

Cambridge International Examinations

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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Page 2	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
1(a)	$0.04 \text{OR} 4 \times 10^{-2}$	1
1(b)(i)	$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$	1
1(b)(ii)	$0.00075\text{OR}7.5\times10^{-4}$	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)	$0.025\text{OR}2.5\times10^{-2}$	1
1(b)(vi)	$0.0125\text{OR}1.25\times10^{-2}\text{OR}0.013\text{OR}1.3\times10^{-2}$	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 N₂O₄ line to 2NO₂ line labelled enthalpy change / ∆H	1
	Arrow vertically up from N ₂ O ₄ line to dashed line from peak labelled activation energy/E _a	1
2(b)(i)	$M_{\rm r} = \frac{m \times R \times T}{p \times V} \left(= \frac{4.606 \times 8.31 \times 323}{1.68 \times 10^5 \times 1 \times 10^{-3}} \right)$	1
	= 73.6	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)	$K_{p} = \frac{pNO_{2}^{2}}{pN_{2}O_{4}}$	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/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
	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
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	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/A l^{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 $S_{(8)}>P_{(4)}>Cl_{(2)}>Ar$	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

Page 6	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark
4(a)(i)	2-bromobutane	1
4(a)(ii)	e.g. of mirror images CH ₃ CH ₃ CH ₃ CH ₂ H ₃ CCH ₂ Br CH ₂ CH ₃	1+1
4(a)(iii)	H ₃ CCH ₂ B _r H ₃ CCH ₂ H CH ₃ CH ₂ CH ₂ CH ₂ Br (CH ₃) ₂ CHCH ₂ Br (CH ₃) ₃ CBr	1 1 1
4(b)(i)	3-bromo-3-ethylpentane	1
4(b)(ii)	H_3CCH_2	1 1 1
4(b)(iii)	S _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● 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