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 must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
1 (a) \[ K_c = \frac{[CH_3CH_2R][H_2O]}{[CH_3CH_2H][ROH]} \]  
no units  

(b) (i) \[ n(\text{NaOH}) = \frac{22.5 \times 2.00}{1000} = 0.045 \]  

(ii) \[ n(\text{NaOH}) = n(\text{HCl}) = 0.005 \]  

(iii) \[ \text{CH}_3\text{CO}_2\text{H} + \text{NaOH} \to \text{CH}_3\text{CO}_2\text{Na} + \text{H}_2\text{O} \]  

(iv) \[ n(\text{NaOH}) = 0.045 - 0.005 = 0.04 \]  
allow ecf on (i) and/or (ii)  

(c) (i) \[ n(\text{NaOH}) \text{ and } n(\text{CH}_3\text{CO}_2\text{H}) = 0.04 \]  
\[ n(\text{CH}_3\text{CO}_2\text{R}) \text{ and } n(\text{H}_2\text{O}) = 0.06 \]  

(ii) \[ K_c = \frac{0.06 \times 0.06}{0.04 \times 0.04} = 2.25 \]  
allow ecf on wrong values in (b)(i)  
allow ecf on wrong expression in (a)  

(d) \[ E_a \text{ for reaction with ester is high or } \]  
\[ E_a \text{ for reaction with acid is low or } \]  
\[ \text{reaction with ester is slow or } \]  
\[ \text{reaction with acid is fast} \]  

(e) \[ \text{equilibrium moves to RHS/more ester would be formed to maintain value of } K_c \text{ or } \]  
\[ \text{to restore system to equilibrium} \]  

[Total: 12]
2 (a) \[ \text{CH}_2=\text{CH}_2 + \text{HF} \rightarrow \text{CH}_3\text{CH}_2\text{F} \]

<table>
<thead>
<tr>
<th>bonds</th>
<th>4 C-H</th>
<th>1640</th>
<th>bonds</th>
<th>5 C-H</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>broken</td>
<td>1 C=C</td>
<td>610</td>
<td>made</td>
<td>1 C-C</td>
<td>350</td>
</tr>
<tr>
<td>/kJ mol(^{-1})</td>
<td>1 H-F</td>
<td>562</td>
<td>/kJ mol(^{-1})</td>
<td>1 C-F</td>
<td>(E)</td>
</tr>
<tr>
<td></td>
<td>2812</td>
<td></td>
<td></td>
<td></td>
<td>((2400 + E))</td>
</tr>
</tbody>
</table>

breaking reactant bonds requires

\[ 4 \times 410 + 610 + 562 = 2812 \text{ kJ mol}^{-1} \]  \(\text{(1)}\)

making product bonds gives

\[ 5 \times 410 + 350 + E = (2400 + E) \text{ kJ mol}^{-1} \]  \(\text{(1)}\)

\[ \Delta H_{\text{reaction}} = -(2400 + E) + 2812 = -73 \text{ kJ mol}^{-1} \]  \(\text{(1)}\)

\[ (2400 + E) = 2812 + 73 = 2885 \text{ kJ mol}^{-1} \]

\[ E = 2885 - 2400 = 485 \text{ kJ mol}^{-1} \]  \(\text{(1)}\)

allow ecf on wrong bond energy values and/or incorrect arithmetic  \([4]\)

(b) any two from non-toxic unreactive volatile non-flammable easily liquefied  \((1 + 1)\)  \([2]\)

(c) in \(\text{CCl}_2\text{F}_2\)

C-C\(\text{I}\) bond energy is 340 kJ mol\(^{-1}\) and is weaker than C-F or C-H bonds  \(\text{(1)}\)

C-C\(\text{I}\) bond is broken by uv or C\(\text{I}\) free radicals are formed  \((1)\)  \([2]\)

(d) (i) the trapping of reflected heat from the Earth in the lower atmosphere producing global warming

(ii) \(\text{CO}_2/\text{carbon dioxide}\)  \((1)\)  \([3]\)

(e) octahedral  \((1)\)  \([1]\)

[Total: 12]
(a) R BaO  
S BaCl₂  
T Ba(OH)₂  
U BaSO₄  
V BaCO₃  
W Ba(NO₃)₂  

(b) (i) T to W  
Ba(OH)₂ + 2HNO₃ → Ba(NO₃)₂ + 2H₂O  
heat on V  
BaCO₃ → BaO + CO₂  

(ii) T to V  
CO₂  
Ba(OH)₂ + CO₂ → BaCO₃ + H₂O  

(c) Na₂SO₄(aq)/K₂SO₄(aq) or any soluble sulfate
(d) (i) $\text{Ba:O} = \frac{81.1}{137} : \frac{18.9}{16} = 0.59 : 1.18 = 1 : 2$ gives $\text{BaO}_2$ (1)

(ii) $\text{BaSO}_4$ (1)

(iii) $\text{BaO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$ (1) [4]

[Total: 15]

4 (a) (i)

- titanium/graphite anode identified correctly (1)
- steel cathode identified correctly (1)
- diaphragm identified correctly (1)
- all three outlets correctly shown (1) [4]

(ii) **anode** $2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2e^-$ (1)

**cathode** $2\text{H}^+(\text{aq}) + 2e^- \rightarrow \text{H}_2(\text{g})$

or $2\text{H}_2\text{O}(\text{l}) + 2e^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$ (1) [2]

(iii) sodium hydroxide (1) [1]

[Total: 7]
5  (a)  \[ \text{CH}_2\text{OCO(C}_2\text{H}_5\text{)}_{16}\text{CH}_3 \]
\[ \text{CHOCO(C}_2\text{H}_5\text{)}_{16}\text{CH}_3 \]
\[ \text{CH}_2\text{OCO(C}_2\text{H}_5\text{)}_{16}\text{CH}_3 \]

all three alcohol groups must be esterified  

(b)  dilute HCl or dilute H_2SO_4 or dilute mineral acid or NaOH(aq) followed by dilute acid  

(c)  \[
\begin{array}{c}
\text{CH}_3\text{(CH}_2\text{)}_7 \\
\text{H} \\
\text{C} = \text{C} \\
\text{H} \\
\text{(CH}_2\text{)}_7\text{CO}_2\text{H}
\end{array}
\]

(d)  (i) fatty acid that contains more than one C=C bond  

(ii) hydrogen  
nickel/Raney nickel/platinum/palladium  

(e)  (i)  \[ \text{CH}_3\text{(CH}_2\text{)}_7\text{CHO} \]
\[ \text{OHC(CH}_2\text{)}_7\text{CX} \]

(ii) 2,4-dinitrophenylhydrazine  
yellow/orange/red precipitate  

(iii)  Tollens’ reagent  or  Fehling’s/Benedict’s solution  
silver mirror  or  brick red ppt.  
grey precipitate  

(f)  (i) two  

(ii) ester  

[Total: 14]