

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9701 CHEMISTRY

9701/21

Paper 2 (AS Structured Questions), maximum raw mark 60

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Page 2	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
1 (a)	regular arrangement / lattice of cations / positive ions surrounded by delocalised electrons	[1] [1]	[2]
(b) (i)	electrical conductor corrosion resistant low density ductile	[1] [1]	[max2]
(ii)	Giant / lattice	[1]	[1]
(iii)	(electrical) insulator	[1]	[1]
(c) (i)	Simple covalent / covalent molecule Weak intermolecular forces / VdW forces OR little energy needed to break down / overcome intermolecular / VdW forces	[1] [1]	[2]
(ii)	$\begin{array}{r} Al \quad Cl \\ 20.3 \quad 79.7 \\ \hline 27 \quad 35.5 \\ \\ 0.752 \quad 2.25 \\ \hline 0.752 \quad 0.752 \\ \\ 1 \quad 3 \quad AlCl_3 \end{array}$	[1] [1]	[2]

Page 3	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
(iii)	$pV = \frac{m}{M_r}RT \quad M_r = \frac{mRT}{pV} = \frac{1.36 \times 8.31 \times 473}{100 \times 10^3 \times 200 \times 10^{-6}} = 267$ <p>OR $pV = nRT \quad n = \frac{pV}{RT} = \frac{100 \times 10^3 \times 200 \times 10^{-6}}{8.31 \times 473} = 5.09 \times 10^{-3}$</p> $M_r = \frac{1.36}{5.09 \times 10^{-3}} = 267$	[1] [1] [1] [1]	 [2]
(iv)	Al_2Cl_6	[1]	[1]
			[13]
2 (a) (i)	The enthalpy change when one mole of a compound is formed from its element(s)	[1] [1]	[2]
(ii)	$S(s) + 1\frac{1}{2}O_2(g) \rightarrow SO_3(l)$	[1]	[1]
(b) (i)	$944 + (3 \times 436) = 2252$ $6 \times 390 = 2340$ $2252 - 2340 = -88 \text{ (kJ mol}^{-1}\text{)}$	[1] [1] [1]	[3]
(ii)	Fe catalyst 200 atm 400–500 (°)C	[1] [1] [1]	[3]
(iii)	High T increases rate AND Low T improves yield owtte Chosen temp is a compromise High P favours/increases (both rate and) yield owtte pressure chosen limited by cost (of compression and ‘thick walls’)	[1] [1] [1] [1]	[4]

Page 4	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
(c) (i)	$2\text{NH}_3 + \text{H}_3\text{PO}_4 \rightarrow (\text{NH}_4)_2\text{HPO}_4$	[1]	[1]
(ii)	NH_3 identified as base AND H_3PO_4 identified as acid base accepts protons AND acid donates protons	[1] [1]	[2]
(d) (i)	nitrates / fertilisers wash into rivers eutrophication / algal bloom / promote algal growth bacteria use up oxygen in decay process	[1] [1] [1]	[3]
(ii)	(oxides of nitrogen / NO_x / NOs) cause acid rain $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_2 + \text{HNO}_3$ OR $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$ OR $\text{SO}_2 + \text{NO}_2 \rightarrow \text{SO}_3 + \text{NO}$ AND $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$	[1] [1]	[2]
			[21]
3 (a) (i)	structural isomers: (different molecules with) same molecular formula but different structural formulae chiral: has a carbon / C attached to 4 different groups / atoms / chains OR has no plane / line of symmetry / has non-superimposable mirror images	[1] [1]	[2]
(ii)	$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$ 3-methylhexane $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ / $(\text{CH}_3)_2\text{CHCH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ 2,3-dimethylpentane	[1] [1] [1] [1]	[4]
(b) (i)	$\text{C}_7\text{H}_{16} + 11\text{O}_2 \rightarrow 7\text{CO}_2 + 8\text{H}_2\text{O}$	[1]	[1]
(ii)	$\text{C}_7\text{H}_{16} + 4\text{O}_2 \rightarrow 7\text{C} + 8\text{H}_2\text{O}$	[1]	[1]

Page 5	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
(iii)	global dimming / PAN / smog / global warming	[1]	[1]
(c) (i)	(Free) Radical Substitution	[1]	[1]
(ii)	$Cl_2 \rightarrow 2Cl\cdot$ OR $Cl_2 \rightarrow Cl\cdot + Cl\cdot$ $C_7H_{16} + Cl\cdot \rightarrow \cdot C_7H_{15} + HCl$ $\cdot C_7H_{15} + Cl_2 \rightarrow C_7H_{15}Cl + Cl\cdot$ $\cdot C_7H_{15} + Cl\cdot \rightarrow C_7H_{15}Cl$ OR $\cdot C_7H_{15} + \cdot C_7H_{15} \rightarrow C_{14}H_{30}$ Initiation; Propagation; Termination (used correctly)	[1] [1] [1] [1]	[5]
			[15]
4 (a) (i)	$CH_3CH_2OH + HCl \rightarrow CH_3CH_2Cl + H_2O$ or $CH_3CH_2OH + PCl_5 \rightarrow CH_3CH_2Cl + HCl + POCl_3$ or $CH_3CH_2OH + SOCl_2 \rightarrow CH_3CH_2Cl + HCl + SO_2$	[1+1]	[2]
(ii)	NaOH / KOH warm / heat / reflux AND aqueous	[1] [1]	[2]
(b) (i)	$CH_2=CH_2$ / ethane / C_2H_4 / CH_2CH_2	[1]	[1]
(ii)	<u>White</u> ppt / solid / suspension	[1]	[1]
(iii)	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	[1]	[1]
(c) (i)	CH_3CHO / ethanal	[1]	[1]

Page 6	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
(ii)	CH ₃ CH ₂ OH higher bpt than CH ₃ CHO ora	[1]	[3]
	due to hydrogen bonding in ethanol/stronger IMFs	[1]	
	prevents further oxidation owtte	[1]	
			[11]