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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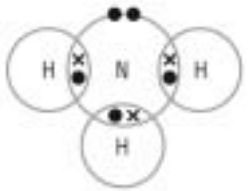
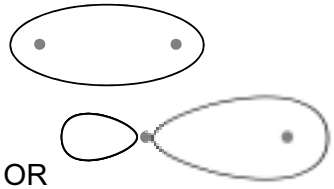
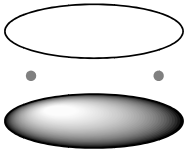
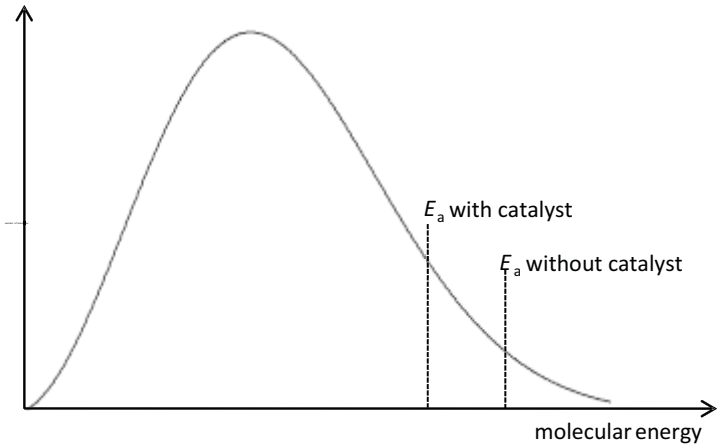
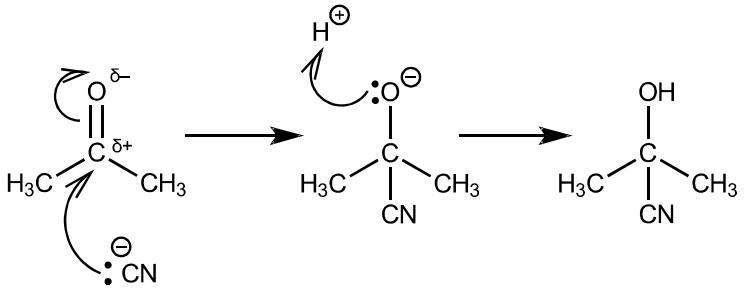
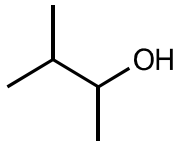
International Examinations

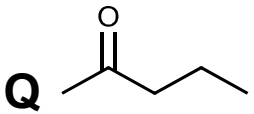
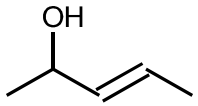
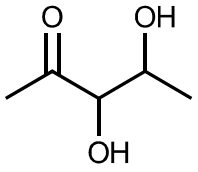
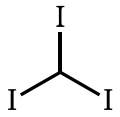
Question	Answer	Mark	Total
1 (a) (i)	greater <u>attractive</u> force OR greater force <u>between nucleus and (outer) electrons</u> proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant	[1] [1]	[2]
(ii)	sulfur's electron removed 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]

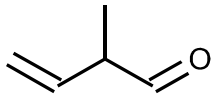
Question	Answer	Mark	Total
(iii)	**(ii)** × $\frac{250}{25.00}$ = **3.28** × **10**$^{-2}$ (mol)	[1]	[1]
(iv)	M_r of $FeCO_3$ = 55.8 + 12.0 + 3(16.0) = **115.8** **(iii)** × $M_r(FeCO_3)$ = **3.79** g	[1] [1]	[2]
(v)	$\frac{\textbf{(iv)}}{5.00}$ × 100% = **75.9**%	[1]	[1]
(b) (i)	$2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$ species balancing	 [1] [1]	[2]
(ii)	**SnC***l*$_2$(**aq**) + **2**HgC*l*$_2$(aq) → SnC*l*$_4$(**aq**) + Hg$_2$C*l*$_2$(**s**) SnC*l*$_2$ 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) <u>acid</u> <u>rain</u>	[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** 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)	**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]