CAMBRIDGE
INTERNATIONAL EXAMINATIONS

**JUNE 2002**

**GCE Advanced Level**

# MARK SCHEME

## MAXIMUM MARK : 40

## SYLLABUS/COMPONENT :9701 /6

## CHEMISTRY
## (OPTIONS (A2))

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

**Biochemistry**

1. **(a)** The three-dimensional shape / how structure folds or coils (1)

contains α-helix (1)
[2]

**(b)** – OH hydrogen bonding (1)
or any polar group

$-CO_2^-$ or $-NH_3^+$ ionic/electrostatic bonding (1)
[2]

if no groups identified, 2 types of bonding score (1)

**(c)** **(i)** Ionic / acid-base / electrostatic (1)

forms salts or complex ions e.g. $-CO_2^- Ag^+$ (1)

**OR** disulphide links (1)

$-CH_2 - S - Ag^+$ (1)

**(ii)** Heat breaks the weakest bond first (1)

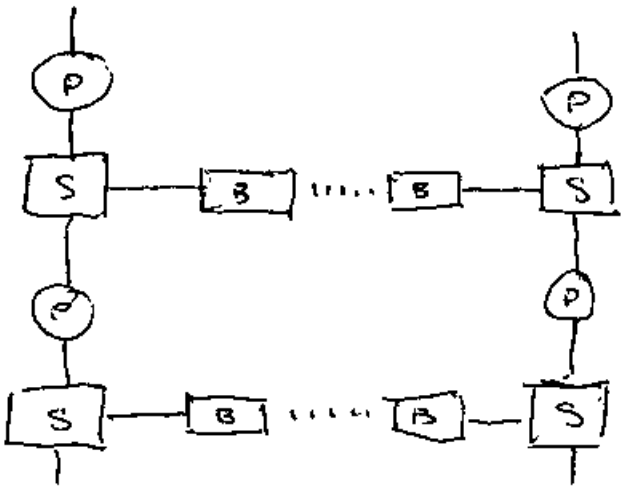
van der Waals' or hydrogen bonds (1)

**(iii)** Addition of $H^+$ or $OH^-$ breaks polar bonds / protonation - deprotonation (1)

ionic **OR** hydrogen bonds

**OR** $-CO_2^- + H^+ \Rightarrow -CO_2H$ (1)
[6]

2. (a)




All low specific bases NOT wtte a1

P, S, B identified (1)

Shape (1)

AT / CG (1)

On example

H-bonds shown (1)

check in (b)

[4]

(b) DNA is the repository of genetic information (1)

It can replicate itself (1)

It contains a triplet code of bases (1)

It unwinds to give a single strand which acts as a template (1)

This forms m-RNA (1)

t-RNA translates the code into a sequence of amino acid (1)

and brings each amino acid in turn (1)

[max 6]

**Environmental Chemistry**

3. **(a)** $SO_2$ bond vibrations absorb in the IR region (1)

There is a change in dipole moment (1)

This process absorbs energy which would be re-radiated as heat back to the Earth's surface (1)

(could be on a diagram)

**(b)** $SO_2$ is easily oxidised to $SO_3$ (1)

This dissolves in water to form sulphate ions (1)

} allow equations

Oxidising agents include $O_2$, $O_3$, $NO_2$ (one only) (1)

**(c)** $SO_2 + H_2O \Rightarrow H_2SO_3$ <~ $H^+ + HSO_3^-$ only scores (1)

$SO_2$ is first oxidised to $SO_3$ (1)

Then this dissolves : $SO_3 + H_2O \Rightarrow H_2SO_4$ (1)

**(d)** Powdered coal and limestone are fluidised by forcing gas through them (1)

On burning, the $SO_2$ is released and reacts with the limestone (1)

$SO_2(g) + CaCO_3(s) \Rightarrow CO_2(g) + CaSO_3(s)$ (1)

[max 10]

4. **(a)** Rain water containing $CO_2$ attacks the limestone (1)

This forms calcium hydrogencarbonate causing the rock to dissolve (1)

Raised temperature or alkaline conditions cause $HCO_3^-$ to precipitate as $CO_3^{2-}$ / low $[CO_2]$ shifts eqbn to left (1)

$CaCO_3 + H_2O + CO_2 \iff Ca(HCO_3)_2$ (1)

or with $Ca^{2+}$ ions [4]

**(b)** **(i)** Root respiration releases carbon dioxide

OR hydrogen ions occupy exchange sites released by the removal of nutrients by the growing plant. (1)

$CO_3^{2-}$ reacts with $H^+$ ions

**(ii)** The calcium ions from the liming displace hydrogen ions from the exchange sites. (1)

This provides long term protection by inhibiting the subsequent retention of hydrogen ions at the exchange sites

OR by being able to release the calcium ions as carbonate to neutralise the soil solution. (1)

**(iii)** Prevents the development of reducing conditions in the soil (1)

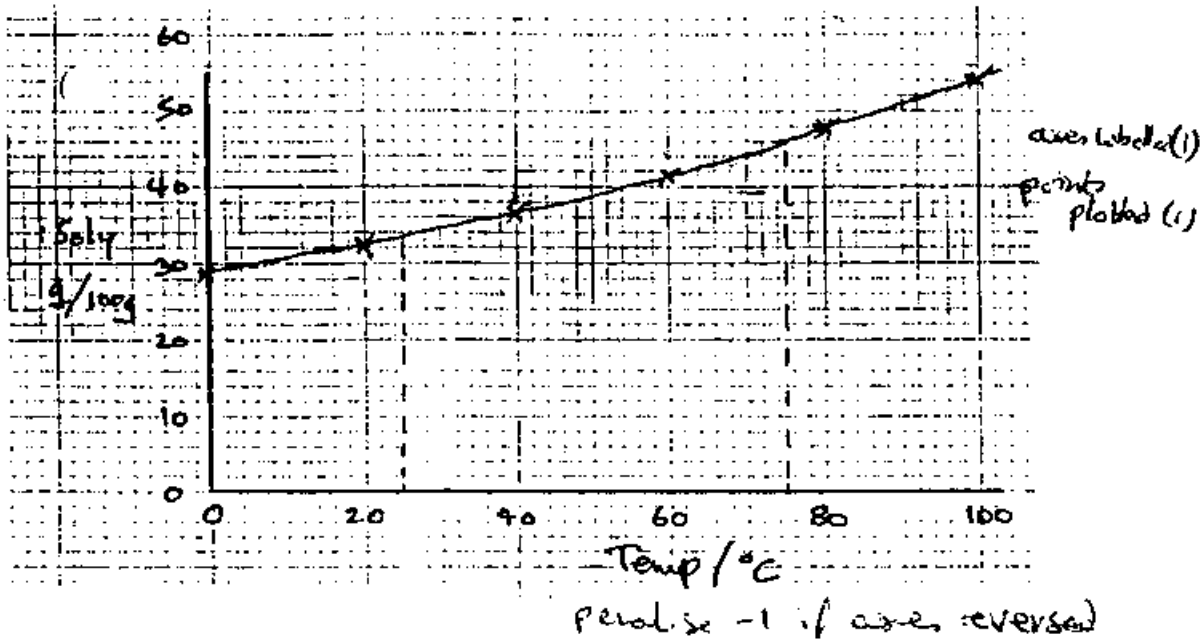
Reduces the risk of ion deficiencies : by precipitation (1)

Leads to / hinders processes which result in the breakdown of clay structures (1) [6]

Low pH causes waterlogging of clay soils

**Phase Equilibria**

**5.** **(a)** **(i)**




**(ii)** 75 °C – 45g ± 1·9 g; 25 °C – 33g ± 1g (1)

[3]

**(b)** **(i)** Crystallisation / crystals separate (1)

Allow solid or ppte

**(ii)** From **(a)(ii)** 12g of KCl separate from the solutions in 100g water (mark consequentially) (1)

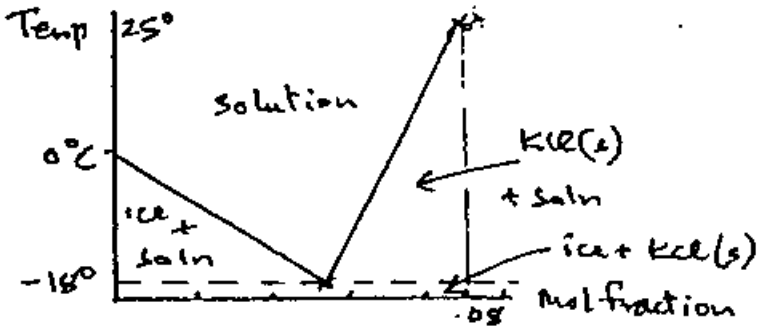
[2]

**(c)** Mole fraction is $\frac{KCl}{H_2O} = \frac{33/74.5}{100/18}$ (1) = 0.08 (1)

[2]

Strictly should be 0·074, allow either for 2 only give part marks if 2 not scored.

**(d)**



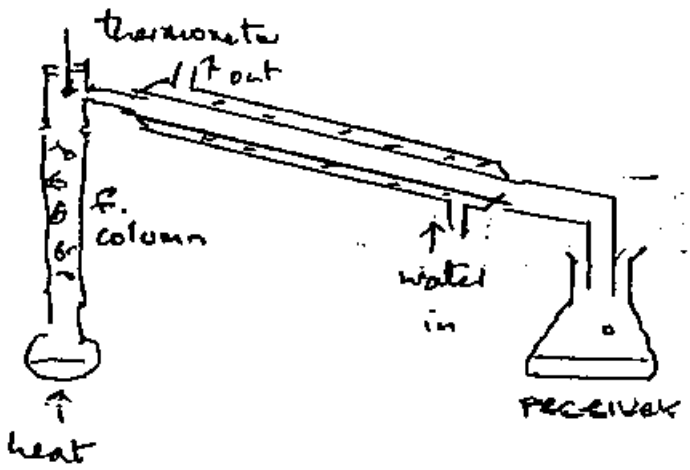

Sketch (1)

3 points (1)

Areas (1)

[3]

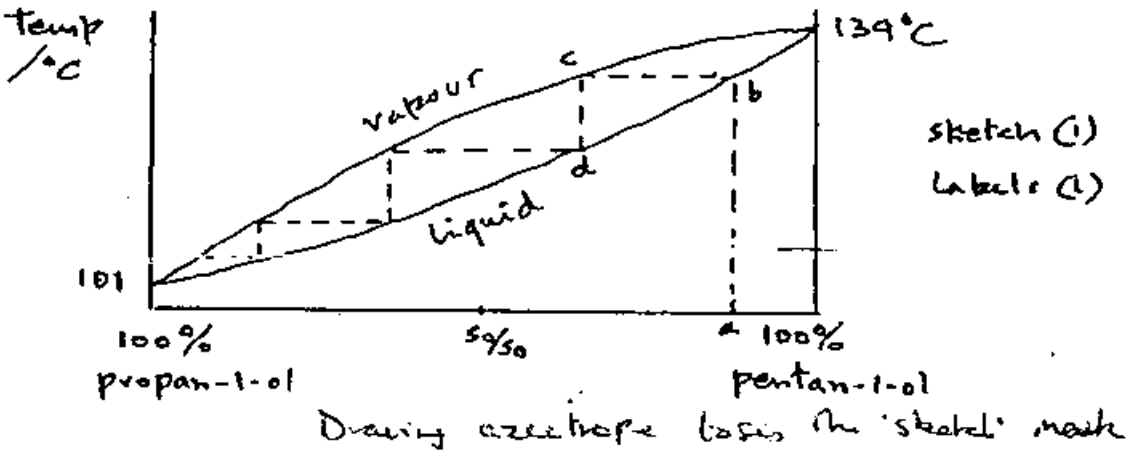
6. (a)




fractionating column + thermometer (1)
Direction of water flow (1)

[2]

(b)




sketch (1)
labels (1)

Drawing azeotrope loses the 'sketch' mark

Liquid **(a)** boils **(b)** giving a vapour richer in the more volatile component (1)

This condenses to liquid **(d)** in the fractionating column (1)

Each horizontal line represents a 'theoretical plate' (1)
a tie line or step
[5]

(c) Propan-1-ol and water have similar intermolecular forces
**OR** both form hydrogen bonds (1)

The larger hydrophobic $C_5H_{12}$ of the pentan-1-ol prevents miscibility (1)

Intermolecular forces pentan-1-ol – pentan-1-ol and water – water are stronger than pentan-1-ol – water. (1)
[3]

**Spectroscopy**

7. **(a)** Make a mull with hydrocarbon / Nujol (1)

Place between NaCl / KBr plates (1)

**OR** Grind up with KBr (1)

Compress under vacuum (1)

**OR** Dissolve in solvent (1)

Use double beam spectrometer with solvent blank (1)
[2 x 2]

**(b)** **(i)** Aspirin : -OH, C=O, C—O,  (1)

Paracetamol : -OH, C=O, C—O,  -N-H (1)

**(ii)** -N—H is the only difference, at 3100-3600 $cm^{-1}$ (1)
[3]

**(c)** Nmr absorptions depend upon the proton environment (1)

Aspirin has , protons in 3 (4) environments (1)

Paracetamol has protons in 4 (5) environments (1)
[3] May

Aspirin → 8 protons, paracetamol 9 protons (1)

**8.** **(a)** **(i)** $^{13}C$ which gives the M+1 peak (1)

**(ii)** Chlorine **OR** bromine (1)

$^{35}Cl$ and $^{37}Cl$, **OR** $^{79}Br$ and $^{81}Br$ (1)
**[3]**

**(b)** Ratio M : M+1 is 100 : 4.4 (1)

No. of carbons, $n = \frac{4.4 \times 100}{100 \times 1.1} = 4$ (1)

Allow any correct logic - calculation not essential **[2]**

**(c)** $M_r$ of **F** is 72, hence peak at 57 is (M – 15) loss of $CH_3$ (1)

Peak at 57 is $^+CH_2CH_2CHO$ allow $C_3H_5O$ (1)

Peak at 29 is $CH_3CH_2^+$ allow $C_2H_5$ or $CHO$ (1)
Do NOT insist on charge **[3]**

**(d)** $M_r$ of **F** is 72, hence peak at 44 is (M – 28)

The alkene is therefore $C_2H_4$ (1)

Thus the peak at 44 is caused by a $C_2H_4O$ fragment (1)

**[3]**

**Transition Elements**

**9.** **(a)** Ligands possess pairs of electrons / negative charge (1)

The orbitals pointing towards the ligands are higher in energy (1)
**[2]**

**(b)** **(i)** $[Ar]3d^7$ (1)

**(ii)** Paramagnetic, since it contains (at least) one unpaired electron (1)
allow partially filled orbitals **[2]**

(c) (i) Co : 25.2/58.9 = 0.428 => 1
N : 24/14.0 = 1.714 => 4
H : 5.1/1.0 = 5.10 => 12
Cl : 45.6/35/5 = 1.29 => 3 (1)

Empirical formula = $CoN_4H_{12}Cl_3$ (1)

Likely ligands = 4 x $NH_3$ and 2 x Cl (1)
From AgCl data one $Cl^-$ is not a ligand (1)

(ii) Oxidation number of cobalt = +3 (1)

(iii) (1)

Diagram of *cis* form (1)

Diagram of *trans* form (1)
[max 6]

Names not required by structure
must be shown as 3-D.

10. (a) (i) Iron is oxidised to $Fe^{2+}$ / Fe -- $2e^-$ => $Fe^{2+}$ (1)

Electrons add to oxygen / $2H_2O + O_2 + 4e^- \Rightarrow 4OH^-$ (1)

The ions combine $Fe^{2+} + 2OH^- \Rightarrow Fe(OH)_2$ (1)

Further oxidation occurs / $2Fe(OH)_2 + \frac{1}{2}O_2 + H_2O \Rightarrow 2Fe(OH)_3$ (1)
to $Fe^{3+}$

(ii) Magnesium has a more negative $E^\ominus$ than iron

**OR** $E^\ominus$ (Mg) = -2.38 V (1)

So it is preferentially oxidised (1)
[6]

(b) (i) $S_2O_8^{2-} + 2I^- \Rightarrow 2SO_4^{2-} + I_2$ (1)

(ii) $Fe^{3+}$ is a homogeneous catalyst (1)

$E^\ominus$ of +0.77 is lower than for $S_2O_8^{2-}$/ $SO_4^{2-}$ but higher than for $I_2/I^-$ (1)

$2I^- + 2Fe^{3+} \Rightarrow I_2 + 2Fe^{2+}$ (1)

$S_2O_8^{2-} + 2Fe^{2+} \Rightarrow 2SO_4^{2-} + 2Fe^{3+}$ (1)
[4]