This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. This shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published Report on the Examination.

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 discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the June 2005 question papers for most IGCSE and GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
Grade thresholds for Syllabus 9701 (Chemistry) in the June 2005 examination.

<table>
<thead>
<tr>
<th>Component 2</th>
<th>maximum mark available</th>
<th>minimum mark required for grade:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.
<table>
<thead>
<tr>
<th>MARK SCHEME</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM MARK: 60</td>
</tr>
<tr>
<td>SYLLABUS/COMPONENT: 9701/02</td>
</tr>
<tr>
<td>CHEMISTRY</td>
</tr>
<tr>
<td>Paper 2 (Structured Questions)</td>
</tr>
</tbody>
</table>
1 (a) same proton no./atomic no./no. of protons (1) 
different mass no./nucleon no./no. of neutrons (1) [2]

(b) 

<table>
<thead>
<tr>
<th>isotope</th>
<th>protons</th>
<th>neutrons</th>
<th>electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{56}\text{Fe}$</td>
<td>26</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>$^{59}\text{Co}$</td>
<td>27</td>
<td>32</td>
<td>27</td>
</tr>
</tbody>
</table>

Give one mark for each correct column.
Allow (1) if no column is correct but one row is correct. [3]

(c) (i) weighted mean/average mass of an atom (not element) (1) 
compared with $^{12}\text{C}$ (1) 
one atom of $^{12}\text{C}$ has a mass of exactly 12 (1) 
[relative to $^{1}/12$ the mass of a $^{12}\text{C}$ atom would get 2]
or

mass of 1 mol of atoms (1) 
compared with $^{12}\text{C}$ (1) 
1 mol of $^{12}\text{C}$ has a mass of 12 g (1)

(ii) $A_r = \frac{54 \times 5.84 + 56 \times 91.68 + 57 \times 2.17}{100}$ (1) 
$= 5573.13 = 55.7$ to 3 sf (1) 
Allow 55.9 if $A_r$ is calculated using 99.69 instead of 100. [5]

[Total: 10]

2 (a) 
1 $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ (1) 
2 $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3 \quad \text{equil}$ (1) equation (1) 
3 $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$ (1) 

Allow sequences that start with $\text{SO}_2$ and include $\text{H}_2\text{S}_2\text{O}_7$ before $\text{H}_2\text{SO}_4$. Equilibrium mark is only scored if $\Rightarrow$ only appears in the $\text{SO}_2/\text{SO}_3$ equation. [4]

(b) vanadium pentoxide/vanadium(V) oxide/$\text{V}_2\text{O}_5$ (1) [1]

(c) (i) $H^\infty_o\text{S}_o^\infty\text{H}$ (1)

(ii) non-linear/bent/V-shaped (1)
(iii) $H_2O$ has hydrogen bonds; $H_2S$ does not or $H_2S$ has van der Waals' forces only
hydrogen bonds are stronger than van der Waals' forces or $H_2S$ has weaker intermolecular bonds than $H_2O$ (1) [4]

(d) (i) $2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$ (1)
from -2 (1) to +4 (1)
allow e.c.f. on equation

(ii) $68.2g$ $H_2S$ react with $3 \times 24$ dm$^3$ $O_2$ (1)
$8.65g$ $H_2S$ react with $3 \times 24 \times 8.65 = 9.13$ dm$^3$ (1)
allow 9.16 dm$^3$ if $H_2S = 68$ is used
allow e.c.f. on (d)(i) [5]

(e) (i) an acid that is partially dissociated into ions (1)

(ii) $H_2S(g) + H_2O(l) \rightarrow H_3O^+(aq) + HS^-(aq)$

or

$H_2S(g) + aq \rightarrow H^+(aq) + HS^-(aq)$

or

$H_2S(aq) \rightarrow H^+(aq) + HS^-(aq)$
equation (1) state symbols (1) [3]

[Total: 17]

3 (a) A MgSO$_4$
B MgCl$_2$
C MgCO$_3$
D MgO
E Mg(OH)$_2$
F Mg(NO$_3$)$_2$

Accept name or formula but penalise when name and formula do not agree (6 x 1) [6]
(b) (i) Mg to cpd A
  \[ \text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2 \]  
  (1)

  cpd C to cpd D
  \[ \text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2 \]  
  (1)

  cpd F to cpd D
  \[ 2\text{Mg(NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2 \]  
  (1) [3]

(ii) Mg(OH)$_2$ → MgO + H$_2$O
  (1) [1]

  [Total: 10]

4 (a) (i) stage I  Cl$_2$/chlorine
  uvl/sunlight
  (1)

  stage II  KCN
  heat in ethanol
  (1)

(ii) stage III  Br$_2$
  uvl/sunlight
  (1) [6]

(b) stage IV  H$_2$SO$_4$(aq)/HCl(aq) or NaOH(aq) followed by H$^+$
  heat/reflux
  (1)

  stage V  NaOH(aq)
  heat
  (1) [4]

(c) (i) a carbon atom in a molecule attached to four different atoms or groups of atoms
  (1)

(ii)

\[
\begin{align*}
\text{Br} & \quad \text{Br/OH} \\
\text{R} - \text{C} - \text{C}:\text{N} & \quad \text{or} \quad \text{R} - \text{C} - \text{C} = \text{O} \\
\text{H} & \quad \text{H} - \text{O} - \text{H}
\end{align*}
\]

  correct cpd correctly displayed
  (1)

  one correct isomer shown as 3D
  (1)

  both isomers shown in
  mirror object/mirror image arrangement
  (1) [4]

  [Total: 13 max]
5 (a) \[ \frac{C: \text{H}: \text{O}}{12} = \frac{66.7}{1} : \frac{11.1}{1} : \frac{22.2}{16} \]

\[ = 5.56 : 11.1 : 1.39 \]

\[ = 4 : 8 : 1 \]

\[ \text{C}_4\text{H}_8\text{O} = 72 \quad \text{molecular formula} = \text{C}_4\text{H}_8\text{O} \]

(b) (i) presence of C=C/alkene/unsaturated (1)

(ii) -OH group (in -\text{CO}_2\text{H} \text{ or } -\text{OH}) present (1) [2]

(c) (i) aldehyde/ketone/carbonyl (1)

(ii) primary alcohol (1) [2]

(d) restricted rotation about a C = C bond (1)

two different groups on each side of C = C (1) [2]

(e) \[
\begin{array}{c}
\text{H} \\
\text{CH}_3
\end{array} \xrightarrow{\text{C=C}} \begin{array}{c}
\text{CH}_2\text{OH} \\
\text{H}
\end{array}
\]

one fully correct structure (1)

two fully correct structures with correctly labelled cis-trans (1)

allow (1) for correctly labelled cis-trans structures that are \( \text{C}_4\text{H}_8\text{O} \) but incorrect [2]

[Total: 10]