Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **May/June 2017**

MARK SCHEME

Maximum Mark: 60

Published

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>atomic number</th><th>nucleon number</th><th>number of electrons</th><th>number of protons</th><th>number of neutrons</th><th>symbol</th></tr>
<tr><td></td><td>6</td><td></td><td>3</td><td>3</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>$^{58}_{26}Fe^{3+}$</td></tr>
</table>
</td><td>2
1
1</td></tr>
<tr><td>1(b)(i)</td><td>EITHER
mass of an atom / isotope
relative / compared to 1/12 (the mass) of (an atom of) C-12 OR
on a scale in which a C-12 (atom / isotope) has (a mass of exactly) 12 (units)

OR
mass of one mol (of atoms) of an isotope
relative / compared to 1/12 (the mass) of 1 mol of C-12 OR
on a scale in which one mol C-12 (atom / isotope) has a mass of (exactly) 12 g</td><td>2
1
1</td></tr>
<tr><td rowspan="2">1(b)(ii)</td><td>$\frac{(10.0129 \times 19.78) + (80.22x)}{100} = 10.8$</td><td>1</td></tr>
<tr><td>x = 10.9941</td><td>1</td></tr>
<tr><td></td><td>Total:</td><td>6</td></tr>
</table>

Question	Answer	Marks
2(a)	strong triple bond	**1**
	non-polar / no dipole	**1**
2(b)(i)	Any 2 points covered correctly scores 2 marks Any 1 point covered correctly scores 1 mark • nitrogen (and oxygen) from the air / atmosphere (react): • high temperature (of internal combustion engine) / (engine) produces enough OR a lot of heat (energy) : • (so) breaks (strong) bond(s) in nitrogen (and oxygen) :	**2**
2(b)(ii)	reduction / decomposition of NO_x using a catalyst / catalytic convertor	**1**
	$2NO_2 + 4CO \rightarrow 4CO_2 + N_2$ OR $2NO + 2CO \rightarrow 2CO_2 + N_2$	**1**
2(b)(iii)	(acts as a homogeneous) catalyst OR oxidising agent	**1**
	$SO_2 + NO_2 \rightarrow SO_3 + NO$	**1**
	$NO + ½O_2 \rightarrow NO_2$ OR $SO_3 + H_2O \rightarrow H_2SO_4$	**1**
2(b)(iv)	$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$ OR $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	**1**
2(c)	fertiliser / nitrates dissolve in (river water) OR fertiliser / nitrates are washed / leached out / flows into (river water)	**1**

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Question	Answer	Marks
	algal bloom / promote algal growth / explosion of plant growth **AND** EITHER sunlight is blocked out (preventing photosynthesis) / plants can no longer carry out photosynthesis (and die) OR bacteria break down or decay dead organisms / plants / algae	**1**
	drop in oxygen (concentration)	**1**
	Total:	**13**

Question	Answer	Marks
3(a)	(+) 103	**1**
3(b)(i)	general shape of the curve and peak are displaced to right of original and starts at origin	**1**
	the peak is lower and curve crosses once only finishing **above** original	**1**
3(b)(ii)	rate increases AND correct explanation in terms of 'more collisions'	**1**
	at higher T area above *E*a is greater / more molecules with $E \geqslant E$a	**1**
	higher frequency of successful collisions OR more successful collisions per unit time / higher chance of successful collisions per unit time / higher proportion of successful collisions per unit time	**1**
3(b)(iii)	increases (%) decomposition (of HBr)	**1**
	(increasing T) shifts equilibrium to the right / in the forward direction / endothermic direction / towards $H_2 + Br_2$	**1**
	to oppose the change or oppose the increase in temperature OR to absorb (additional) energy / heat OR to decrease the temperature	**1**
3(b)(iv)	H-I bond strength less than H-Br OR less energy needed to break H-I *ora*	**1**
	I (atom) is big(ger) (than Br) OR I (atom) has more shielding (than Br) *ora*	**1**
	Br (atom) has greater (%) orbital / outer shell overlap OR attraction (of nucleus in iodine) for shared (pair of) electrons is weak(er) OR attraction (of nucleus in iodine) for bonding pair (or electrons) is weak(er) *ora*	**1**

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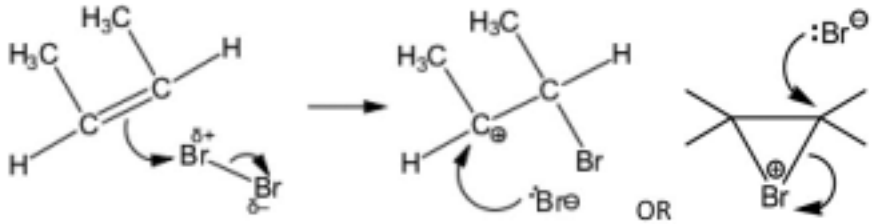
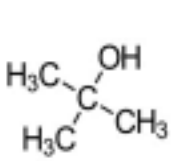
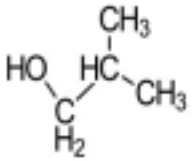
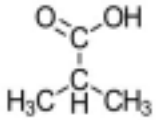
Question	Answer	Marks
3(c)(i)	H_2 = 0.015 (mol)	**1**
	HCl = 0.27 (mol)	**1**
3(c)(ii)	HCl = 9/10 AND xH_2 = 1/20 AND Cl_2 = 1/20 OR HCl = 0.9(0) AND H_2 = 0.05 AND Cl_2 = 0.05	**1**
3(d)(i)	(K_p =) $\frac{pH_2 \times pCl_2}{pHCl^2}$	**1**
3(d)(ii)	equal number of moles (of gas) on either side (of equation) / (total) pressure cancels	**1**
3(d)(iii)	4.649×10^{-3}	**1**
	Total:	**18**

Question	Answer	Marks
4(a)(i)	(**A** =) 	**1**
4(a)(ii)	(**A** / straight chain) has strong(er) (temporary dipole-) induced dipole (attractions) *ora*	**1**
	(because **A** / straight chain has) bigger (surface) area / more (points of) contact (in unbranched isomer) *ora* OR (so) more energy required to break the intermolecular forces *ora*	**1**
4(a)(iii)	$CH_3CHCHCH_3$ OR $CH_3CH{=}CHCH_3$	**1**
4(a)(iv)	No rotation / restricted / limited rotation of C=C / (carbon) double bond	**1**
	One (of the two) methyl groups / one (of the two) H (atoms) is on each C (of C=C)	**1**
4(a)(v)	 arrow from the C=C double bond drawn to the bromine	**1**
	dipole on Br_2 in correct orientation AND arrow from the Br-Br bond to the $Br^{\delta-}$	**1**
	correct carbocation / bromonium ion from the structure with C=C drawn	**1**
	Br^- with lone pair, negative charge AND arrow from lone pair to the carbon atom of intermediate OR using both arrows shown (in alternative diagram)	**1**
4(a)(vi)	electrons in pi bond induce it (the dipole) OR (high) electron density in pi bond / double bond / C=C repels electrons (away from nearest Br) OR polarised by (high) electron density in pi bond / double bond / C=C	**1**

Question	Answer	Marks
4(b)(i)	**C** = (2-)methylpropan-2-ol / $(CH_3)_3COH$ / any unambiguous structure	**1**
	D = (2-)methylpropan-1-ol / $(CH_3)_2CHCH_2OH$ / any unambiguous structure	**1**
	E = (2-)methylpropanoic acid /$(CH_3)_2CHCO_2H$ / any unambiguous structure	**1**
	 C  D  E	
4(b)(ii)	$2C_4H_8O_2 + Na_2CO_3 \rightarrow 2C_4H_7O_2Na + H_2O + CO_2$	**1**
4(c)(i)	triiodomethane	**1**
4(c)(ii)	**F** = $CH_3CH_2CH_2COCH_3$	**1**
	G = $C_2H_5CH(CH_3)CHO$	**1**
4(c)(iii)	a (tetrahedral) atom with four different groups / atoms / substituents attached OR a carbon (atom) with four different groups / atoms / substituents attached	**1**
4(d)(i)	**H** C=O (group / bond) AND O–H (group / bond)	**1**
	I C=O (group / bond) AND C–H (group / bond)	**1**

Question	Answer	Marks
4(d)(ii)	**H** = ethanoic acid	**1**
	I = methyl methanoate	**1**
	Total:	**23**

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