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**CHEMISTRY**

**9701/21**

Paper 2 AS Structured Questions

**October/November 2017**

MARK SCHEME

Maximum Mark: 60

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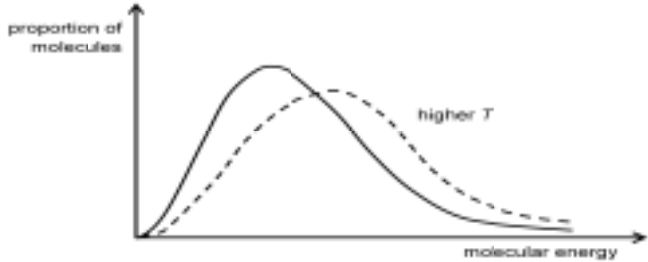
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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

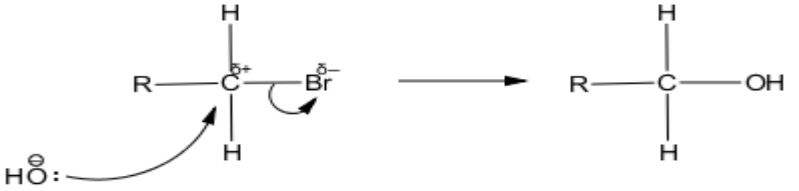
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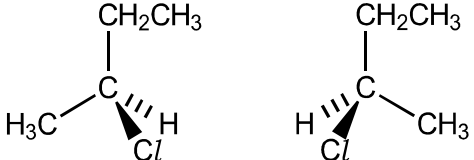
Question	Answer	Marks
1(a)(i)	energy needed / required to break a mole of (covalent) bonds	1
	(All) in the gaseous state	1
1(a)(ii)	$-92 = \{944 + 3(436)\} - 6E(\text{N-H})$	1
	$E(\text{N-H}) = (+)390.7 / 390.67 / 391$	1
1(b)(i)	general shape of the curve and peak are displaced to right of original line and starts at origin	1
	the peak is lower and curve crosses once only finishing <b>above</b> 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 $E \geq E_a$	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)	$n_{\text{TOTAL}} = 3.7$ mol	1
	mol fraction of $NH_3 = 0.3 / 3.7$	1
	$p_{NH_3} = 2 \times 10^7 \times (0.3 / 3.7) = 1.62 \times 10^6$	1
1(d)(i)	$K_p = \frac{p_{NH_3}^2}{p_{N_2} \times p_{H_2}^3}$	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)	Al (the outer / valence) electron (which is lost) is in (3)p sub-shell (Mg is in (3)s subshell) OR Al (the outer / valence) electron (which is lost) is in higher energy sub-shell	1 ora
	(electron to be removed) is more shielded / experiences greater screening effect	1 ora
	S has a pair of electrons in (a) (3)p <u>orbital</u> / (a 3)p <u>orbital</u> is full <b>ora</b>	1
	electron pair repulsion	1
2(b)(i)	(L=) $\text{MgCl}_2$ / magnesium chloride	1
	<i>Any two from</i> (giant) ionic (with strong attractions) $\text{Mg}^{2+}(\text{aq}) / \text{Mg}(\text{H}_2\text{O})_6^{2+}(\text{aq})$ is neutral / undergoes (partial) hydrolysis $\text{Mg}(\text{OH})_2$ is the white precipitate / solid / insoluble / partially soluble $\text{MgCl}_2 + 2\text{NaOH} \rightarrow \text{Mg}(\text{OH})_2 + 2\text{NaCl}$	2
2(b)(ii)	(M=) $\text{SiCl}_4$ / silicon chloride	1
	<i>Any two from</i> (simple) molecular / simple covalent hydrolysis possible due to available d orbitals forms $\text{HCl}(\text{aq})$ / hydrochloric acid / solution and / or $\text{HCl}$ gas / fumes white solid is (hydrated) $\text{SiO}_2$ $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$	2

Question	Answer			Marks																					
3(a)	<table border="1"> <thead> <tr> <th data-bbox="331 220 465 268">reaction</th> <th data-bbox="465 220 1070 268">reagent(s) and conditions</th> <th data-bbox="1070 220 1451 268">reaction type(s)</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 268 465 363">1</td> <td data-bbox="465 268 1070 363">aqueous / aq / dilute NaOH / KOH OR water</td> <td data-bbox="1070 268 1451 363">substitution OR hydrolysis</td> </tr> <tr> <td data-bbox="331 363 465 459">2</td> <td data-bbox="465 363 1070 459">alcoholic / ethanolic NaOH / KOH</td> <td data-bbox="1070 363 1451 459">elimination</td> </tr> <tr> <td data-bbox="331 459 465 555">3</td> <td data-bbox="465 459 1070 555">NaCN / KCN in ethanol / alcohol</td> <td data-bbox="1070 459 1451 555">substitution</td> </tr> <tr> <td data-bbox="331 555 465 651">4</td> <td data-bbox="465 555 1070 651">aqueous / dilute H<sub>2</sub>SO<sub>4</sub> / H<sup>+</sup>(aq)</td> <td data-bbox="1070 555 1451 651">hydrolysis OR substitution OR addition-elimination</td> </tr> <tr> <td data-bbox="331 651 465 746">5</td> <td data-bbox="465 651 1070 746">acidified / H<sup>+</sup> (with) K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> / Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> (and distil) NOT reflux</td> <td data-bbox="1070 651 1451 746">oxidation OR elimination</td> </tr> <tr> <td data-bbox="331 746 465 842">6</td> <td data-bbox="465 746 1070 842">acidified / H<sup>+</sup> K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> / Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> Fehling's / Tollens' / Benedict's (reagent)</td> <td data-bbox="1070 746 1451 842">oxidation</td> </tr> </tbody> </table>			reaction	reagent(s) and conditions	reaction type(s)	1	aqueous / aq / dilute NaOH / KOH OR water	substitution OR hydrolysis	2	alcoholic / ethanolic NaOH / KOH	elimination	3	NaCN / KCN in ethanol / alcohol	substitution	4	aqueous / dilute H <sub>2</sub> SO <sub>4</sub> / H <sup>+</sup> (aq)	hydrolysis OR substitution OR addition-elimination	5	acidified / H <sup>+</sup> (with) K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> (and distil) NOT reflux	oxidation OR elimination	6	acidified / H <sup>+</sup> K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> Fehling's / Tollens' / Benedict's (reagent)	oxidation	6
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3(b)	 <p data-bbox="324 1077 1198 1157">M1 lone pair on O of <sup>-</sup>OH AND curly arrow from lone pair to C(—Br) M2 correct dipole on C<sup>δ+</sup>—Br<sup>δ-</sup> AND curly arrow from bond to Br</p>			2																					

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 <sub>N</sub> / nucleophilic substitution	1
	((CH <sub>3</sub> ) <sub>3</sub> CBr / 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 groups 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)	<b>1</b>
3(d)(v)	one acceptable 3D structure of 2-chlorobutane	<b>1</b>
	<p>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.</p> 	<b>1</b>