

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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Page 2	Mark Scheme	Syllabus	Paper
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Question	Mark Scheme	Mark	Total																									
1 (a)	<table border="1"> <thead> <tr> <th>name of isotope</th> <th>type of particle</th> <th>charge</th> <th>symbol</th> <th>electron configuration</th> </tr> </thead> <tbody> <tr> <td>carbon-13</td> <td>atom</td> <td>0</td> <td>${}^{13}_6\text{C}$</td> <td>$1s^2 2s^2 2p^2$</td> </tr> <tr> <td>chloride(-37)</td> <td>anion</td> <td>1-</td> <td>Cl</td> <td>$1s^2 2s^2 2p^6 3s^2 3p^6$</td> </tr> <tr> <td>sulfur-34</td> <td>atom</td> <td>0</td> <td>${}^{34}_{16}\text{S}$</td> <td>$1s^2 2s^2 2p^6 3s^2 3p^4$</td> </tr> <tr> <td>iron-54</td> <td>cation</td> <td>2+</td> <td>${}^{54}_{26}\text{Fe}^{(2+)}$</td> <td>$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$</td> </tr> </tbody> </table>	name of isotope	type of particle	charge	symbol	electron configuration	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+	${}^{54}_{26}\text{Fe}^{(2+)}$	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$	[5]	[5]
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(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(s)</u> (of electrons) OR metallic positive ions/cations surrounded by delocalised electrons	[1] [1] [1] [1]	[2]																									
(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 therefore similar energy needed	[1] [1]	[2]																									

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(ii)	M1 HCl polar/has a dipole AND F ₂ non-polar/has no dipole OR (permanent) dipole (-dipole) attractions/forces between HCl (molecules) AND induced dipole (-induced dipole) attractions/forces/LDFs between F ₂ (molecules)	[1]	[2]
	M2 more energy needed for HCl than F ₂ OR pd-pd forces stronger than id-id forces OR IMFs/VdWs in HCl stronger than in F ₂	[1]	
(iii)	Hydrogen bonding (between methanol molecules)	[1]	[2]
	Stronger than IMFs/van der Waals' in other three/is the strongest intermolecular force	[1]	
			[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	[1]	[2]
	M2 measured at standard conditions	[1]	
(b) (i)	q = 2125.53	[1]	[1]
(ii)	amount = 0.025(0)	[1]	[1]
(iii)	-85.(0)	[1]	[1]

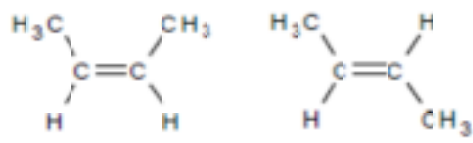
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(iv)	$\begin{array}{ccc} & \text{(MgSO}_4\text{(s) + 7H}_2\text{O(l) } \rightarrow \text{ MgSO}_4\cdot\text{7H}_2\text{O(s))} & \\ & \swarrow \quad \searrow & \\ -85.0 \text{ (kJ mol}^{-1}\text{)} & & (+)9.60 \text{ (kJ mol}^{-1}\text{)} \\ & \searrow \quad \swarrow & \\ & \text{MgSO}_4\text{(aq)} & \end{array}$	[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 4Na + O ₂ → 2Na ₂ O or 2Na + O ₂ → Na ₂ O ₂ S: Blue flame / (yellow) solid melts / turns red / amber / white fumes S + O ₂ → 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]

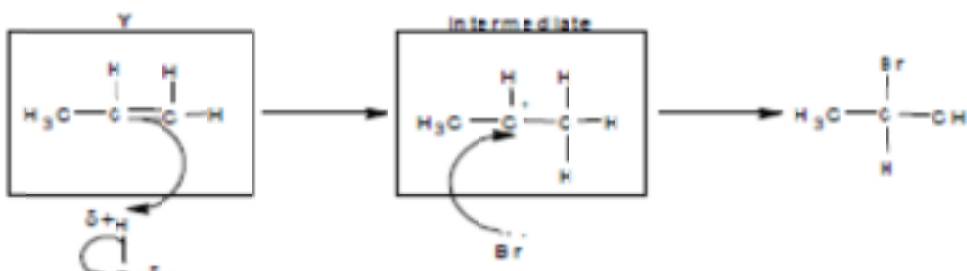
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Question	Mark Scheme	Mark	Total
(iii)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ OR $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$ $Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ OR $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ OR $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ OR $Al_2O_3 + 2OH^- + 7H_2O \rightarrow 2[Al(OH)_4(H_2O)_2]^-$ OR $Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2[Al(OH)_4]^-$ OR $Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$	[1] [1]	[2]
(c)	sulfur forms $SO_2/SO_2 + /$ mixes $H_2O \rightarrow H_2SO_3$ or in words OR $SO_2 + /$ mixes $H_2O (\rightarrow acid) /$ or in words OR $SO_2 + /$ mixes $H_2O + (1/2O_2) \rightarrow H_2SO_4 /$ 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)	 <p><i>cis-but-2-ene</i> <i>trans-but-2-ene</i></p>	[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)	 <p>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(+)</p>	[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]