

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Subsidiary and Advanced Level

## **MARK SCHEME for the March 2016 series**

### **9701 CHEMISTRY**

**9701/22**

Paper 2 (AS Structured Questions), maximum raw mark 60

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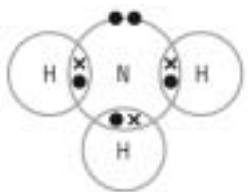
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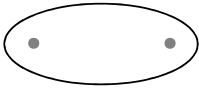



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<b>Question</b>	<b>Answer</b>	<b>Mark</b>	<b>Total</b>
<b>1 (a) (i)</b>	greater <u>attractive</u> force OR greater force <u>between nucleus and (outer) electrons</u>  proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant	[1]  [1]	[2]
<b>(ii)</b>	sulfur's electron removed from full (3p) <u>orbital</u> OR sulfur has two electrons in the same orbital  electron–electron repulsion (reduces energy required)	[1]  [1]	[2]
<b>(iii)</b>	sodium has mobile / free electrons / electrons free (to move throughout the structure)  phosphorus is simple / covalent / molecular	[1]  [1]	[2]
<b>(iv)</b>	magnesium has <u>two</u> free / delocalised / outer / valence electrons per atom OR <u>more</u> free / delocalised / <u>outer</u> electrons than sodium	[1]	[1]
<b>(b) (i)</b>	<b>A</b> = Mg(NO <sub>3</sub> ) <sub>2</sub> <b>B</b> = H <sub>2</sub> <b>C</b> = NO <sub>2</sub> OR O <sub>2</sub> <b>D</b> = O <sub>2</sub> OR NO <sub>2</sub>	[1] [1] [1] [1]	[4]
<b>(ii)</b>	any Group I carbonate OR ammonium carbonate	[1]	[1]
			<b>[12]</b>
<b>2 (a) (i)</b>	$\frac{27.30}{1000} \times 0.020 = 5.46 \times 10^{-4}$ (mol)	[1]	[1]
<b>(ii)</b>	<b>(i)</b> $\times 6 = 3.28 \times 10^{-3}$ (mol)	[1]	[1]

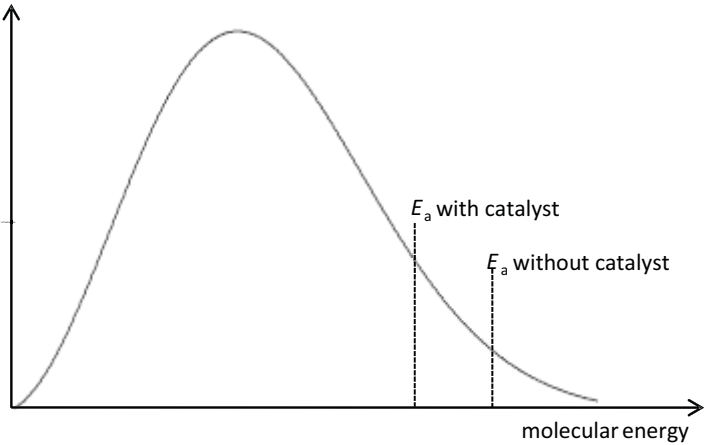
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Question	Answer	Mark	Total
(iii)	(ii) $\times \frac{250}{25.00} = 3.28 \times 10^{-2} \text{ (mol)}$	[1]	[1]
(iv)	$M_r \text{ of FeCO}_3 = 55.8 + 12.0 + 3(16.0) = 115.8$ (iii) $\times M_r(\text{FeCO}_3) = 3.79 \text{ g}$	[1] [1]	[2]
(v)	$\frac{\text{(iv)}}{5.00} \times 100\% = 75.9\%$	[1]	[1]
(b) (i)	$2\text{Fe}^{3+} + \text{Sn}^{2+} \rightarrow 2\text{Fe}^{2+} + \text{Sn}^{4+}$ species balancing	[1] [1]	[2]
(ii)	$\text{SnCl}_2(\text{aq}) + 2\text{HgCl}_2(\text{aq}) \rightarrow \text{SnCl}_4(\text{aq}) + \text{Hg}_2\text{Cl}_2(\text{s})$  SnCl <sub>2</sub> AND 2 state symbols	[1] [1]	[2]
			[10]
3 (a) (i)	 <p>three bonding pairs lone pair AND octet shape = (trigonal) pyramidal</p>	[1] [1] [1]	[3]

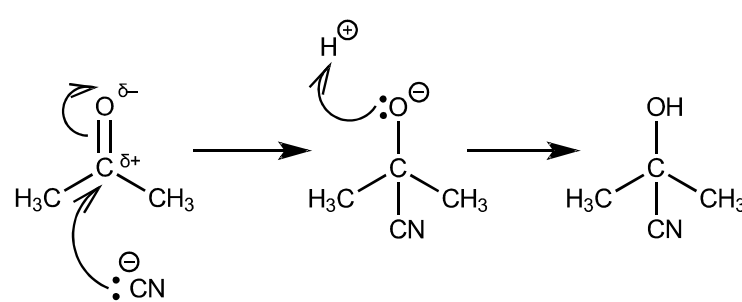
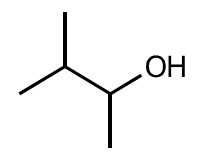
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Question	Answer	Mark	Total
(ii)	<p>sigma(<math>\sigma</math>) bond</p>  <p>OR</p>  <p>pi(<math>\pi</math>) bond</p>  	[1]	[2]
(b) (i)	<p>forward and backward reactions occurring <u>at same rate</u></p> <p>OR</p> <p><u>the rate of</u> forward and backward reactions are equal</p>	[1]	[1]
(ii)	<p>M1 = decreased yield of products/less products formed / ora</p> <p>M2 = <u>left</u>-hand side has fewer moles of gas</p> <p>OR</p> <p>equilibrium shifts to the <u>left</u></p>	[1]	[2]

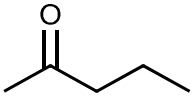
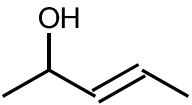
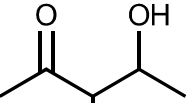
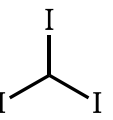
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Question	Answer	Mark	Total
(c)	 <p>M1 = correct Boltzmann curve</p> <p>M2, M3 any 2 from:</p> <ul style="list-style-type: none"> <li>• line for <b>both</b> <math>E_a</math> values or statement in text that catalyst lowers <math>E_a</math></li> <li>• (catalyst) increases proportion/number of molecules/particles with energy <math>\geq</math> activation energy</li> <li>• so more frequent successful collisions</li> </ul>	[1] [1] [1]	[3]

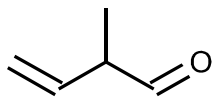
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Question	Answer	Mark	Total
(d) (i)	nucleophilic addition	[1]	[1]
(ii)	 <p>correct dipole on carbonyl  curly arrow from lone pair on CN⁻ AND from C=O to O  correct intermediate  curly arrow from lone pair on O⁻ to H⁺  correct product</p>	[1] [1] [1] [1] [1]	[5]
			[17]
4 (a) (i)	<u>C<sub>4</sub>H<sub>10</sub></u>	[1]	[1]
(ii)	<u>C<sub>4</sub>H<sub>9</sub></u>	[1]	[1]
(iii)		[1]	[1]
(b)	$C_8H_{18} + 12\frac{1}{2}O_2 \rightarrow 8CO_2 + 9H_2O$	[1]	[1]
(c)	sulfur dioxide would be produced on combustion (which contributes to) <u>acid rain</u>	[1] [1]	[2]

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Question	Answer	Mark	Total
(d)	M1 = H has more/greater/stronger van der Waals'/intermolecular forces than G / ora M2 = (because) H has more electrons (than G) M3 = J has hydrogen bonding (between molecules) M4 = strong(er)/great(er) forces require AND high/more energy to overcome	[1] [1] [1] [1]	[4]
(e)	NaOH(aq)	[1]	[1]
			[11]
5 (a) (i)	<p>Q </p> <p>R </p> <p>S </p> <p>T </p>	[1] [1]  [1] [1]	[4]
(ii)	pent-3-en(e)-2-one OR 3-penten-2-one	[1]	[1]
(iii)	red / orange / yellow precipitate / solid	[1]	[1]

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Question	Answer	Mark	Total
(b)	<p><i>This question was discounted.</i></p> <p>M1 = decolourises bromine / <math>1500\text{--}1600\text{ cm}^{-1}</math> = alkene  M2 = absorption at <math>1700\text{ cm}^{-1}</math> is C=O  AND  (very) broad absorption at <math>2500\text{--}3000\text{ cm}^{-1}</math> is O—H = carboxylic acid  M3 = no cis-trans so terminal alkene  OR  chiral so contains a carbon atom with 4 different groups attached  M4 = <b>U</b> is</p> 	<p>[1] [1]</p> <p>[1]</p> <p>[1]</p>	[4]
			[10]