This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It 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 6</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>23</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: 40</td>
</tr>
<tr>
<td>SYLLABUS/COMPONENT: 9701/06</td>
</tr>
<tr>
<td>CHEMISTRY Paper 6 (Options)</td>
</tr>
</tbody>
</table>
Biochemistry

1. (a)  
   (i) Carboxylic acid and amino/amine groups (formulae accepted)  
   (1)

   (ii)  
   (1) [2]

(b)  
   (i)  
   (1)

   (ii)  
   (1) [2]

(c)  
   (i) B will form -CO$_2^-$ at high pH  
   D will form -NH$_3$ at low pH  
   (1) (1)

   (ii) B will form e.g. -CO$_2$Ag (other heavy metals inc Hg, Cd, Pb)  
   C will form salts or ‘alcohoates’ e.g. -CH$_2$OAg$^+$  
   D will form complex ions  
   -CH$_2$NH$_2$ $\rightarrow$ Cu$^{2+}$ (or equiv)  
   (1) (1) [6]

[Total: 10]
2 (a) (i) T is present in DNA not RNA (or U present in RNA) (1)

DNA is double helix/RNA usually single strand (1)

(ii) X is deoxyribose (1)

Y is phosphate/phosphorus (1) [4]

(b) Since A is 29%, T must also be 29% (1)

\[ G = C = \frac{(100 - 58)}{2} = 21\% \] (1) [2]

(c) Sequence of 3 bases in m-RNA/triplet code/codon (1)

Corresponds to a particular amino acid (1)

m-RNA is complementary to section of 1 strand of DNA (1)

Base sequence of m-RNA/DNA determines the primary structure (1)

Other codons are for initiation or termination (1)

[4 max]

[Total: 10]
Environmental Chemistry

3 (a) Formation of photochemical smog

Compounds irritate mucous membranes/respiratory system

Photosynthesis is adversely affected

Increases ‘greenhouse effect’

[Any 2]

(b) \[ \text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2 \]

\[ \text{O}_3 \rightarrow \text{O}^\cdot + \text{O}_2 \] 3 eqns => 2 marks

\[ \text{NO}_2 + \text{O}^\cdot \rightarrow \text{NO} + \text{O}_2 \] 2 eqns => 1 mark

NO is regenerated in the third reaction so reaction continues

[3]

(c) (i) \[ \text{O}_3 + \text{H}_2\text{O} \rightarrow \text{O}_2 + 2\text{OH}^\cdot \] (or other sensible eqns)

(ii) NO is used up thus preventing the continued destruction of ozone

OH^\cdot is regenerated so the reaction continues

Some comment about hydrocarbons providing an alternative oxidation pathway without using ozone

(iii) HCHO or NO\(_2\)

[5]

[Total: 10]

4 (a) \[ \text{O}_2 + 4\text{H}^+ + 4e^- = 2\text{H}_2\text{O} \quad E^0 = 1.23 \text{ V} \]

(b) The oxygen concentration is lower

The pH is higher

[2]

(c) (i) Increase in the pH of the soil affects the half-cell reaction

Waterlogging reduces oxygen circulation

(ii) \[ \text{Fe}^{3+} + e^- = \text{Fe}^{2+} \quad E^0 = 0.77 \text{ V} \]

In normal soil the \( E^0 \) drops from 1.23 V to 0.83 V, any further drop takes it below that in the half-equation above

[4]
(d) (i) Extreme reducing conditions produce hydrogen sulphide

\[ \text{SO}_4^{2-} + 10\text{H}^+ + 8e^- = \text{H}_2\text{S} + 4\text{H}_2\text{O} \]

(ii) Hydrogen sulphide will gradually kill plants as it reacts with iron

[Total: 10]

Phase Equilibria

5 (a) (i) The mass of gas which dissolves in a given volume of solvent at a particular temperature, is proportional to the pressure of the gas

(ii) 24 dm\(^3\) of oxygen weighs 32 g

Hence 0.2 dm\(^3\) of oxygen weighs \(\frac{0.2 \times 32}{24} = 0.267\) g

(iii) Volume of oxygen = \(0.031 \times 10^3 = 31\) cm\(^3\)

Thus the mass of oxygen = \(\frac{31 \times 32}{24000} = 0.041(3)\) g

(b) Henry’s Law only holds at a given temp and when the same (molecular) species are present in both gas and liquid phases

The blood will not be at the same temperature as the atmosphere

In blood the oxygen is present as O\(_2^-\) haemoglobin complex

CO\(_2\) reacts with blood

[Total: 4]

(c) (i) Mass of O\(_2\) = \(5 \times 5 \times 0.0413 = 1.03\) g

(ii) Oxygen will not form bubbles as it combines with haemoglobin,

hence the gas is nitrogen

CO\(_2\) reacts with blood/forms H\(_2\)CO\(_3\)/forms H\(^+\) and HCO\(_3^-\)

[Total: 4]
6  (a)  

Axes (1)  
Points and lines (1)  
Labels of 3 areas (1)  

(b)  
(i)  140 °C/eutectic temperature  
(ii) 41% Cd (eutectic)  

(c)  The liquid is 66 ± 2% Cd  
Hence the composition by mass is Bi 40g and Cd 80g  
The solid is cadmium, and there is 80 g of it  

(d)  Two valid explanations e.g.  
The metals have different atomic radii  
Different electronic arrangement giving different colour  
The lattice structure of the alloy is different/disrupted  

[Total: 10]
Spectroscopy

7  (a) Addition of ligands causes splitting of d-orbitals
   Electron(s) are promoted from lower to higher energy orbitals
   Energy is absorbed
   This is in the visible region

   (b) Green/turquoise/cyan

   Minimum energy absorbed is at 400 nm and above 600 nm
   (Accept in blue and red parts of spectrum)
   or colour is compliment of energy absorbed

   (c) (i)  $n \rightarrow \sigma^*$
   (ii)  $\pi \rightarrow \pi^*$
   (iii) $\pi \rightarrow \pi^*$, $n \rightarrow \sigma^*$, $n \rightarrow \pi^*$  $3 \rightarrow 2, 2 \rightarrow 1, 1 \rightarrow 0$

[Total: 10]
From mass spectrum

8  \( M_r \) of \( Y \) is 210
    \[ M : M + 1 = 0.65 : 0.11 \]

No of carbons present = \( 0.11 \times 100 = 15 \)
\[
\frac{0.65 \times 1.1}{1.1}
\] (1)

From nmr spectrum

There are only two types of proton present (1)
Since \( M_r \) of \( Y \) is 210, this suggests \( C_{15}H_{14}O \) (1)
Absorption at 7.2 \( \delta \) suggests \( C_6H_5^- \) groups  (1)
This leaves -CH\(_2\) groups (1)
C=O is central/between CH\(_2\) groups (1)

From ir spectrum

Strong absorption at 1720 cm\(^{-1}\) suggests C=O (1)
There is no characteristic -OH absorption (1)
There is no characteristic -C-O absorption (1)
\( Y \) is likely to be

Additional possible marks from mass spectrum

\[ 91 - \]
(1)

\[ 119 - \]
(1)

\[ 28 - \]
\( \text{C} = \text{O} \)
(1)

[Total: max 10]
Transition Elements

9 (a) occurs as cobalamine/vitamin B$_{12}$

which is needed to prevent pernicious anaemia
or used to synthesise amino acids or carbon-carbon bonds etc. (1) [2]

(b) (i) $E^\circ$ for Co$^{3+}$/Co$^{2+}$ is +1.82V
$E^\circ$ for O$_2$/OH$^-$ is -0.40V (1)

O$_2$ is not strong enough to oxidise Co$^{2+}$(aq), but is more positive than
$E^\circ$([Co(NH$_3$)$_6$]$^{3+}$/[Co(NH$_3$)$_6$]$^{2+}$), so oxidation occurs. (1)

(ii) $E^\circ$ for Co$^{3+}$/Co$^{2+}$ is +1.82V
$E^\circ$ for Cr$_2$O$_7^{2-}$/Cr$^{3+}$ is +1.33V (1)

so oxidation from green (Cr$^{3+}$) to orange (Cr$_2$O$_7^{2-}$) will occur

6Co$^{3+}$ + 2Cr$^{3+}$ + 7H$_2$O $\rightarrow$ 6Co$^{2+}$ + Cr$_2$O$_7^{2-}$ + 14H$^+$ (1) [5]

(c) To make stainless steel/chromium plating/nichrome wire (1) [1]

d) (NH$_4$)$_2$Cr$_2$O$_7$ $\rightarrow$ N$_2$ + 4H$_2$O + Cr$_2$O$_3$

gases are N$_2$ + steam (1) [2]

[Total: 10]

10 (a) both zinc and copper dissolve at the anode:

Cu - 2e$^-$ $\rightarrow$ Cu$^{2+}$(aq)
Zn - 2e$^-$ $\rightarrow$ Zn$^{2+}$(aq) (both) (1)

copper is preferentially discharged at the cathode
or Cu$^{2+}$ + 2e$^-$ $\rightarrow$ Cu(s) (1)

$E^\circ$(Cu$^{2+}$/Cu) = +0.34V
$E^\circ$(Zn$^{2+}$/Zn) = -0.76V
hence zinc remains in solution (1) [4]

(b) aldehydes reduce Cu(II) to Cu(I) not Cu (1)

RCHO + 2Cu$^{2+}$ + 5OH$^-$ $\rightarrow$ RCO$_2$- + Cu$_2$O + 3H$_2$O (1)
or 2Cu$^{2+}$ + 2OH$^-$ + 2e$^-$ $\rightarrow$ Cu$_2$O + H$_2$O

Cu$_2$O forms a (brick) red ppt. (1) [3]
(c)  

(i) \( CuI = 63.5 + 127 = 190.5 \)

\[
\text{moles CuI} = \frac{1.16}{190.5} = 0.00609 \\
\text{mass of Cu} = 0.00609 \times 63.5 = 0.3867\text{g} \\
\text{% of Cu} = 100 \times \frac{0.3867}{0.5} = 77.3\%
\]

(ii) zinc

[Total: 10]