Cambridge International AS & A Level

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CHEMISTRY **9701/22**

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

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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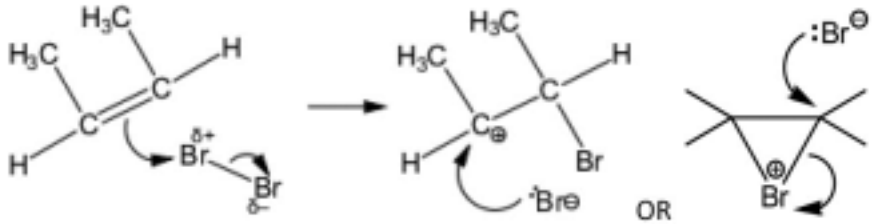
Question	Answer	Marks
1(a)	<table><tr><th>atomic number</th><th>nucleon number</th><th>number of electrons</th><th>number of protons</th><th>number of neutrons</th><th>symbol</th></tr><tr><td></td><td>6</td><td></td><td>3</td><td>3</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td>$^{58}_{26}Fe^{3+}$</td></tr></table>	**2** **1** **1**
1(b)(i)	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	**2** **1** **1**
1(b)(ii)	$\frac{(10.0129 \times 19.78) + (80.22x)}{100} = 10.8$	**1**
	x = 10.9941	**1**
	Total:	**6**

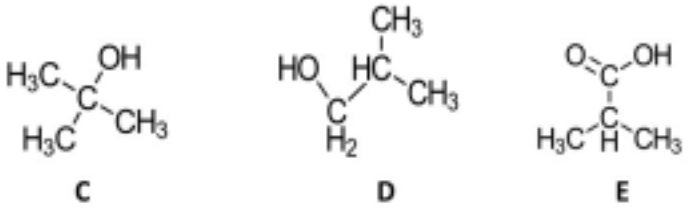
Question	Answer	Marks
2(a)	strong triple bond	**1**
	non-polar / no dipole	**1**
2(b)(i)	Any 2 points covered correctly scores 2 marks Any 1 point covered correctly scores 1 mark • nitrogen (and oxygen) from the air / atmosphere (react): • high temperature (of internal combustion engine) / (engine) produces 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**

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**

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**