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**CHEMISTRY**

**9701/22**

Paper 2 AS Structured Questions

**October/November 2017**

MARK SCHEME

Maximum Mark: 60

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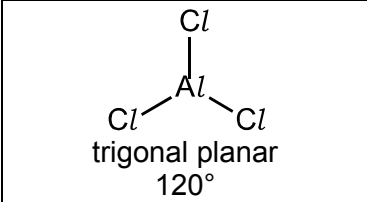
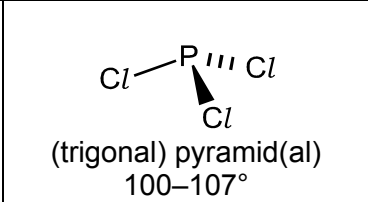
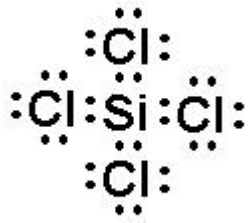
**Published**

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.

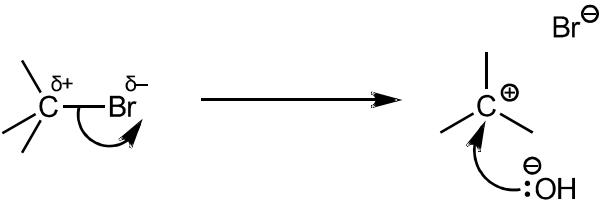
Cambridge International will not enter into discussions about these mark schemes.

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

Question	Answer	Marks
1(a)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>trigonal planar 120°</p> </div> <div style="text-align: center;">  <p>(trigonal) pyramid(al) 100–107°</p> </div> </div> <p>3 marking points for each box: diagram, name and shape. for each box: all three correct = 2 marks two correct = 1 mark</p>	<b>4</b>
1(b)(i)	SiCl <sub>4</sub> simple / molecular <b>AND</b> Van der Waals' / id-id forces / London / dispersion forces / IMFs	<b>1</b>
	NaCl ionic <b>OR</b> giant	<b>1</b>
	bonding (in NaCl) stronger (than forces in SiCl <sub>4</sub> ) owtte	<b>1</b>
1(b)(ii)	SiCl <sub>4</sub> has more electrons ORA	<b>1</b>
	stronger Van der Waals' / id-id forces / London / dispersion forces / IMFs	<b>1</b>
1(b)(iii)		<b>1</b>

Question	Answer	Marks
2(a)	-444	1
2(b)(i)	(higher rate / rate increases) due to higher frequency of successful collisions	1
	more molecules / particles with $E \geq E_a$	1
2(b)(ii)	(percentage decomposition of $\text{PCl}_5$ ) increases	1
	(forward) reaction is endothermic	1
2(c)	<u>rates</u> of forward and reverse / backward reactions are equal	1
	closed / sealed system/container	1
2(d)(i)	$n_{\text{TOTAL}} = 1.20 + 0.80 + 0.80$ OR 2.80 (mol) OR mole fraction = $1.20 / 2.80$ OR 0.429	1
	$p_{\text{PCl}_5} = 1 \times 10^5 \times (1.20 / 2.80) = 4.29 \times 10^4$ (Pa)	1
2(d)(ii)	$K_p = \frac{p_{\text{PCl}_3} \times p_{\text{Cl}_2}}{p_{\text{PCl}_5}}$	1
2(d)(iii)	$1.91 \times 10^4$	1
	Pa	1

Question	Answer	Marks
3(a)	(IE) <u>decreases / lower</u> because increasing <b>distance</b> of outer electron(s) from nucleus <b>OR</b> increasing distance of outer / valence shell from nucleus <b>OR</b> increased <b>shielding</b> / screening (from inner shells)	<b>1</b>
	reduces nuclear <b>attraction</b> (for electrons)	<b>1</b>
3(b)(i)	(Melting point) <u>increases / higher</u> because (molecules have an) increasing (number of) electrons	<b>1</b>
	increasing strength / number / amount of IMFs / Van der Waals' / id-id / London / dispersion (forces)	<b>1</b>
3(b)(ii)	increased metallic / (cat)ionic radius / size <b>OR</b> decreasing (cat)ion charge-density	<b>1</b>
	decreased attraction (of ions) for delocalised / outer electrons	<b>1</b>
3(c)(i)	reaction 1: HNO <sub>3</sub> or nitric(V) acid	<b>1</b>
	reaction 2: water / H <sub>2</sub> O	<b>1</b>
3(c)(ii)	barium oxide	<b>1</b>
	2Ba + O <sub>2</sub> → 2BaO	<b>1</b>
3(c)(iii)	NO <sub>2</sub> / nitrogen dioxide / nitrogen(IV) oxide <b>AND</b> O <sub>2</sub> / oxygen	<b>1</b>
	(red / yellow-)brown gas <b>OR</b> gas given off that relights glowing splint	<b>1</b>
3(c)(iv)	<u>white</u> ppt / solid / suspension	<b>1</b>
	of BaSO <sub>4</sub> / barium sulfate <b>OR</b> Mg(OH) <sub>2</sub> / magnesium hydroxide	<b>1</b>
	BaSO <sub>4</sub> is insoluble <b>OR</b> Mg(OH) <sub>2</sub> is insoluble / partially / slightly / sparingly soluble	<b>1</b>

Question	Answer		Marks											
4(a)	<table border="1"> <tr> <td data-bbox="320 220 383 403">1</td> <td data-bbox="383 220 949 403">           concentrated <math>\text{H}_2\text{SO}_4</math> / <math>\text{H}_3\text{PO}_4</math> <b>AND</b> NaBr   <b>OR</b> (red) P / <math>\text{Br}_2</math>  <b>OR</b> HBr         </td> <td data-bbox="949 220 1196 403">substitution</td> </tr> <tr> <td data-bbox="320 403 383 491">2</td> <td data-bbox="383 403 949 491">aqueous / dilute NaOH / KOH</td> <td data-bbox="949 403 1196 491">hydrolysis <b>OR</b> substitution</td> </tr> <tr> <td data-bbox="320 491 383 611">3</td> <td data-bbox="383 491 949 611">           concentrated <math>\text{H}_2\text{SO}_4</math> / <math>\text{H}_3\text{PO}_4</math>  <b>OR</b> <math>\text{Al}_2\text{O}_3</math> / <math>\text{P}_4\text{O}_{10}</math> / pumice / porous pot / <math>\text{SiO}_2</math> </td> <td data-bbox="949 491 1196 611">dehydration</td> </tr> <tr> <td data-bbox="320 611 383 659">4</td> <td data-bbox="383 611 949 659">(ethanolic) HBr</td> <td data-bbox="949 611 1196 659">addition</td> </tr> </table> <p data-bbox="477 667 1189 703" style="text-align: center;"><i>4 marks for column 1 (one per row) 1 mark for col 2</i></p>	1	concentrated $\text{H}_2\text{SO}_4$ / $\text{H}_3\text{PO}_4$ <b>AND</b> NaBr  <b>OR</b> (red) P / $\text{Br}_2$ <b>OR</b> HBr	substitution	2	aqueous / dilute NaOH / KOH	hydrolysis <b>OR</b> substitution	3	concentrated $\text{H}_2\text{SO}_4$ / $\text{H}_3\text{PO}_4$ <b>OR</b> $\text{Al}_2\text{O}_3$ / $\text{P}_4\text{O}_{10}$ / pumice / porous pot / $\text{SiO}_2$	dehydration	4	(ethanolic) HBr	addition	<b>5</b>
1	concentrated $\text{H}_2\text{SO}_4$ / $\text{H}_3\text{PO}_4$ <b>AND</b> NaBr  <b>OR</b> (red) P / $\text{Br}_2$ <b>OR</b> HBr	substitution												
2	aqueous / dilute NaOH / KOH	hydrolysis <b>OR</b> substitution												
3	concentrated $\text{H}_2\text{SO}_4$ / $\text{H}_3\text{PO}_4$ <b>OR</b> $\text{Al}_2\text{O}_3$ / $\text{P}_4\text{O}_{10}$ / pumice / porous pot / $\text{SiO}_2$	dehydration												
4	(ethanolic) HBr	addition												
4(b)	 <p data-bbox="320 954 1189 1023">M1 correct dipole on <math>\delta^+\text{C}-\text{Br}^{\delta-}</math> <b>AND</b> curly arrow from C—Br bond to Br</p> <p data-bbox="320 1054 815 1091">M2 correct intermediate with + charge</p> <p data-bbox="320 1129 1084 1182">M3 curly arrow from lone pair on <math>:\text{OH}^-</math> to <math>\text{C}^+</math> of carbocation</p>		<b>3</b>											

Question	Answer	Marks
4(c)(i)	(different molecules) 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
4(c)(ii)	S <sub>N</sub> / nucleophilic substitution	1
	no (stable) (carbo)cation / intermediate is formed	1
	only one alkyl group / fewer alkyl / methyl groups (compared to reaction 2) <b>AND</b> limited (+)I / inductive effect / less electron donating (effect)	1
4(d)(i)	mirror images are super(im)posable <b>OR</b> not chiral / no chirality / no chiral/asymmetric carbon/centre / achiral	1
	one or both C/end of <b>double bond</b> has identical groups / 2 methyl groups / 2 H (atoms)	1
4(d)(ii)	addition	1
	$  \begin{array}{c}  \text{H}_3\text{C} \quad \text{H} \\    \quad   \\  \text{---C---C---} \\    \quad   \\  \text{H}_3\text{C} \quad \text{H}  \end{array}  $ marking points: <ul style="list-style-type: none"> <li>• correct number of tetravalent carbon atoms in backbone, with extension bonds</li> <li>• correct groups on backbone carbon atoms <b>and</b> only one repeat unit</li> </ul>	2
4(d)(iii)	not/non- biodegradable / harmful combustion products	1

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(e)	2-bromo-2-methylpropane	<b>1</b>
	1-bromo-2-methylpropane	<b>1</b>