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CHEMISTRY **9701/21**

Paper 2 AS Structured Questions **October/November 2017**

MARK SCHEME

Maximum Mark: 60

Published

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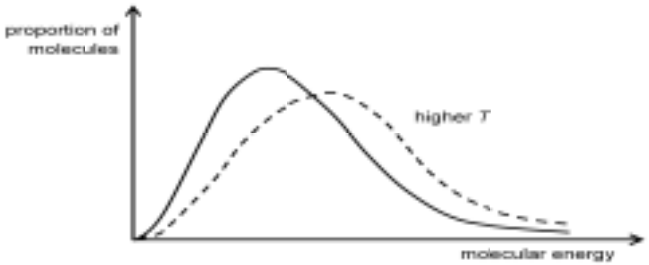
Question	Answer	Marks
1(a)(i)	energy needed / required to break a mole of (covalent) bonds	**1**
	(All) in the gaseous state	**1**
1(a)(ii)	–92 = {944 + 3(436)} – 6E(N–H)	**1**
	E(N–H) = (+)390.7 / 390.67 / 391	**1**
1(b)(i)	general shape of the curve and peak are displaced to right of original line 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**

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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**

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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**

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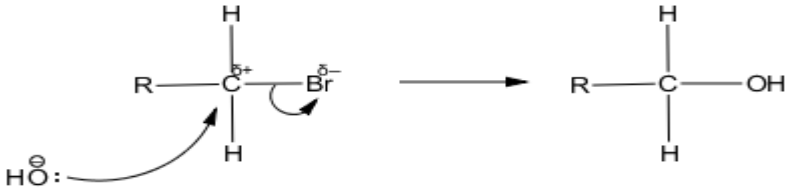
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th>reaction</th><th>reagent(s) and conditions</th><th>reaction type(s)</th></tr>
<tr><td>1</td><td>aqueous / aq / dilute NaOH / KOH
OR water</td><td>substitution
OR hydrolysis</td></tr>
<tr><td>2</td><td>alcoholic / 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**

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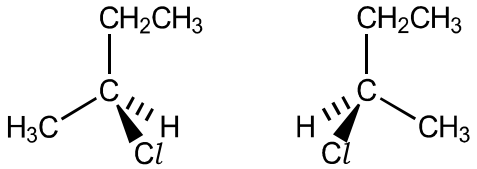
Question	Answer	Marks
3(d)(iv)	optical (isomerism)	**1**
3(d)(v)	one acceptable 3D structure of 2-chlorobutane	**1**
	the 2nd optical isomer EITHER drawn as a mirror image of the first OR the same bond pattern is shown but two of the groups swap positions.  	**1**