increasing charge / charge density of (cat)ion	1 1
3(b)(ii)	Attraction for electrons too strong to fully delocalise all 3 in Al 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/Cl 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₎ >Cl ₍₂₎ >Ar (melting point depends on strength of) VdW/IMFs 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 1 1
3(b)(iv)	Giant covalent (structure) / many (strong) covalent bonds (need breaking)	1
	Total:	15

Page 6	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
4(a)(i)	2-bromobutane	1
4(a)(ii)	<p>e.g. of mirror images</p> <p>e.g. of swapped groups</p>	1+1
4(a)(iii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$ $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$ $(\text{CH}_3)_3\text{CBr}$	1 1 1
4(b)(i)	3-bromo-3-ethylpentane	1
4(b)(ii)	<p>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(+)</p>	1 1 1
4(b)(iii)	$\text{S}_{\text{N}}1$ / nucleophilic substitution	1

Page 7	Mark Scheme	Syllabus	Paper
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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

Page 8	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
5(a)(i)	$Cl\bullet$ and $\bullet CH_3$	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