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)		[5]	[5]

name of isotope	type of particle	charge	symbol	electron configuration
carbon-13	atom	0	$^{13}_{6}C$	$1s^2 2s^2 2p^2$
chloride(-37)	anion	1−	Cl	$1s^2 2s^2 2p^6 3s^2 3p^6$
sulfur-34	atom	0	$^{34}_{16}S$	$1s^2 2s^2 2p^6 3s^2 3p^4$
iron-54	cation	2+	$^{54}_{26}Fe^{(2+)}$	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

(b) (i)	ability / tendency / power of an atom / nucleus to attract / pull electron(s) in a covalent bond / shared pair of electrons / bonding pair of electrons	[1] [1]	[2]
(ii)	Covalent overlap of orbitals OR shared <u>pair</u>(s) (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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Question	Mark Scheme	Mark	Total
(ii)	M1 HC*l* polar / has a dipole AND F_2 non-polar / has no dipole OR (permanent) dipole (-dipole) attractions / forces between HC*l* (molecules) AND induced dipole (-induced dipole) attractions / forces / LDFs between F_2 (molecules) M2 more energy needed for HC*l* than F_2 OR pd-pd forces stronger than id-id forces OR IMFs / VdWs in HC*l* stronger than in F_2	[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)	M1 Heat (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) equation 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]

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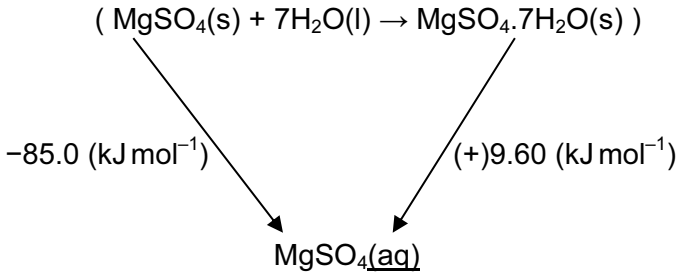
Question	Mark Scheme	Mark	Total
(iv)		[1]	[1]
(v)	ΔH + 9.6 = −85.0 ΔH = −85.0 – 9.6 = −94.6 (kJ mol^{-1})	[1]	[1]
			[7]
3 (a) (i)	Na_2O or Na_2O_2; MgO; P_4O_{10} or P_4O_6 ; SO_2	[1] [1]	[2]
(ii)	Na: Yellow / orange / gold flame / white solid / powder / smoke $4Na + O_2 \rightarrow 2Na_2O$ or $2Na + O_2 \rightarrow Na_2O_2$ S: Blue flame / (yellow) solid melts / turns red / amber / white fumes $S + O_2 \rightarrow SO_2$	[1] [1] [1] [1]	[4]
(b) (i)	acidic P and S amphoteric A*l* and basic Na and Mg	[1] [1]	[2]
(ii)	acidic: covalent (bonding) basic: ionic (bonding)	[1] [1]	[2]

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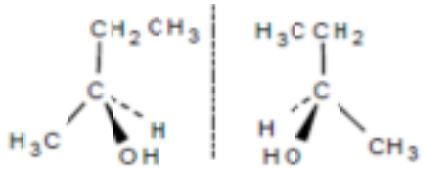
Question	Mark Scheme	Mark	Total
(iii)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ **OR** $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$ $Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ **OR** $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ **OR** $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ **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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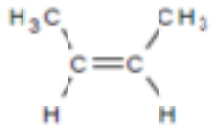
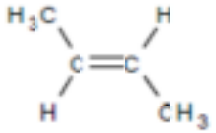
Question	Mark Scheme	Mark	Total
(v)	 *cis*-but-2-ene  *trans*-but-2-ene	[1] [1]	[2]
(vi)	But-1-ene 2 Hs on one of the double-bonded Cs OR does not have 2 different groups on both atoms / each atom in C=C	[1] [1]	[2]
(b) (i)	ammonia / NH_3	[1]	[1]
(ii)	propanoyl chloride / C_2H_5COCl	[1]	[1]
(iii)	$CH_3CH(NHCOC_2H_5)CH_3$	[1]	[1]
(iv)	Reduction (1) $LiAlH_4$ / lithium aluminium hydride / lithium tetrahydridoaluminate	[1] [1]	[2]
(v)	aluminium oxide	[1]	[1]

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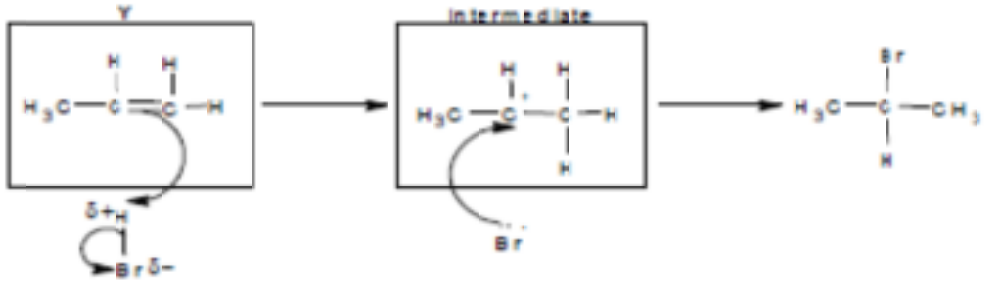
Question	Mark Scheme	Mark	Total
(vi)	 M1 = correct structure of **Y** and curly arrow from double bond to H M2 = dipole and curly arrow from H-Br bond to Br M3 = correct intermediate M4 = Br^- with lone pair and curly arrow from lone pair to C(+)	[1] [1] [1] [1]	[4]
(vii)	electrophilic addition	[1]	[1]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

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