UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the June 2005 question paper

9701 CHEMISTRY

9701/06 **Paper 6 (Options), maximum raw mark 40**

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*.

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Grade thresholds for Syllabus 9701 (Chemistry) in the June 2005 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 6	40	23	20	11

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.

June 2005

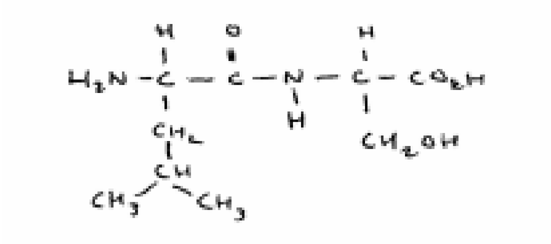
GCE A LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9701/06 **CHEMISTRY** **Paper 6 (Options)**

Biochemistry

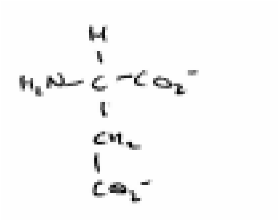
1 **(a)** **(i)** Carboxylic acid and amino/amine groups (formulae accepted) **(1)**

(ii)



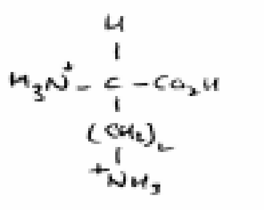
(1) **[2]**

(b) **(i)**



(1)

(ii)



(1) **[2]**

(c) **(i)** **B** will form -CO_2^- at high pH **(1)**
D will form -NH_3 at low pH **(1)**

(ii) **B** will form e.g. -CO_2Ag (other heavy metals inc Hg, Cd, Pb) **(1)**

C will form salts or 'alcohoates' e.g. -$CH_2O^-Ag^+$ **(1)**

D will form complex ions **(1)**

-$CH_2NH_2 \rightarrow Cu^{2+}$ (or equiv) **(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 DNA1 **(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 **(1)**

Compounds irritate mucous membranes/respiratory system **(1)**

Photosynthesis is adversely affected **(1)**

Increases 'greenhouse effect' **(1)**
[Any 2]

(b) $NO + O_3 \rightarrow NO_2 + O_2$

$O_3 \rightarrow O\bullet + O_2$

$NO_2 + O\bullet \rightarrow NO + O_2$

3 eqns => 2 marks
2 eqns => 1 mark **(2)**

NO is regenerated in the third reaction so reaction continues **(1)** **[3]**

(c) **(i)** $O_3 + H_2O \rightarrow O_2 + 2OH\bullet$ (or other sensible eqns) **(1)**

(ii) NO is used up thus preventing the continued destruction of ozone **(1)**

OH• is regenerated so the reaction continues **(1)**

Some comment about hydrocarbons providing an alternative oxidation pathway without using ozone **(1)**

(iii) HCHO or NO_2 **(1)** **[5]**

[Total: 10]

4 **(a)** $O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$ $E^\ominus = 1.23$ V **(1)** **[1]**

(b) The oxygen concentration is lower **(1)**

The pH is higher **(1)** **[2]**

(c) **(i)** Increase in the pH of the soil affects the half-cell reaction **(1)**

Waterlogging reduces oxygen circulation **(1)**

(ii) $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ $E^\ominus = 0.77$ V **(1)**

In normal soil the $E^\ominus$ drops from 1.23 V to 0.83 V, any further drop takes it below that in the half-equation above **(1)** **[4]**

(d) (i) Extreme reducing conditions produce hydrogen sulphide (1)

$SO_4^{2-} + 10H^+ + 8e^- \rightleftharpoons H_2S + 4H_2O$ (1)

(ii) Hydrogen sulphide will gradually kill plants as it reacts with iron (1) [3]

[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 (1)

(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 (1)

(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 (1) [3]

(b) Henry's Law only holds at a given temp and when the same (molecular) species are present in both gas and liquid phases (1)

The blood will not be at the same temperature as the atmosphere (1)

In blood the oxygen is present as O_2- haemoglobin complex (1)

CO_2 reacts with blood (1) [4]

(c) (i) Mass of O_2 = 5 x 5 x 0.0413 = 1.03 g (1)

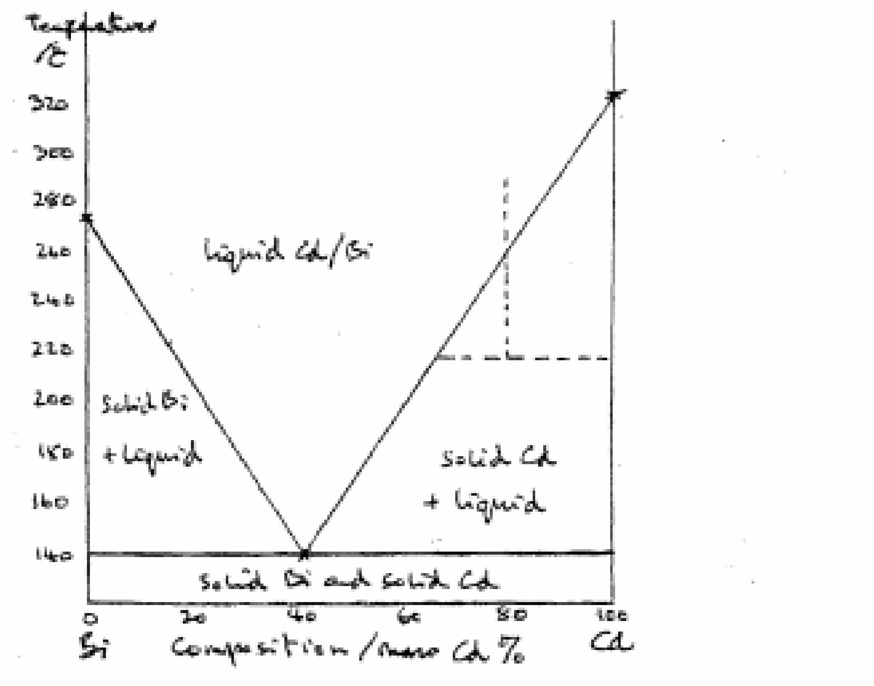
(ii) Oxygen will not form bubbles as it combines with haemoglobin, (1)

hence the gas is nitrogen (1)

CO_2 reacts with blood/forms H_2CO_3/forms H^+ and HCO_3^- (1) [4]

[Total: 10]

6 **(a)**



axes (1)
points and lines (1)
labels of 3 areas (1)

[3]

(b) **(i)** 140 °C/eutectic temperature **(1)**

(ii) 41% Cd (eutectic) **(1)** **[2]**

(c) The liquid is 66 ± 2% Cd **(1)**
Hence the composition by mass is Bi 40g and Cd 80g **(1)**
The solid is cadmium, and there is 80 g of it **(1)** **[3]**

(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 **2 x (1)** **[2]**

[Total: 10]

Spectroscopy

7 (a) Addition of ligands causes splitting of d-orbitals **(1)**

Electron(s) are promoted from lower to higher energy orbitals **(1)**

Energy is absorbed **(1)**

This is in the visible region **(1) [4]**

(b) Green/turquoise/cyan **(1)**

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

<u>or</u> colour is compliment of energy absorbed **(1) [2]**

(c) (i) $n \rightarrow \sigma^*$ **(1)**

(ii) $\pi \rightarrow \pi^*$ **(1)**

(iii) $\pi \rightarrow \pi^*$, $n \rightarrow \sigma^*$, $n \rightarrow \pi^*$ $3 \rightarrow 2$, $2 \rightarrow 1$, $1 \rightarrow 0$ **(2) [4]**

[Total: 10]

From mass spectrum

8 M_r of **Y** is 210
M : M + 1 = 0.65 : 0.11

No of carbons present = $0.11 \times \frac{100}{0.65 \times 1.1} = 15$ **(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 δ suggests C_6H_5- groups **(1)**

This leaves $-CH_2-$ groups **(1)**

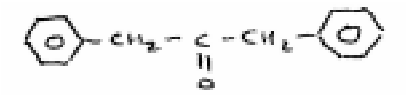
C=O is central/between CH_2 groups **(1)**

From ir spectrum

Strong absorption at 1720 cm^{-1} suggests C=O **(1)**

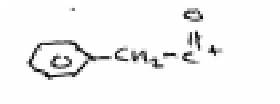
There is no characteristic -OH absorption **(1)**

There is no characteristic -C-O absorption **(1)**

Y is likely to be  **(1)**

Additional possible marks from mass spectrum

91 -  **(1)**

119 -  **(1)**

28 - $C^+ = O$ **(1)**

[Total: max 10]

Transition Elements

9 **(a)** occurs as cobalamine/vitamin B_{12} **(1)**

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

(b) **(i)** $E^{\ominus}$ for Co^{3+}/Co^{2+} is + 1.82V
$E^{\ominus}$ for O_2/OH^- is -0.40V **(1)**

O_2 is not strong enough to oxidise Co^{2+}(aq), but is more positive than $E^{o}([Co(NH_3)_6]^{3+}/[Co(NH_3)_6]^{2+})$, so oxidation occurs. **(1)**

(ii) $E^{\ominus}$ for Co^{3+}/Co^{2+} is + 1.82V
$E^{\ominus}$ for $Cr_2O_7^{2-}/Cr^{3+}$ is + 1.33V **(1)**

so **oxidation** from **green** (Cr^{3+}) to **orange** ($Cr_2O_7^{2-}$) will occur **(1)**
$6Co^{3+} + 2Cr^{3+} + 7H_2O \longrightarrow 6Co^{2+} + Cr_2O_7^{2-} + 14H^+$ **(1)** **[5]**

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

(d) $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + 4H_2O + Cr_2O_3$ **(1)**

gases are N_2 + steam **(1)** **[2]**

[Total: 10]

10 **(a)** both zinc and copper dissolve at the anode: **(1)**

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

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

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

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

$RCHO + 2Cu^{2+} + 5OH^- \longrightarrow RCO_2^- + Cu_2O + 3H_2O$ **(1)**
or $2Cu^{2+} + 2OH^- + 2e^- \longrightarrow Cu_2O + H_2O$

Cu_2O forms a (brick) red ppt. **(1)** **[3]**

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

moles CuI = 1.16/190.5 = 0.00609 (1)

mass of Cu = 0.00609 x 63.5 = 0.3867g

% of Cu = 100 x 0.3867/0.5 = 77.3% (1)

(ii) zinc (1) [3]

[Total: 10]