MARK SCHEME for the October/November 2008 question paper

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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates’ scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

• CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2008 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
1 (a) (i) substance that speeds up a chemical reaction (1)
by lowering $E_a$
or by providing an alternative reaction pathway
or without being used up in the process (1)

(ii) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ (1) [3]

(b) (i) alkanes or paraffins (1)

(ii) $2\text{H}_2\text{O} : \text{O}_2$ and $\text{C}_{15}\text{H}_{32} : 23\text{O}_2$ (1)
whence $\text{C}_{15}\text{H}_{32} : 46\text{H}_2\text{O}_2$ (1)
allow e.c.f. on (a)(ii) [3]

(c) (i) $\text{C}_{15}\text{H}_{32} = 212$ (1)

\[
n(\text{C}_{15}\text{H}_{32}) = \frac{212\times10^6}{212} = 1 \times 10^6 \text{ mol}
\]
allow e.c.f. on wrong $M_r$ of $\text{C}_{15}\text{H}_{32}$ (1)

(ii) $n(\text{H}_2\text{O}_2)$ required $= 46 \times 10^6 \text{ mol}$ (1)
mass of $\text{H}_2\text{O}_2 = 34 \times 46 \times 10^6 \text{ g} = 1564 \text{ tonnes}$
final answer must be in tonnes (1)
allow e.c.f. on (b)(ii) and (c)(i) [4]

(d) they would dissolve (1)

[Total: 11]

2 (a) (i) $\text{H}–\text{C}–\text{H}$ 117 to 120° (1)
$\text{C}=\text{C}=\text{O}$ 180° (1)

(ii) molecule contains both ketone and alkene (1) [3]

(b) (i) $\text{C}_2\text{H}_2\text{O} + 2\text{O}_2 \rightarrow 2\text{CO}_2 + \text{H}_2\text{O}$ (1)

(ii) from eqn., $42 \text{ g C}_2\text{H}_2\text{O} \rightarrow 48 \text{ dm}^3\text{ of CO}_2$ (1)
whence $3.5 \text{ g C}_2\text{H}_2\text{O} \rightarrow \frac{48 \times 3.5}{42} \text{ dm}^3\text{ of CO}_2$ (1)

\[= 4.0 \text{ dm}^3\text{ of CO}_2 \text{ (1)}
\]

or $n(\text{C}_2\text{H}_2\text{O}) = \frac{42}{3.5} = 0.0833$ (1)

$n(\text{CO}_2) = 2 \times 0.083 = 0.166$ (1)
vol. of $\text{CO}_2 = 0.0166 \times 24 = 4.0 \text{ dm}^3$ (1)
allow e.c.f. on wrong eqn. in (b)(i)
penalise significant figure error [4]
(c) (i) enthalpy change when
1 mol of a compound is formed (1)
from its elements (1)
in their standard states under standard conditions (1)

(ii) \[ \begin{align*}
C + O_2 & \rightarrow CO_2 \quad -395 \text{ kJ mol}^{-1} \\
H_2 + \frac{1}{2}O_2 & \rightarrow H_2O \quad -286 \text{ kJ mol}^{-1} \\
C_2H_2O + 2O_2 & \rightarrow 2CO_2 + H_2O \quad -1028 \text{ kJ mol}^{-1} \\
2C + H_2 + \frac{1}{2}O_2 & \rightarrow C_2H_2O \quad \Delta H = 2(-395) + (-286) -(-1028) \\
& \quad = -48 \text{ kJ mol}^{-1}
\end{align*} \]
correct cycle (1) use of 2 for C/CO \[ \quad \] (1) answer (1) [6]

(d) H\(_2\)O/water/steam (1) [1]

[Total: 14]

3 (a) anode \[ Cl^- \text{(aq)} \rightarrow \frac{1}{2} Cl_2 \text{(g)} + e^- \] (1)
cathode \[ H^+ \text{(aq)} + e^- \rightarrow \frac{1}{2} H_2 \text{(g)} \]
\[ \text{or} \quad 2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^- \text{(aq)} \] (1)
correct state symbols (1) [2]

(b) because the iron in steel will react with chlorine (1) [1]

(c) (i) sodium hydroxide/NaOH (1)
\[ 2H_2O \quad + \quad 2e^- \rightarrow H_2 + 2OH^- \]
\[ \text{or} \quad 2H^+ + 2e^- \rightarrow H_2 \] (1)
leaving OH\(^-\) in solution as NaOH (1) [3]

(d) Na burns with a yellow flame/forms a white solid (1)
\[ 2Na \quad + \quad Cl_2 \rightarrow 2NaCl \] (1)
P burns with a white flame/forms a colourless liquid (PC\(_l_3\)) or a white solid (PC\(_l_5\)) (1)
\[ P \quad + \quad 1\frac{1}{2}Cl_2 \rightarrow PCl_3 \text{ or} \quad P_4 + 6Cl_2 \rightarrow 4PCl_3 \]
\[ \text{or} \quad P \quad + \quad 2\frac{1}{2}Cl_2 \rightarrow PCl_5 \text{ or} \quad P_4 + 10Cl_2 \rightarrow 4PCl_5 \] (1) [4]

(e) MgCl\(_2\) 6 to 7 (1)
\[ \text{SiCl}_4 \quad 0 \text{ to } 3 \]
MgCl\(_2\) dissolves without reaction (1)
\[ \text{SiCl}_4 \quad \text{reacts with water/hydrolyses} \]
\[ \text{SiCl}_4 \quad + \quad 2H_2O \rightarrow SiO_2 \quad + \quad 4HC\ell \text{ or} \]
\[ \text{SiCl}_4 \quad + \quad 4H_2O \rightarrow Si(OH)_4 \quad + \quad 4HC\ell \text{ or} \]
\[ \text{SiCl}_4 \quad + \quad 4H_2O \rightarrow SiO_2\cdot2H_2O \quad + \quad 4HC\ell \] (1) [5]

[Total: 15 max]
<table>
<thead>
<tr>
<th>organic reaction</th>
<th>type of reaction</th>
<th>reagent(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_3$CHO →</td>
<td>nucleophilic</td>
<td>HCN</td>
</tr>
<tr>
<td>CH$_3$CH(OH)CN</td>
<td>addition</td>
<td>or HCN and CN$^-$</td>
</tr>
<tr>
<td>CH$_3$CH$_2$CH$_2$CH$_3$ →</td>
<td>free radical</td>
<td>Br$_2$</td>
</tr>
<tr>
<td>CH$_3$CH$_2$CHBrCH$_3$</td>
<td>substitution</td>
<td>or Br$_2$ in an organic solvent not Br$_2$(aq)</td>
</tr>
<tr>
<td>CH$_3$CH(OH)CH$_3$ →</td>
<td>elimination</td>
<td>conc. H$_2$SO$_4$</td>
</tr>
<tr>
<td>CH$_3$CH=CH$_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH$_3$CH=CH$_2$ →</td>
<td>addition</td>
<td>KMnO$_4$/MnO$_4$ $^-$</td>
</tr>
<tr>
<td>CH$_3$CH(OH)CH$_2$OH</td>
<td>or oxidation</td>
<td></td>
</tr>
</tbody>
</table>

[10]

[Total: 10]
5  (a)  $\text{C}_4\text{H}_8\text{O}_2$ (1)  

(b)  

<table>
<thead>
<tr>
<th></th>
<th>HCO$_2$CH(CH$_3$)$_2$</th>
<th>HCO$_2$CH$_2$CH$_2$CH$_3$</th>
<th>CH$_3$CO$_2$CH$_2$CH$_3$</th>
<th>CH$_3$CH$_2$CO$_2$CH$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>HCO$_2$CH(CH$_3$)$_2$</td>
<td>HCO$_2$CH$_2$CH$_2$CH$_3$</td>
<td>CH$_3$CO$_2$CH$_2$CH$_3$</td>
<td>CH$_3$CH$_2$CO$_2$CH$_3$</td>
</tr>
<tr>
<td>X</td>
<td>or</td>
<td>or</td>
<td>or</td>
<td>or</td>
</tr>
<tr>
<td>Y</td>
<td>or</td>
<td>or</td>
<td>or</td>
<td>or</td>
</tr>
<tr>
<td>Z</td>
<td>or</td>
<td>or</td>
<td>or</td>
<td>or</td>
</tr>
</tbody>
</table>

Each correct structure is worth (1)  

(c)  

(i)  presence of $\text{>C=O}$ group/carbonyl group (1)  

(ii)  $\text{–CHO}$ group/aldehyde group is absent or ketone is present (1)  

(iii)  alcohol $\text{C}$ is (CH$_3$)$_2$CHOH  

allow e.c.f. on (c)(i) and (ii) (1)  

(iv)  correct identification of candidate’s ester (W in this case)  

allow e.c.f. on (c)(iii) (1)  

(d)  none  

no chiral centres are present in any of the four esters  

allow e.c.f. on candidate’s compounds in (a) (1)  

[Total: 10]