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

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.

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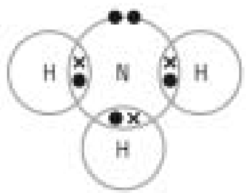
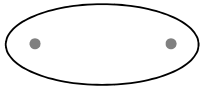
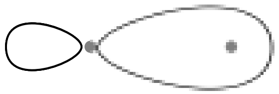
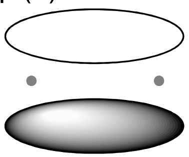
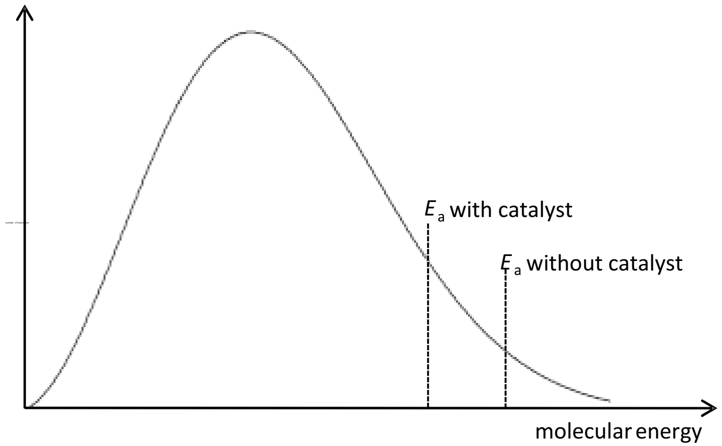
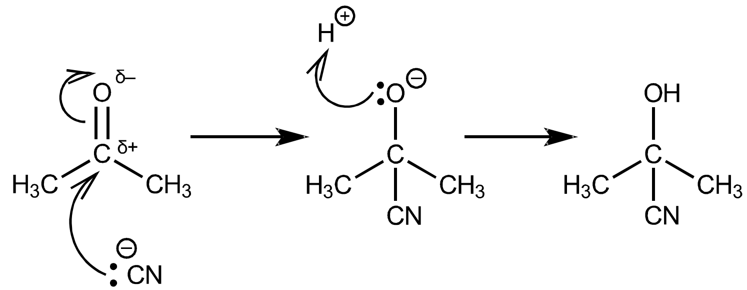
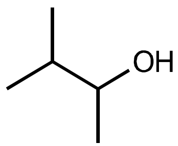
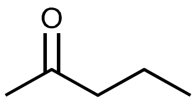
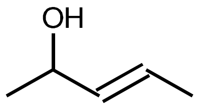
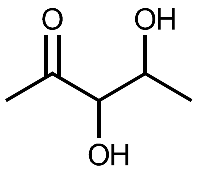
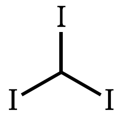
Question	Answer	Mark	Total
1 (a) (i)	greater <u>attractive</u> force OR greater force <u>between nucleus and (outer) electrons</u> proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant	[1] [1]	[2]
(ii)	sulfur's electron removed from full (3p) <u>orbital</u> OR sulfur has two electrons in the same orbital electron–electron repulsion (reduces energy required)	[1] [1]	[2]
(iii)	sodium has mobile / free electrons / electrons free (to move throughout the structure) phosphorus is simple / covalent / molecular	[1] [1]	[2]
(iv)	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) (i)	**A** = $Mg(NO_3)_2$ **B** = H_2 **C** = NO_2 OR O_2 **D** = O_2 OR NO_2	[1] [1] [1] [1]	[4]
(ii)	any Group I carbonate OR ammonium carbonate	[1]	[1]
			[12]
2 (a) (i)	$\frac{27.30}{1000} \times 0.020 = \mathbf{5.46 \times 10^{-4}}$ (mol)	[1]	[1]
(ii)	**(i)** $\times 6 = \mathbf{3.28 \times 10^{-3}}$ (mol)	[1]	[1]

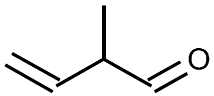
Question	Answer	Mark	Total
(iii)	**(ii)** × $\frac{250}{25.00}$ =**3.28 × 10^{-2}** (mol)	[1]	[1]
(iv)	M_r of $FeCO_3$ =55.8 + 12.0 + 3(16.0) = **115.8** **(iii)** × $M_r(FeCO_3)$ =**3.79** g	[1] [1]	[2]
(v)	$\frac{\textbf{(iv)}}{5.00}$ ×100% = **75.9**%	[1]	[1]
(b) (i)	$2Fe^{3+}$ + Sn^{2+} → $2Fe^{2+}$ + Sn^{4+} species balancing	 [1] [1]	[2]
(ii)	**$SnCl_2$(aq)** + **2**$HgCl_2$(aq) → $SnCl_4$(**aq**) + Hg_2Cl_2(**s**) $SnCl_2$ AND 2 state symbols	 [1] [1]	[2]
			[10]
3 (a) (i)	 three bonding pairs lone pair AND octet shape = (trigonal) pyramidal	 [1] [1] [1]	[3]

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

Question	Answer	Mark	Total
(c)			[3]
	M1 = correct Boltzmann curve	[1]	
	M2, M3 any 2 from: • line for **both** E_a values or statement in text that catalyst lowers E_a • (catalyst) increases proportion/number of molecules/particles with energy ⩾ activation energy • so more frequent successful collisions	[1] [1]	

Question	Answer	Mark	Total
(d) (i)	nucleophilic addition	[1]	[1]
(ii)	 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	[1] [1] [1] [1] [1]	[5]
			[17]
4 (a) (i)	$\underline{C_4H_{10}}$	[1]	[1]
(ii)	$\underline{C_4H_9}$	[1]	[1]
(iii)		[1]	[1]
(b)	$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$	[1]	[1]
(c)	sulfur dioxide would be produced on combustion (which contributes to) acid rain	[1] [1]	[2]

Question	Answer	Mark	Total
(d)	M1 = **H** has more / greater / stronger van der Waals' / intermolecular forces than **G / ora** M2 = (because) **H** <u>has more electrons</u> (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)	**Q**  **R**  **S**  **T** 	[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]

Question	Answer	Mark	Total
(b)	*This question was discounted.* M1 = decolourises bromine / 1500–1600 cm^{-1} = alkene M2 = absorption at 1700 cm^{-1} is C=O AND (very) broad absorption at 2500–3000 cm^{-1} 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 = **U** is 	[1] [1] [1] [1]	[4]
			[10]