Cambridge International AS & A Level

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CHEMISTRY **9701/21**

Paper 2 AS Structured Questions **October/November 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.

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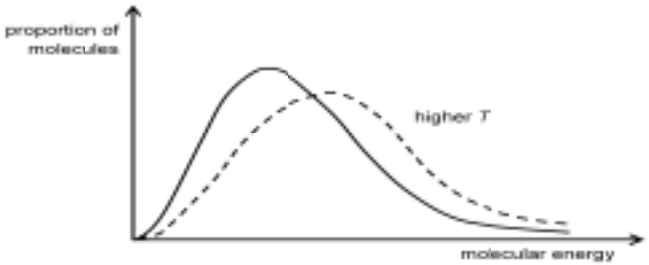
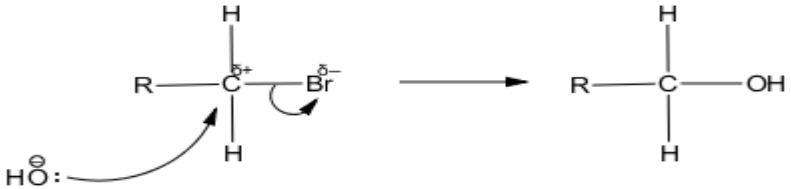
Question	Answer	Marks
1(a)(i)	energy needed / required to break a mole of (covalent) bonds	**1**
	(All) in the gaseous state	**1**
1(a)(ii)	–92 = {944 + 3(436)} – 6E(N–H)	**1**
	E(N–H) = (+)390.7 / 390.67 / 391	**1**
1(b)(i)	general shape of the curve and peak are displaced to right of original line and starts at origin	**1**
	the peak is lower and curve crosses once only finishing **above** original line	**1**
		
1(b)(ii)	rate increases AND explanation in terms of collisions	**1**
	(at higher T) area above E_a is greater OR (at higher T) 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**

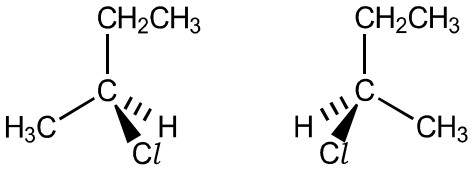
Question	Answer	Marks
1(b)(iii)	reduces yield (of ammonia).	**1**
	(increasing *T)* shifts equilibrium (reaction) to the left / in the reverse direction / towards N_2 and H_2 / towards reactants / in endothermic direction	**1**
	to oppose the change OR oppose the increase in temperature OR to absorb the (additional) heat / energy OR decrease the temperature	**1**
1(c)(i)	N_2 = 0.850 (mol)	**1**
	H_2 = 2.55 (mol)	**1**
1(c)(ii)	n_{TOTAL} = 3.7 mol	**1**
	mol fraction of NH_3 = 0.3 / 3.7	**1**
	$pNH_3 = 2 \times 10^7 \times (0.3 / 3.7) = 1.62 \times 10^6$	**1**
1(d)(i)	$K_p = \frac{pNH_3^{\,2}}{pN_2 \times pH_2^{\,3}}$	**1**
1(d)(ii)	$K_p = 1.(00) \times 10^{-16}$	**1**
	Pa^{-2}	**1**
1(d)(iii)	(yield of ammonia) increases	**1**
	(value of K_p) stays the same	**1**

Question	Answer	Marks
2(a)(i)	due to increasing nuclear attraction (for electrons)	**1**
	due to increasing nuclear charge / atomic / proton number AND similar shielding / same (outer/number of) shell / energy level	**1**
2(a)(ii)	Cross shown on first vertical line from the y-axis (Group 0 / Ne) is clearly higher than all shown	**1**
	Cross shown on second vertical line from the y-axis (Group 1 / Na) lower than all shown	**1**
2(a)(iii)	A*l* (the outer / valence) electron (which is lost) is in (3)p sub-shell (Mg is in (3)s subshell) OR A*l* (the outer / valence) electron (which is lost) is in higher energy sub-shell ora	**1**
	(electron to be removed) is more shielded / experiences greater screening effect ora	**1**
	S has a pair of electrons in (a) (3)p <u>orbital</u> / (a 3)p <u>orbital</u> is full **ora**	**1**
	electron pair repulsion	**1**
2(b)(i)	(**L**=) $MgCl_2$ / magnesium chloride	**1**
	Any two from (giant) ionic (with strong attractions) $Mg^{2+}(aq)$ / $Mg(H_2O)_6^{2+}(aq)$ is neutral / undergoes (partial) hydrolysis $Mg(OH)_2$ is the white precipitate / solid / insoluble / partially soluble $MgCl_2 + 2NaOH \rightarrow Mg(OH)_2 + 2NaCl$	**2**
2(b)(ii)	(**M**=) $SiCl_4$ / silicon chloride	**1**
	Any two from (simple) molecular / simple covalent hydrolysis possible due to available d orbitals forms HC*l* (aq) / hydrochloric acid / solution and / or HC*l* gas / fumes white solid is (hydrated) SiO_2 $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th>reaction</th><th>reagent(s) and conditions</th><th>reaction type(s)</th></tr>
<tr><td>1</td><td>aqueous / aq / dilute NaOH / KOH
OR water</td><td>substitution
OR hydrolysis</td></tr>
<tr><td>2</td><td>alcoholic / ethanolic NaOH / KOH</td><td>elimination</td></tr>
<tr><td>3</td><td>NaCN / KCN in ethanol / alcohol</td><td>substitution</td></tr>
<tr><td>4</td><td>aqueous /dilute H_2SO_4 / H^+(aq)</td><td>hydrolysis OR substitution
OR addition-elimination</td></tr>
<tr><td>5</td><td>acidified / H^+ (with) $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$
(and distil) NOT reflux</td><td>oxidation OR elimination</td></tr>
<tr><td>6</td><td>acidified / H^+ $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$
Fehling’s / Tollens’ / Benedict’s (reagent)</td><td>oxidation</td></tr>
</table>
</td><td>6</td></tr>
<tr><td>3(b)</td><td> 

M1 lone pair on O of $^-$OH AND curly arrow from lone pair to C(—Br)
M2 correct dipole on $C^{\delta+}$—$Br^{\delta-}$ AND curly arrow from bond to Br</td><td>2</td></tr>
</table>

Question	Answer	Marks
3(c)(i)	(different molecules) with same molecular formula / same numbers of atoms of (each type) of element	**1**
	different structural formulae / displayed formulae	**1**
	chain / skeletal functional group position(al) / regioisomerism two types correct = 1 mark, all three correct = 2 marks	**2**
3(c)(ii)	S_N / nucleophilic substitution	**1**
	$((CH_3)_3CBr$ / tertiary halogenoalkane) forms a stable (carbo)cation / stable intermediate (as charge density on cation is reduced) OR (in) 1-bromobutane / primary halogenoalkane there is no (stable) (carbo)cation / intermediate formed	**1**
	(because) there are (3 /more) alkyl / methyl group**s** AND (+) I / (greater) inductive effect OR (because) there is only one / fewer alkyl / methyl group(s) (compared to reaction with 2-bromo-2-methyl propane / tertiary halogenoalkane) AND limited (+) I / (less) inductive effect	**1**
3(d)(i)	(different molecules) with the same (molecular and) structural formula /	**1**
	with different arrangements of <u>atoms</u> in space / spatial arrangement of <u>atoms</u>	**1**
3(d)(ii)	mirror images are super(im)posable / no chiral carbon / no chiral centre / it is achiral	**1**
	(one) C of double bond has identical groups / H (atoms) (attached) OR (one) end of double bond has identical groups / 2 H (atoms) (attached)	**1**
3(d)(iii)	**X** = 2-chlorobutane	**1**
	Y = 1-chlorobutane	**1**

Question	Answer	Marks
3(d)(iv)	optical (isomerism)	**1**
3(d)(v)	one acceptable 3D structure of 2-chlorobutane	**1**
	the 2nd optical isomer EITHER drawn as a mirror image of the first OR the same bond pattern is shown but two of the groups swap positions. 	**1**