

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/06

CHEMISTRY
Options



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Biochemistry

- 1 (a) Enzymes (1)
 globular proteins (1) **[2]**
- (b) (i) Monosaccharides/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) $\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CHOH} \\ | \\ \text{CH}_2\text{OH} \end{array}$ $\text{CH}_3(\text{CH}_2)_n\text{CO}_2\text{H}$ or RCO_2H 2x(1)
 Need to show $\begin{array}{c} \text{O} \\ || \\ \text{C} \\ | \\ \text{OH} \end{array}$ once in either fatty acid or amino acid
 $\text{H}_2\text{NCHRCO}_2\text{H}$ (or the zwitterions) (1)
 NOT $\text{CO}_2 + \text{H}_2\text{O}$
 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]**

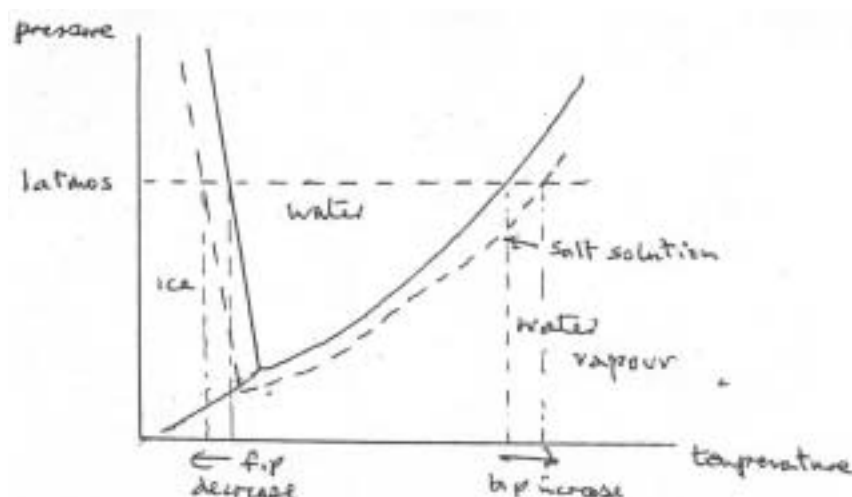
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Environmental Chemistry

- 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)** Regular 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)** $\text{SO}_2 + \text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + \text{NO}$ (1)
Allow two equations
 $\left. \begin{array}{l} \text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3 \\ 2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_2 + \text{HNO}_3 \end{array} \right\} \text{both needed}$
- (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 (1)
can then be washed away. (1) **[max 5]**
- 4 (a) (i)** Temperature must 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)
- Al³⁺(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)

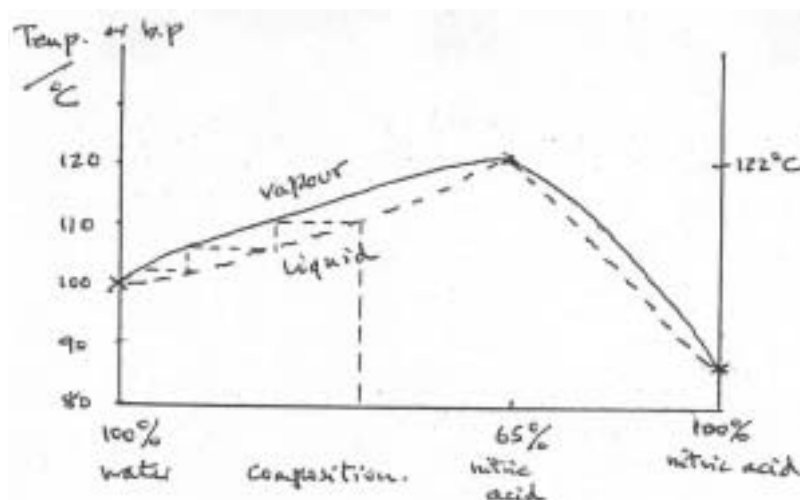
lines drawn on diagram (1) **[4]**

(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]**

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- (b) (i) Pure water } lines on graph (1) (1)
(ii) Azeotrope (or 65% nitric acid) } (1)

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

- (c) (i) $V = n_{AP_A}$ 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)

$\text{HNO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{NO}_3^-$ OR (1)
(or equivalent) [3]

Spectroscopy

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

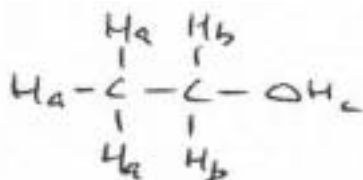
This generates a magnetic moment (1)

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

This gives two energy (1)

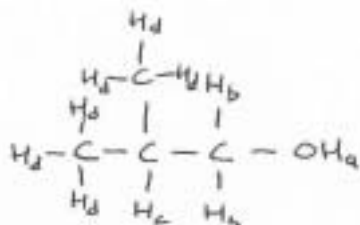
- (ii) External magnetic field may be modified by moments from other protons in the molecule (1)

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]

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

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

M peak is at 72 hence molecular formula is C₄H₈O (1)

Mass spectrum peak at 57 is (M-CH₃) or C₂H₅CO⁺ (1)

Mass spectrum peak at 43 could be (M-CHO or M-C₂H₅) or C₃H₇⁺ or CH₃CO (1)

E is CH₃CH₂COCH₃ or CH₃CH₂CH₂CHO (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

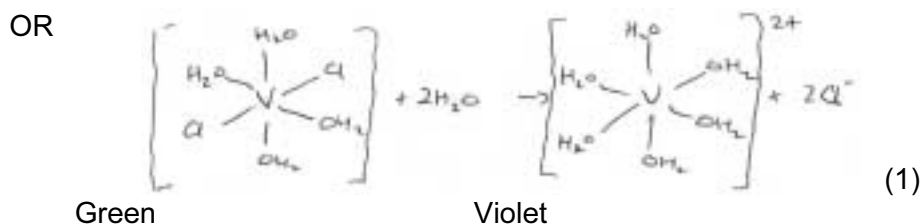
9 (a) Colour is due to the absorption of visible light (1)

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) [max 3]

(b) Ligand exchange between chloride and water occurs



d-orbital energy gap with CT ligands is different to that with H₂O ligands (1) [2]

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- (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 $e^- = 0.02 \times 5 \times 20/1000 = 0.002$ (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) (1)
Brass, with zinc (+ example use) (1)
Accept also bronze (Cu + Sn), duralumin (Cu+Al), cupronickel (Cu+Ni) nicrome (Ni+Cr)
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)

\downarrow
 Ba^{2+}
 \downarrow
 $BaCrO_4(s)$
yellow

(1)
Equilibrium shifts to the right as CrO_4^{2-} ions are removed and hence the solution becomes more acidic (1)
- (ii) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ (1)
(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 – $[Cr(H_2O)_5 Cl]^{2+} 2Cl^- \cdot H_2O$ (1) [max 8]