

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9701 CHEMISTRY

9701/22

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

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Question	Mark Scheme					Mark	Total
1 (a)	name of isotope	type of particle	charge	symbol	electron configuration	[5]	[5]
	carbon-13	atom	0	$^{13}_6\text{C}$	$1s^2 2s^2 2p^2$		
	chloride(-37)	anion	1-	Cl^-	$1s^2 2s^2 2p^6 3s^2 3p^6$		
	sulfur-34	atom	0	$^{34}_{16}\text{S}$	$1s^2 2s^2 2p^6 3s^2 3p^4$		
	iron-54	cation	2+	$^{54}_{26}\text{Fe}^{(2+)}$	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$		
(b) (i)	ability / tendency / power of an atom / nucleus to attract / pull electron(s)					[1]	[2]
	in a covalent bond / shared pair of electrons / bonding pair of electrons					[1]	
(ii)	Covalent overlap of orbitals OR shared <u>pair</u> (s) (of electrons)					[1] [1]	[2]
	OR metallic positive ions / cations surrounded by delocalised electrons					[1] [1]	
(iii)	Ionic/electrovalent (electrostatic) Attraction between oppositely charged / +ve and -ve <u>ions</u>					[1] [1]	[2]
(c) (i)	similar strength / amount / number of intermolecular forces / induced dipole / van der Waals' / VdW / London forces / LDF / dispersion forces					[1]	[2]
	therefore similar energy needed					[1]	

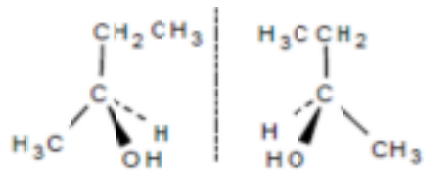
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Question	Mark Scheme	Mark	Total
(ii)	M1 HCl polar/has a dipole AND F₂ non-polar/has no dipole OR (permanent) dipole (-dipole) attractions/forces between HCl (molecules) AND induced dipole (-induced dipole) attractions/forces/LDFs between F₂ (molecules) M2 more energy needed for HCl than F₂ OR pd-pd forces stronger than id-id forces OR IMFs/VdWs in HCl stronger than in F₂	[1] [1]	[2]
(iii)	Hydrogen bonding (between methanol molecules) Stronger than IMFs/van der Waals' in other three/is the strongest intermolecular force	[1] [1]	[2]
			[17]
2 (a)	<u>M1 Heat</u> (energy) change (or H_{prod} – H_{react}) measured at constant pressure OR enthalpy change when the amount/moles of reactants as shown in a (reaction) <u>equation</u> react together to give products M2 measured at standard conditions	[1] [1]	[2]
(b) (i)	q = 2125.53	[1]	[1]
(ii)	amount = 0.025(0)	[1]	[1]
(iii)	–85.(0)	[1]	[1]

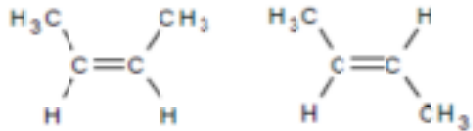
Page 4	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total
(iv)	$\begin{array}{ccc} & \text{(MgSO}_4\text{(s)} + 7\text{H}_2\text{O(l)} \rightarrow \text{MgSO}_4 \cdot 7\text{H}_2\text{O(s)}) & \\ & \swarrow \quad \searrow & \\ -85.0 \text{ (kJ mol}^{-1}\text{)} & & (+)9.60 \text{ (kJ mol}^{-1}\text{)} \\ & \searrow \quad \swarrow & \\ & \text{MgSO}_4\text{(aq)} & \end{array}$	[1]	[1]
(v)	$\Delta H + 9.6 = -85.0$ $\Delta H = -85.0 - 9.6 = -94.6 \text{ (kJ mol}^{-1}\text{)}$	[1]	[1]
			[7]
3 (a) (i)	Na ₂ O or Na ₂ O ₂ ; MgO; P ₄ O ₁₀ or P ₄ O ₆ ; SO ₂	[1] [1]	[2]
(ii)	Na: Yellow / orange / gold flame / white solid / powder / smoke $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$ or $2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}_2$ S: Blue flame / (yellow) solid melts / turns red / amber / white fumes $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$	[1] [1] [1] [1]	[4]
(b) (i)	acidic P and S amphoteric Al and basic Na and Mg	[1] [1]	[2]
(ii)	acidic: covalent (bonding) basic: ionic (bonding)	[1] [1]	[2]

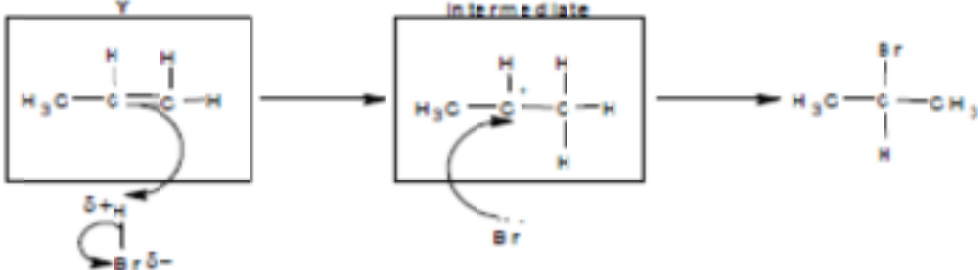
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Question	Mark Scheme	Mark	Total
(iii)	$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$ CR $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$ $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 7\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4(\text{H}_2\text{O})_2$ OR $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl}(\text{OH})_4$ OR $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$ OF $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 7\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4(\text{H}_2\text{O})_2]^-$ OF $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2[\text{Al}(\text{OH})_4]^-$ OR $\text{Al}_2\text{O}_3 + 2\text{OH}^- \rightarrow 2\text{AlO}_2^- + \text{H}_2\text{O}$	 [1] [1]	[2]
(c)	sulfur forms $\text{SO}_2/\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$ or in words OR $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{acid}$ / or in words OR $\text{SO}_2 + \text{H}_2\text{O} + (1/2\text{O}_2) \rightarrow \text{H}_2\text{SO}_4$ / or in words	 [1] [1]	[2]
			[14]
4 (a) (i)	Nucleophilic Substitution	[1]	[1]
(ii)	Has a chiral centre / carbon OR has a <u>carbon / C</u> attached to 4 different groups / atoms / chains OR has no plane / line of symmetry	[1]	[1]
(iii)		[1+1]	[2]
(iv)	Elimination	[1]	[1]

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(v)	 <i>cis-but-2-ene</i> <i>trans-but-2-ene</i>	[1] [1]	[2]
(vi)	But-1-ene 2 Hs on one of the double-bonded Cs OR does not have 2 different groups on both atoms / each atom in C=C	[1] [1]	[2]
(b) (i)	ammonia / NH ₃	[1]	[1]
(ii)	propanoyl chloride / C ₂ H ₅ COCl	[1]	[1]
(iii)	CH ₃ CH(NHCOC ₂ H ₅)CH ₃	[1]	[1]
(iv)	Reduction LiAlH ₄ / lithium aluminium hydride / lithium tetrahydridoaluminate	(1) [1] [1]	[2]
(v)	aluminium oxide	[1]	[1]

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(vi)	 M1 = correct structure of Y and curly arrow from double bond to H M2 = dipole and curly arrow from H-Br bond to Br M3 = correct intermediate M4 = Br⁻ with lone pair and curly arrow from lone pair to C(+)	 [1] [1] [1] [1]	[4]
(vii)	electrophilic addition	[1]	[1]
(viii)	secondary carbocation more stable than primary due to electron releasing character / (positive) inductive effect of alkyl groups	[1] [1]	[2]
			[22]