Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**CHEMISTRY** **9701/21**

Paper 2 AS Level Structured Questions **May/June 2016**

MARK SCHEME

Maximum Mark: 60

**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.

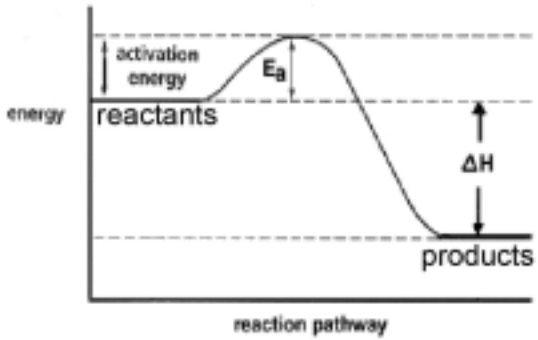
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

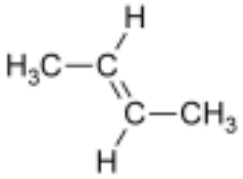
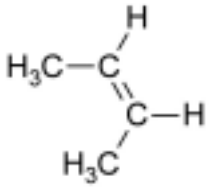
Cambridge will not enter into discussions about these mark schemes.

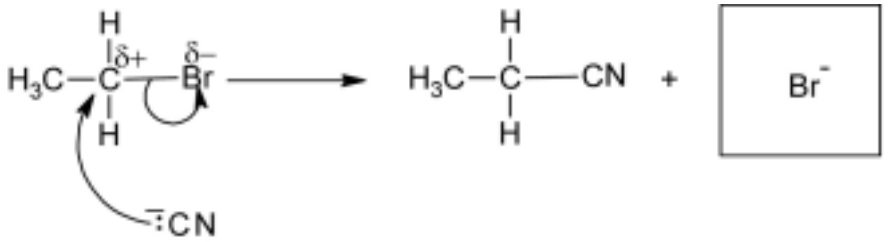
Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

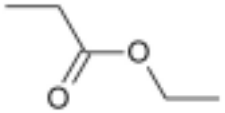
<table>
<tr><th>Question</th><th>Mark Scheme</th><th>Mark</th><th>Total</th></tr>
<tr><td>1 (a)</td><td>
<table>
<tr><th>name of element</th><th>nucleon no.</th><th>atomic no.</th><th>no. of protons</th><th>no. of neutrons</th><th>no. of electrons</th><th>overall charge</th></tr>
<tr><td>lithium</td><td>6</td><td>3</td><td>3</td><td>3</td><td>2</td><td>+1</td></tr>
<tr><td>oxygen</td><td>17</td><td>8</td><td>8</td><td>9</td><td>10</td><td>–2</td></tr>
<tr><td>iron</td><td>54</td><td>26</td><td>26</td><td>28</td><td>24</td><td>+2</td></tr>
<tr><td>chlorine</td><td>35</td><td>17</td><td>17</td><td>18</td><td>17</td><td>0</td></tr>
</table>
</td><td>[1]<br>[1]<br>[1]<br>[1]</td><td>[4]</td></tr>
<tr><td>(b)</td><td>line straight on labelled ‘neutrons’<br>line (curving) up labelled ‘protons’<br>proton line clearly shows less (overall) deflection than electron curve</td><td>[1]<br>[1]<br>[1]</td><td>[3]</td></tr>
<tr><td>(c) (i)</td><td>Group 16 / 6 / VI<br>AND<br>Big (owtte) increase / big difference / big gap / big jump / jump in increase / jump in difference after 6th IE</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(ii)</td><td>increases (across period) due to increasing attraction (of nucleus for electrons)<br><br>due to increasing nuclear charge / atomic / proton number AND<br>constant/similar shielding / same (outer / number of) shell / energy level</td><td>[1]<br><br>[1]</td><td>[2]</td></tr>
<tr><td>(iii)</td><td>electron (pair) repulsion<br>(Y has a) pair of electrons in a (3)<u>p</u> <u>orbital</u> / a (3)<u>p</u> <u>orbital</u> is full ORA</td><td>[1]<br>[1]</td><td>[2]</td></tr>
<tr><td>(iv)</td><td>$(1s^2)2s^2 2p^6 3s^2 3p^5$</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(d) (i)</td><td>0.56(%)</td><td>[1]</td><td>[1]</td></tr>
</table>

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| (ii) | $\frac{(A \times 0.56) + (86 \times 9.86) + (87 \times 7.00) + (88 \times 82.58)}{100} = 87.71$<br><br>$A$ = 84 | [1]<br><br>[1] | [2] |
| | | | **[16]** |
| **2** **(a)** | **D** = Ga **G** = Se | [1] | [1] |
| **(b)** **(i)** | $\mathbf{D}_2O_3$ + $6HCl \rightarrow 2\mathbf{D}Cl_3$ + $3H_2O$<br>M1 = species;<br>M2 = balancing | [1]<br>[1] | [2] |
| (ii) | $\mathbf{D}_2O_3$ + $2NaOH$ + $7H_2O \rightarrow 2Na\mathbf{D}(OH)_4(H_2O)_2$ OR<br>$\mathbf{D}_2O_3$ + $2NaOH$ + $3H_2O \rightarrow 2Na\mathbf{D}(OH)_4$ OR<br>$\mathbf{D}_2O_3$ + $2NaOH \rightarrow 2Na\mathbf{D}O_2$ + $H_2O$ OR<br>$\mathbf{D}_2O_3$ + $2OH^-$ + $7H_2O \rightarrow 2[\mathbf{D}(OH)_4(H_2O)_2]^-$ OR<br>$\mathbf{D}_2O_3$ + $2OH^-$ + $3H_2O \rightarrow 2[\mathbf{D}(OH)_4]^-$ OR<br>$\mathbf{D}_2O_3$ + $2OH^- \rightarrow 2\mathbf{D}O_2^-$ + H2O<br><br>M1 = species;<br>M2 = balancing | [1]<br>[1] | [2] |
| **(c)** | giant ionic / ionic lattice | [1] | [1] |
| **(d)** | $\mathbf{G}O_2$ + $H_2O \rightarrow H_2\mathbf{G}O_3$ | [1] | [1] |
| | | | **[7]** |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| 3 (a) (i) | bubbles / effervescence / fizzing | [1] | max [3] |
| | calcium gets smaller / disappears | [1] | |
| | water turns cloudy / milky | [1] | |
| | calcium sinks | [1] | |
| (ii) | $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ | [1] | [1] |
| (iii) | faster bubbling / disappearance of Ba<br>OR<br>no / less precipitate forms (owtte) | [1] | [1] |
| (b) (i) |  | | [2] |
| | M1 – general layout with products below reactants AND both labelled | [1] | |
| | M2 – $E_a$ and $\Delta H$ / energy change / released labelled with vertical lines | [1] | |
| (ii) | activation energy is high | [1] | [2] |
| | so few/no particles with $E \geqslant E_a$ | [1] | |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| (iii) | high melting / boiling point<br><br>strong forces (of attraction / between oppositely charged ions) / strong (ionic) bonding | [1]<br><br>[1] | [2] |
| (iv) | MgO is basic / reacts with acid | [1] | [1] |
| (c) (i) | increases (down the group) | [1] | [1] |
| (ii) | $MgCO_3 \rightarrow MgO + CO_2$ | [1] | [1] |
| (iii) | $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$ | [1] | [1] |
| | | | **[15]** |
| **4** (a) | $CH_2{=}CHCH_2CH_3$ / $CH_2CHCH_2CH_3$<br>AND<br>$CH_3CH{=}CHCH_3$ / $CH_3CHCHCH_3$ | [1] | [1] |
| (b) | $CH_2{=}CHCH_2CH_3$ / $CH_2CHCH_2CH_3$<br>AND<br>$(CH_3)_2C{=}CH_2$ / $(CH3)_2CCH_2$ | [1] | [1] |
| (c) |  <br><br>*trans*-but-2-ene (or *E*) | [1] | [2] |
| |  <br><br>*cis*-but-2-ene (or *Z*) | [1] | |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| (d) | **B** is $CH_2=CHCH_2CH_3$ OR $CH_3CH=CHCH_3$ OR $(CH_3)_2C=CH_2$ | [1] | |
| | distinguished by addition of bromine | [1] | [3] |
| | brown/red/orange/yellow to colourless/decolourises with **B** (but not **A**) | [1] | |
| | | | **[7]** |
| 5 (a) |  | | [2] |
| | M1 = lone pair on C of $CN^-$ AND curly arrow from lone pair to C of C—Br | [1] | |
| | M2 = correct dipole on C—Br, curly arrow from C—Br bond to Br AND $Br^-$ | [1] | |
| (b) (i) | reduction | [1] | [1] |
| (ii) | disappearance of peak / dip / trough / absorption at 1680–1730 | [1] | |
| | due to (loss of) C=O | [1] | |
| | OR | | [2] |
| | peak at 3200–3650 | [1] | |
| | due to (alcohol) O—H (formation) | [1] | |
| (c) (i) | sodium/potassium hydroxide<br>aqueous | [1]<br>[1] | [2] |

| Question | Mark Scheme | Mark | Total |
|---|---|---|---|
| (ii) | ethanol | [1] | [1] |
| (d) (i) | (conc) $H^+$ / (conc) acid / (conc)$H_2SO_4$ / (conc)$H_3PO_4$ | [1] | [1] |
| (ii) |  | [1] | [1] |
| (iii) | ethyl propanoate | [1] | [1] |
| (e) (i) | **V** = $CH_3CH_2CHCHCH_2CH_3$ / $CH_3CH_2CH{=}CHCH_2CH_3$<br>**T** = $CH_3CH_2CH(OH)CH(OH)CH_2CH_3$ | [1]<br>[1] | [2] |
| (ii) | **V** = geometric(al) / *cis-trans* / *E–Z*<br>**T** = optical | [1]<br>[1] | [2] |
| | | | **[15]** |