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 October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.
1 (a) \[\text{ZnCO}_3 \rightarrow \text{Zn(OH)}_2 \rightarrow \text{ZnO} \]
\[\text{not Zn or other compounds of Zn}\] (any 2) [2]

(b) (i) to ensure all of the water of crystallisation had been driven off or to be at constant mass (1)

(ii) mass of \(\text{ZnSO}_4\) = 76.34 – 74.25 = 2.09 g (1)

\[M_r \text{ ZnSO}_4 = 65.4 + 32.1 + (4 \times 16.0) = 161.5\]

allow use of \(\text{Zn} = 65\) and/or \(\text{S} = 32\) to give values between 161 and 161.5 (1)

\[n(\text{ZnSO}_4) = \frac{2.09}{161.5} = 0.01294 = 1.29 \times 10^{-2}\]

\(\text{ZnSO}_4 = 161\) gives \(1.30 \times 10^{-2}\) (1)

(iii) mass of \(\text{H}_2\text{O}\) driven off = 77.97 – 76.34 = 1.63 g (1)

\[n(\text{H}_2\text{O}) = \frac{1.63}{18} = 0.0905 = 9.1 \times 10^{-2}\] (1)

(iv) \(1.29 \times 10^{-2}\) mol \(\text{ZnSO}_4\) are combined with \(9.1 \times 10^{-2}\) mol \(\text{H}_2\text{O}\)

\[1 \text{ mol } \text{ZnSO}_4 \text{ is combined with } \frac{9.1 \times 10^{-2}}{1.29 \times 10^{-2}} = 7.054 \equiv 7 \text{ mol } \text{H}_2\text{O}\]

answer must be expressed as a whole number allow ecf on candidate’s answers to (b)(ii) and (b)(iii) (1) [7]

(c) (i) \[n(\text{Zn}) = n (\text{CH}_3\text{CO}_2)_2\text{Zn.2H}_2\text{O}\]

\[n(\text{Zn}) = \frac{0.015}{65.4} = 2.290 \times 10^{-4}\]

= \(2.29 \times 10^{-4}\) (1)

mass of crystals = \(2.29 \times 10^{-4} \times 219.4 = 0.0502655\) g

= 0.05 g = 50 mg (1)

(ii) concentration of (\(\text{CH}_3\text{CO}_2\))\(_2\)\(\text{Zn.2H}_2\text{O}\) = \(2.29 \times 10^{-4}\) = \(0.0458\)

\[= 4.58 \times 10^{-2} \text{ mol dm}^{-3}\] (1)

allow correct answers if \(\text{Zn} = 65\) is used [4]

[Total: 13]
2 (a) (i) thermal stability decreases down Group VII

(ii) from Cl to I, atomic size increases or
the bonding pair is further from the nucleus of X or
H—X bond becomes longer or
smaller orbital overlap occurs
hence H—X bond strength decreases down Group VII

(b) \[ K_c = \frac{[HI]^2}{[H_2][I_2]} \] (1)

no units – must be clearly stated (1) [2]

c (i) no change \( K_c \) has no units or
same no. of molecules / moles each side of equilibrium (1)

(ii) equilibrium moves to RHS \( K_c \) increases with decreasing temperature or
forward reaction is exothermic or
reverse reaction is endothermic (1) [4]

d \[ H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \]

<table>
<thead>
<tr>
<th></th>
<th>initial moles</th>
<th>equil. moles</th>
<th>equil. conc/mol dm(^{-3})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.02</td>
<td>(0.02 – y)</td>
<td>(0.02 – y)</td>
</tr>
<tr>
<td></td>
<td>0.02</td>
<td>(0.02 – y)</td>
<td>(0.02 – y)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2y</td>
<td>2y</td>
</tr>
</tbody>
</table>

\[ K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(2y)^2}{(0.02 – y)^2} = 59 \] (1)

\[ \frac{2y}{(0.02 – y)} = \sqrt{59} = 77 \]

\[ 2y = (7.7 \times 0.02) – 7.7y \]

\[ 9.7y = 0.154 \]

\[ \text{gives } y = \frac{0.154}{9.7} = 0.0159 \approx 0.016 \] (1)

at equilibrium

\[ n(HI) = 2 \times 0.016 = 0.032 \text{ and} \]

\[ n(H_2) = n(I_2) = (0.02 – 0.016) = 0.004 \] (1)

allow ecf where possible [4] [Total: 13]
3 (a) (i) \( \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \) or
\( \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g}) \)

state symbols required (1)

(ii) pressure between 60 and 250 atm or between 60 \( \times 10^5 \) Pa and 250 \( \times 10^5 \) Pa (1)

temperature between 300 and 550 °C (1)

catalyst iron / iron oxide (1)

(iii) manufacture of HNO\(_3\) / as a cleaning agent / refrigerant / fertiliser / manufacture of fertilisers / explosives / to remove SO\(_2\) from combustion products of hydrocarbon fuels (1) [5]

(b) (i) \( \text{NH}_4\text{Cl} \) and \( \text{Ca(OH)}_2 \)
both formulae required (1)

(ii) \( 2\text{NH}_4\text{Cl} + \text{Ca(OH)}_2 \rightarrow \text{CaCl}_2 + 2\text{NH}_3 + 2\text{H}_2\text{O} \) or
\( \text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O} \)
correct products (1)
correctly balanced equation (1)

(iii) CaO
it is not an acid / it is basic / it does not react with \( \text{NH}_3 \) or both \( \text{P}_2\text{O}_5 / \text{P}_4\text{O}_{10} \) and \( \text{H}_2\text{SO}_4 \) are acidic / react with \( \text{NH}_3 \) (1) [5]

(c) \[
\begin{array}{c}
\text{H} \\
\text{H-N}^+ \text{H}
\end{array}
\]

correct displayed eqn.,
with positive charge clearly shown (1)
lone pair on \( \text{NH}_3 \) (1)
co-ordinate / dative bond clearly shown (1) [3]

[Total: 13]
4 (a) (i) 

<table>
<thead>
<tr>
<th>reaction</th>
<th>organic compound</th>
<th>reagent</th>
<th>structural formulae of organic products</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(CH$_3$)$_3$COH</td>
<td>Cr$_2$O$_7^{2-}$/H$^+$ heat under reflux</td>
<td>no reaction</td>
</tr>
<tr>
<td>B</td>
<td>CH$_3$CH$_2$CHO</td>
<td>Fehling's reagent warm</td>
<td>CH$_3$CH$_2$CO$_2$H or CH$_3$CH$_2$CO$_2^-$</td>
</tr>
<tr>
<td>C</td>
<td>HCO$_2$CH(CH$_3$)$_2$</td>
<td>NaOH(aq) warm</td>
<td>HCO$_2$Na or HCO$_2^-$</td>
</tr>
<tr>
<td>D</td>
<td>CH$_2$=CHCHO</td>
<td>NaBH$_4$</td>
<td>CH$_2$=CHCH$_2$OH</td>
</tr>
<tr>
<td>E</td>
<td>(CH$_3$)$_3$COH</td>
<td>NaBH$_4$</td>
<td>no reaction</td>
</tr>
<tr>
<td>F</td>
<td>CH$_3$CH$_2$COCH$_3$</td>
<td>MnO$_4^-$/H$^+$ heat under reflux</td>
<td>no reaction</td>
</tr>
</tbody>
</table>

Each correct answer gets (1) 

(ii) reaction colour at the beginning of the reaction colour at the end of the reaction

<table>
<thead>
<tr>
<th>reaction</th>
<th>colour at the beginning of the reaction</th>
<th>colour at the end of the reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>blue</td>
<td>brick red</td>
</tr>
</tbody>
</table>

Each correct answer gets 1 (1 +1 + 1) [10]

(b) (i) 

![Diagram](image)

(1)

(ii) red or orange (1) [2]

[Total: 12]
5 (a) (i) carboxylic acid or alcohol present or
carboxylic acid and alcohol present
not acid or carboxyl or hydroxyl

(ii) carboxylic acid not present or
only alcohol present

(iii) alkene or $>\text{C}=$C$<$ present

(b) (i) each correct structure gets (1)

(ii) pair 1 geometrical or cis-trans or $E/Z$ isomerism

pair 2 optical isomerism – accept chiral compounds

[Total: 9]