
CHEMISTRY

9701/21

Paper 2 AS Structured Questions

October/November 2017

MARK SCHEME

Maximum Mark: 60

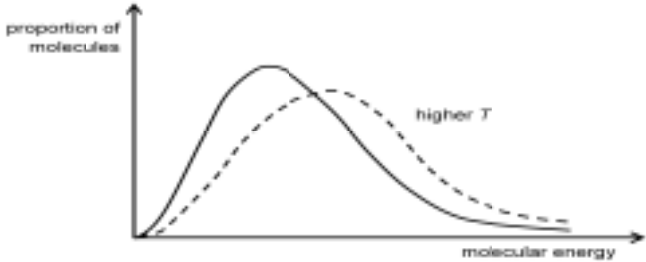
Published

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.

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

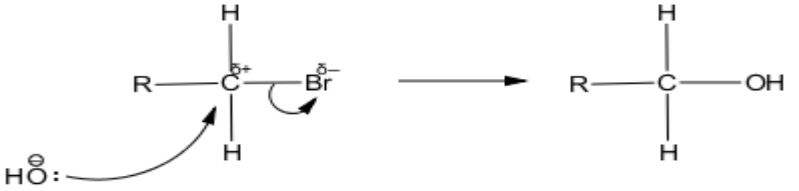
Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2017 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

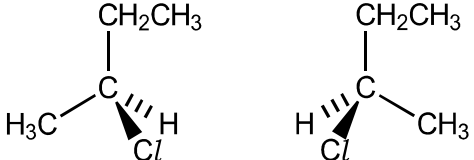
Question	Answer	Marks
1(a)(i)	energy needed / required to break a mole of (covalent) bonds	1
	(All) in the gaseous state	1
1(a)(ii)	$-92 = \{944 + 3(436)\} - 6E(\text{N-H})$	1
	$E(\text{N-H}) = (+)390.7 / 390.67 / 391$	1
1(b)(i)	general shape of the curve and peak are displaced to right of original line and starts at origin	1
	the peak is lower and curve crosses once only finishing 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 $E \geq E_a$	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 ora	1
	electron pair repulsion	1
2(b)(i)	(L=) 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=) 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 HCl gas / fumes white solid is (hydrated) 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 H₂SO₄ / H⁺(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⁺ (with) K₂Cr₂O₇ / Cr₂O₇²⁻ (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⁺ K₂Cr₂O₇ / Cr₂O₇²⁻ 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 ₂ SO ₄ / H ⁺ (aq)	hydrolysis OR substitution OR addition-elimination	5	acidified / H ⁺ (with) K ₂ Cr ₂ O ₇ / Cr ₂ O ₇ ²⁻ (and distil) NOT reflux	oxidation OR elimination	6	acidified / H ⁺ K ₂ Cr ₂ O ₇ / Cr ₂ O ₇ ²⁻ Fehling's / Tollens' / Benedict's (reagent)	oxidation	6
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 ₂ SO ₄ / H ⁺ (aq)	hydrolysis OR substitution OR addition-elimination																							
5	acidified / H ⁺ (with) K ₂ Cr ₂ O ₇ / Cr ₂ O ₇ ²⁻ (and distil) NOT reflux	oxidation OR elimination																							
6	acidified / H ⁺ K ₂ Cr ₂ O ₇ / Cr ₂ O ₇ ²⁻ Fehling's / Tollens' / Benedict's (reagent)	oxidation																							
3(b)	 <p data-bbox="324 1077 1198 1157">M1 lone pair on O of ⁻OH AND curly arrow from lone pair to C(—Br) M2 correct dipole on C^{δ+}—Br^{δ-} 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 _N / nucleophilic substitution	1
	((CH ₃) ₃ 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)	1
3(d)(v)	one acceptable 3D structure of 2-chlorobutane	1
	<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> 	1