**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.

Cambridge will not enter into discussions about these mark schemes.

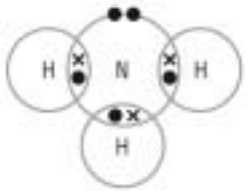
Cambridge is publishing the mark schemes for the March 2016 series for most Cambridge IGCSE® and Cambridge International A and AS Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

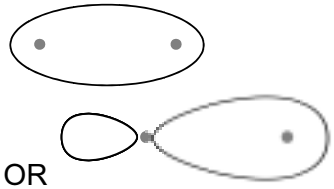
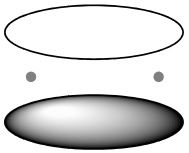
CAMBRIDGE
International Examinations

| Question | Answer | Mark | Total |
|---|---|---|---|
| 1 (a) (i) | greater <u>attractive</u> force<br>OR<br>greater force <u>between nucleus and (outer) electrons</u><br><br>proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant | [1]<br><br><br><br>[1] | [2] |
| (ii) | sulfur's electron removed from full (3p) <u>orbital</u><br>OR<br>sulfur has two electrons in the same orbital<br><br>electron–electron repulsion (reduces energy required) | [1]<br><br><br><br>[1] | [2] |
| (iii) | sodium has mobile / free electrons / electrons free (to move throughout the structure)<br><br>phosphorus is simple / covalent / molecular | [1]<br><br>[1] | [2] |
| (iv) | magnesium has <u>two</u> free / delocalised / outer / valence electrons per atom<br>OR<br><u>more</u> free / delocalised / <u>outer</u> electrons than sodium | [1] | [1] |
| (b) (i) | **A** = $Mg(NO_3)_2$<br>**B** = $H_2$<br>**C** = $NO_2$ OR $O_2$<br>**D** = $O_2$ OR $NO_2$ | [1]<br>[1]<br>[1]<br>[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] |

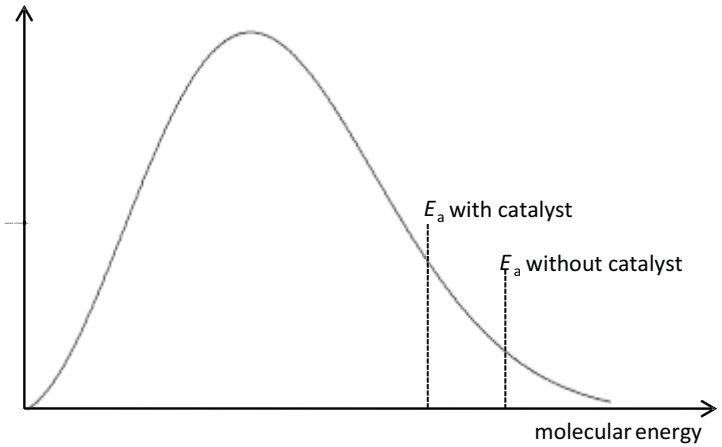
© Cambridge International Examinations 2016

| 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**<br>**(iii)** × $M_r(FeCO_3)$ = **3.79** g | [1]<br>[1] | [2] |
| (v) | $\frac{\textbf{(iv)}}{5.00}$ × 100% = **75.9**% | [1] | [1] |
| (b) (i) | $2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$<br>species<br>balancing | <br>[1]<br>[1] | [2] |
| (ii) | **Sn**$\boldsymbol{Cl_2}$**(aq)** + **2**$HgCl_2$(aq) → $SnCl_4$**(aq)** + $Hg_2Cl_2$**(s)**<br><br>$SnCl_2$ AND 2<br>state symbols | <br>[1]<br>[1] | [2] |
| | | | **[10]** |
| **3** (a) (i) | <br>three bonding pairs<br>lone pair AND octet<br>shape = (trigonal) pyramidal | <br>[1]<br>[1]<br>[1] | [3] |

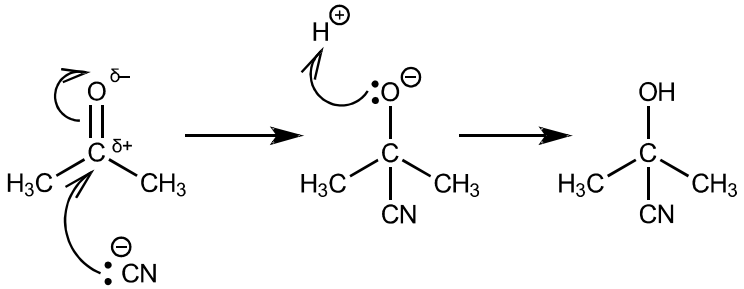
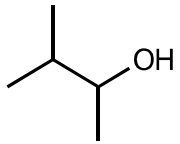
© Cambridge International Examinations 2016

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

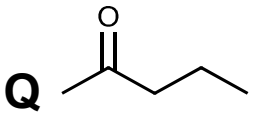
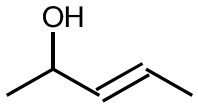
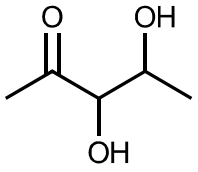
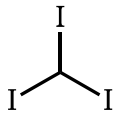
© Cambridge International Examinations 2016

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

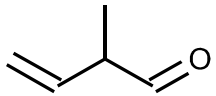
© Cambridge International Examinations 2016

| Question | Answer | Mark | Total |
|---|---|---|---|
| (d) (i) | nucleophilic addition | [1] | [1] |
| (ii) | <br>correct dipole on carbonyl<br>curly arrow from lone pair on $CN^-$ AND from C=O to O<br>correct intermediate<br>curly arrow from lone pair on $O^-$ to $H^+$<br>correct product | [1]<br>[1]<br>[1]<br>[1]<br>[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<br>(which contributes to) <u>acid</u> <u>rain</u> | [1]<br>[1] | [2] |

© Cambridge International Examinations 2016

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

© Cambridge International Examinations 2016

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

© Cambridge International Examinations 2016