

**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)	<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><math>{}^{13}_6\text{C}</math></td> <td><math>1s^2 2s^2 2p^2</math></td> </tr> <tr> <td>chloride(-37)</td> <td>anion</td> <td>1-</td> <td><math>\text{Cl}</math></td> <td><math>1s^2 2s^2 2p^6 3s^2 3p^6</math></td> </tr> <tr> <td>sulfur-34</td> <td>atom</td> <td>0</td> <td><math>{}^{34}_{16}\text{S}</math></td> <td><math>1s^2 2s^2 2p^6 3s^2 3p^4</math></td> </tr> <tr> <td>iron-54</td> <td>cation</td> <td>2+</td> <td><math>{}^{54}_{26}\text{Fe}^{(2+)}</math></td> <td><math>1s^2 2s^2 2p^6 3s^2 3p^6 3d^6</math></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-	$\text{Cl}$	$1s^2 2s^2 2p^6 3s^2 3p^6$	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) in a covalent bond/shared pair of electrons/bonding pair of electrons	[1] [1]	[2]																									
(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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<b>Question</b>	<b>Mark Scheme</b>	<b>Mark</b>	<b>Total</b>
<b>(ii)</b>	M1 HCl polar/has a dipole AND F <sub>2</sub> non-polar/has no dipole OR (permanent) dipole (-dipole) attractions/forces between HCl (molecules) AND induced dipole (-induced dipole) attractions/forces/LDFs between F <sub>2</sub> (molecules)	[1]	[2]
	M2 more energy needed for HCl than F <sub>2</sub> OR pd-pd forces stronger than id-id forces OR IMFs/VdWs in HCl stronger than in F <sub>2</sub>	[1]	
<b>(iii)</b>	Hydrogen bonding (between methanol molecules)	[1]	[2]
	Stronger than IMFs/van der Waals' in other three/is the strongest intermolecular force	[1]	
			<b>[17]</b>
<b>2 (a)</b>	<u>M1 Heat</u> (energy) change ( <b>or</b> H <sub>prod</sub> – H <sub>react</sub> ) 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>(b) (i)</b>	q = 2125.53	[1]	[1]
<b>(ii)</b>	amount = 0.025(0)	[1]	[1]
<b>(iii)</b>	-85.(0)	[1]	[1]

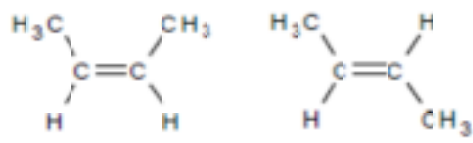
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Question	Mark Scheme	Mark	Total
(iv)	$\begin{array}{ccc} & \text{( MgSO}_4\text{(s) + 7H}_2\text{O(l) } \rightarrow \text{ MgSO}_4\cdot\text{7H}_2\text{O(s) )} & \\ & \swarrow \quad \searrow & \\ -85.0 \text{ (kJ mol}^{-1}\text{)} & & (+)9.60 \text{ (kJ mol}^{-1}\text{)} \\ & \searrow \quad \swarrow & \\ & \text{MgSO}_4\text{(aq)} & \end{array}$	[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 <sub>2</sub> O or Na <sub>2</sub> O <sub>2</sub> ; MgO; P <sub>4</sub> O <sub>10</sub> or P <sub>4</sub> O <sub>6</sub> ; SO <sub>2</sub>	[1] [1]	[2]
(ii)	Na: Yellow / orange / gold flame / white solid / powder / smoke 4Na + O <sub>2</sub> → 2Na <sub>2</sub> O or 2Na + O <sub>2</sub> → Na <sub>2</sub> O <sub>2</sub>  S: Blue flame / (yellow) solid melts / turns red / amber / white fumes S + O <sub>2</sub> → SO <sub>2</sub>	[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]

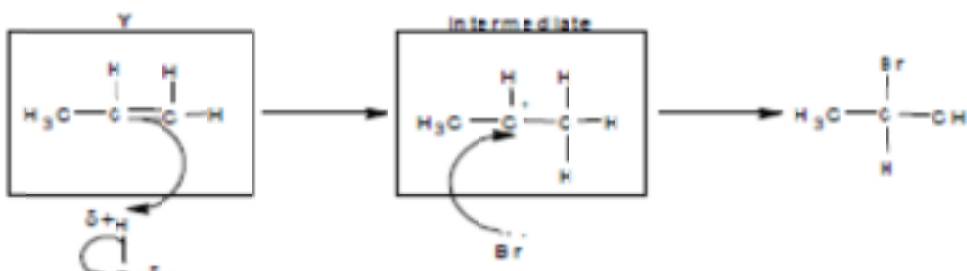
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(iii)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ OR $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$  $Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ OR $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ OR $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ 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 <sub>3</sub>	[1]	[1]
(ii)	propanoyl chloride / C <sub>2</sub> H <sub>5</sub> COCl	[1]	[1]
(iii)	CH <sub>3</sub> CH(NHCOC <sub>2</sub> H <sub>5</sub> )CH <sub>3</sub>	[1]	[1]
(iv)	Reduction LiAlH <sub>4</sub> / 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<sup>-</sup> 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]