CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/06

CHEMISTRY
Options

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Biochemistry

1 (a) Enzymes (1)
globular proteins (1) **[2]**

(b) (i) Monasaccharides/simple sugars/glucose (1)

(ii) Glycerol and fatty (or carboxylic) acids/carboxylates – both needed (1)

(iii) Amino acids (1)

(iv) Deoxyribose/ribose, bases/ nucleotides, phosphate (1) **[4]**

(c) CH_2OH–$CHOH$–CH_2OH $CH_3(CH_2)_nCO_2H$ or RCO_2H 2x(1)

Need to show $-C(=O)OH$ once in either fatty acid or amino acid

$H_2NCHRCO_2H$ (or the zwitterions) (1)

NOT $CO_2 + H_2O$

Mark consequentially on **(b)(ii)** and **(b)(iii)** **[3]**

(d) Hydrolysis (1)

NOT Hydration

2 (a) UCAG are bases (1)
found in m-RNA (1)

Phe, Leu etc. are amino acids (1)

Sequence of amino acids determines the protein/peptide (1)

This is called the 'triplet code'/codon (1)

Three bases correspond to one amino acid or 4^3 argument (1)

Hence sequence of bases in nucleic acid determines the sequence of amino acids in the protein/transcription takes place (1)

The chief role of DNA/RNA/nucleic acids is in protein synthesis (1)

Code is not unique/more than one base sequence for given amino acid (1) **[max 8]**

(b) Instructions to start a protein molecule (1)

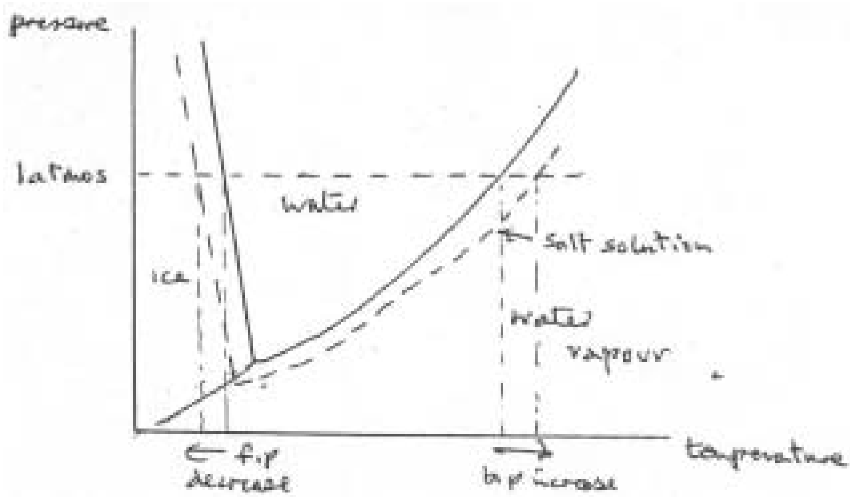
Instructions to end the molecule (1) **[2]**

Environmental Chemistry

3	**(a)**	**(i)**	2:1 clay with two layers of silicate and one of aluminium oxide.	(1)	
			Units held by water to adjacent silicate units/lamellae by hydrogen bonding	(1)	
		(ii)	<u>Regular</u> substitution of Al for Si has occurred within the silicate layers	(1)	
			This leads to cation deficiency	(1)	
			which is balanced by the presence of K^+ on the surface of the clay.	(1)	**[5]**
	(b)	**(i)**	Ammonium and potassium ions are held firmly at the surface of the soil as a result of ion substitution within the clay OR the presence of surface oxides in silicate structures OR the presence of humus.	(1)	
		(ii)	$SO_2 + NO_2 + H_2O \rightarrow H_2SO_4 + NO$ Allow two equations $\left.\begin{array}{l} SO_2 + H_2O \rightarrow H_2SO_3 \\ 2NO_2 + H_2O \rightarrow HNO_2 + HNO_3 \end{array}\right\}$ both needed	(1)	
		(iii)	Hydrogen ions can also be held at exchange sites	(1)	
			and in high enough concentration	(1)	
			will displace the other cations from the surface can then be washed away.	(1) (1)	**[max 5]**
4	**(a)**	**(i)**	Temperature much be high enough for efficient combustion	(1)	
			If chlorinated waste is present when dioxins may form	(1)	
			Temperature must be > 800°C to destroy them	(1)	
		(ii)	Organic matter may be suspended in the water	(1)	
			Al^{3+}(aq) precipitates as the hydroxide settling the organic matter	(1)	
			which must be removed otherwise toxic chlorinated organic matter may form	(1)	**[6]**
	(b)	**(i)**	Phosphates are added to soften hard water	(1)	
			by forming complexes with calcium and magnesium ions	(1)	
		(ii)	Excess phosphate released into waterways encourages growth of algae	(1)	
			Eutrophication can then occur	(1)	
			Increases BOD	(1)	
				[max 2]	**[4]**

Phase Equilibria

5 (a)



Axes labeled and sketch (1)
areas labeled (1)

Slope of ice/water line is atypical (1)
since the solid (ice) is less dense than water/floats on water (1)

High pressure favours a smaller volume of liquid (1) **[max 4]**

(b) 1 atmosphere (or other labeled pressure) line drawn (1)

Salt solution line drawn (1)

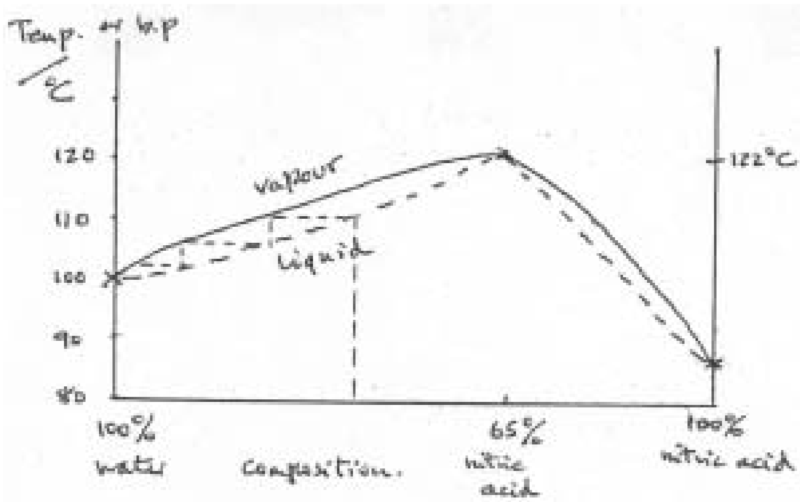
F.p. decrease **and** b.p. increase (1)
lines drawn on diagram (1) **[4]**

(c) At any temperature vapour pressure of water is greater than salt soln (1)

Rate of evaporation is proportional to vapour pressure (1)

Ions attract water molecules making evaporation more difficult. (1) **[max 2]**

6 (a)



Sketch, (1)
two labels, (1)
three points (1)
axes labeled (1) **[4]**

(b) **(i)** Pure water (1)

(ii) Azeotrope (or 65% nitric acid) (1)

lines on graph (1)

This may be consequential on **(a)** if candidates vertical line is wrong **[3]**

(c) **(i)** $V = n_A p_A$ etc (or in words) (allow proportionality) (1)

(ii) Any 2 of:
Nitric acid and water react/attract each other more strongly than molecules of each/mixing is exothermic (1)

Show negative deviation from Raoult's law (1)

$HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$ OR (1)
(or equivalent) **[3]**

Spectroscopy

7 **(a)** **(i)** Protons possess nuclear spin (1)

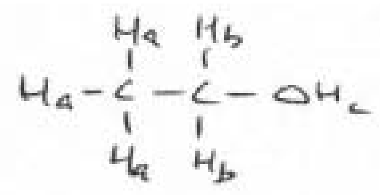
This generates a magnetic moment (1)

This moment can align with or against an external magnetic field (1)

This gives two energy (1)

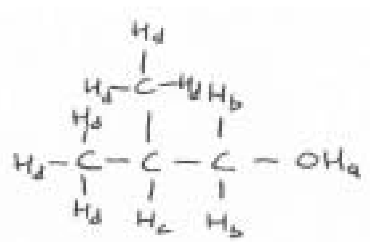
(ii) External magnetic field may be modified by moments from other protons in the molecule (1)

Example from ethanol e.g. comment on 1 : 2 : 1 splitting pattern (1)



[6]

(b)



Correct displayed formula (1)

3, 2 1 for each correct proton (since if 3 are right, 4 must be!) (3) **[4]**

8 **(a)** I.r. peak at 1720 cm^{-1} suggests C=O (1)

	%	%/A_r	Ratio		
C	66.7	5.55	4		
H	11.1	11.1	8		
O	22.2	1.4	1	gives C_4H_8O	(1)

M peak is at 72 hence molecular formula is C_4H_8O (1)

Mass spectrum peat at 57 is (M-CH_3) or $C_2H_5CO^+$ (1)
Mass spectrum peak at 43 could be (M-CHO or M-C_2H_5) or $C_3H_7^+$ or CH_3CO (1)

E is $CH_3CH_2COCH^3$ **or** $CH_3CH_2CH_2CHO$ (1) **[max 5]**

(b) **(i)** Non-invasive (1)

Flesh is transparent to radio waves (1)

Low energy/no tissue damage (1)

May be 'tuned' to particular protons/types of tissue (1) **[max 3]**

(ii) Standards are prepared (1)

Calibration graph produced (1)

Sample diluted (1)

Concentration read from calibration graph (1) **[max 3]**
[max 5 for (b)]

Transition Elements

9 **(a)** Colour is due to the absorption of visible light (1)

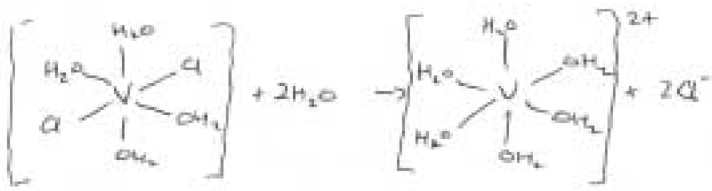
Atom needs vacancy(ies) in the d-orbitals (1)

The d-orbitals are split into two energy levels by ligands (1)

Energy is used to promote electrons from lower to upper d-orbitals OR Energy gap in non-transition metals does not lie in visible range (1) **[max3]**

(b) Ligand exchange between chloride and water occurs

OR



Green Violet (1)

d-orbital energy gap with Cl^- ligands is different to that with H_2O ligands (1) **[2]**

	(c)		V(III) is V^{3+} (or $[V(H_2O)_6]^{3+}$) and is green	(1)	
			V(IV) is VO^{2+}(aq) and is blue NOT V^{4+}	(1)	**[2]**
	(d)	**(i)**	MnO_4^-/Mn^{2+} is +1,52V, higher than VO_2^+/VO^{2+} so final state is 5	(1)	
		(ii)	moles of e^- = 0.02 x 5 x 20/1000 = 0.002	(1)	
			Hence 2 moles of electrons are used per mole of vanadium Change is from V(III) to V(V)		
		(iii)	x is 1, hence $VOCl$	(1)	**[3]**
10	**(a)**		Stainless steel, with iron (+ example use) Brass, with zinc (+ example use) Accept also bronze (Cu + Sn), duralumin (Cu+Al), cupronickel (Cu+Ni) nicrome (Ni+Cr)	(1) (1)	
			NB two correct pairs of metals scores (1) **OR** two correct alloys and uses scores (1)		**[2]**
	(b)	**(i)**	$Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$	(1)	
			$CrO_4^{2-} \xrightarrow{Ba^{2+}} BaCrO_4(s)$ yellow	(1)	
			Equilibrium shifts to the right as CrO_4^{2-} ions are removed and hence the solution becomes more acidic	(1)	
		(ii)	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ (i.e. ammonia solution contains OH^- ions)	(1)	
			$CU^{2+} + 2OH^- + Cu(OH)_2$ (pale blue ppte)	(1)	
			Then $4NH_3 + Cu^{2+}(aq) = [Cu(NH_3)_4]^{2+}$ (deep blue solution)	(1)	
			NH_3 is a stronger ligand than H_2O and displaces it	(1)	
		(iii)	violet – $[Cr(H_2O)_6]^{3+}\ 3Cl^-$	(1)	
			green – $[Cr(H_2O)_5\ Cl^-]^{2+}\ 2Cl^-.H_2O$	(1)	**[max 8]**