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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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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 owtte	[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)	$\frac{Al}{20.3}$ $\frac{Cl}{79.7}$ 27 35.5 $\frac{0.752}{0.752}$ $\frac{2.25}{0.752}$ 1 3 $AlCl_3$	[1] [1]	[2]

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Question	Mark Scheme	Mark	Total
(iii)	$pV = \frac{m}{M_r}RT$ $\quad M_r = \frac{mRT}{pV}$ $\quad = \frac{1.36 \times 8.31 \times 473}{100 \times 10^3 \times 200 \times 10^{-6}}$ = 267 **OR** $pV = nRT$ $\quad n = \frac{pV}{RT}$ $\quad = \frac{100 \times 10^3 \times 200 \times 10^{-6}}{8.31 \times 473}$ $= 5.09 \times 10^{-3}$ $M_r = \frac{1.36}{5.09 \times 10^{-3}} = 267$	[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)	$S(s) + 1½O_2(g) \rightarrow SO_3(l)$	[1]	[1]
(b) (i)	$944 + (3 \times 436) = 2252$ $6 \times 390 = 2340$ $2252 - 2340 = -88\,(kJ\,mol^{-1})$	[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]

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Question	Mark Scheme	Mark	Total
(c) (i)	$2NH_3 + H_3PO_4 \rightarrow (NH_4)_2HPO_4$	[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 $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$ OR $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$ OR $SO_2 + NO_2 \rightarrow SO_3 + NO$ AND $SO_3 + H_2O \rightarrow H_2SO_4$	[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)	$CH_3CH_2CH(CH_3)CH_2CH_2CH_3$ 3-methylhexane $CH_3CH(CH_3)CH(CH_3)CH_2CH_3$ / $(CH_3)_2CHCH(CH_3)CH_2CH_3$ 2,3-dimethylpentane	[1] [1] [1] [1]	[4]
(b) (i)	$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$	[1]	[1]
(ii)	$C_7H_{16} + 4O_2 \rightarrow 7C + 8H_2O$	[1]	[1]

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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)	$Cl_2 \rightarrow 2Cl\bullet$ OR $Cl_2 \rightarrow Cl\bullet + Cl\bullet$ $C_7H_{16} + Cl\bullet \rightarrow \bullet C_7H_{15} + HCl$ $\bullet C_7H_{15} + Cl_2 \rightarrow C_7H_{15}Cl + Cl\bullet$ $\bullet C_7H_{15} + Cl\bullet \rightarrow C_7H_{15}Cl$ OR $\bullet C_7H_{15} + \bullet C_7H_{15} \rightarrow C_{14}H_{30}$ Initiation; Propagation; Termination (used correctly)	[1] [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)	White ppt / solid / suspension	[1]	[1]
(iii)	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$	[1]	[1]
(c) (i)	CH_3CHO / ethanal	[1]	[1]

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Question	Mark Scheme	Mark	Total
(ii)	CH_3CH_2OH higher bpt than CH_3CHO ora	[1]	
	due to hydrogen bonding in ethanol / stronger IMFs	[1]	[3]
	prevents further oxidation owtte	[1]	
			[11]

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