CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/06

CHEMISTRY
Options

Biochemistry

1. **(a)** Enzymes consist of biological catalysts (1)

They have an active site, into which the substrate fits (1)

Idea of 'lock and key' mechanism (1)

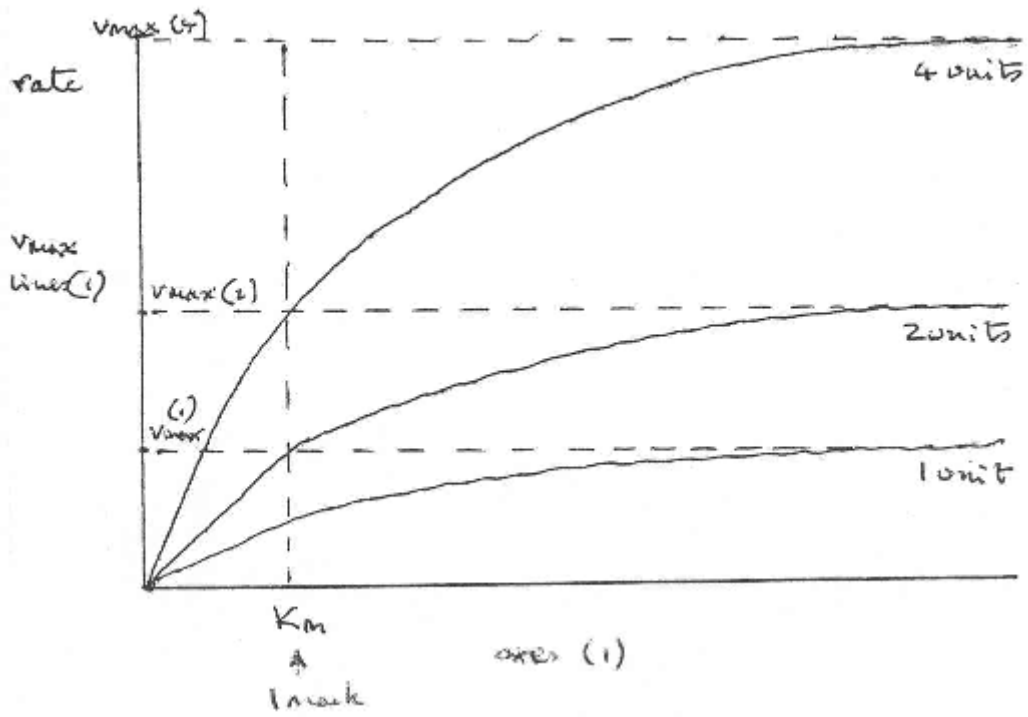
Bond(s) in substrate are weakened (1)

They are specific for a substrate (1)

E + S → ES → E + products (1)

[max 5]

(b)



Axes (1)

1 correct graph (1)

3 correct graphs (2)

Graphs to show V_{max} is proportional to enzyme units, and (1)

K_m is constant (1)

[5]

2. **A** is ATP/adenosine triphosphate/adenine ribose triphosphate (1)

It is associated with energy changes (1)

B is an amino acid/glutamic acid NOT aspartic acid (1)

It is found in proteins (1)

C is a phospholipid/phosphoglyceride (1)

It is found in bilayers/membranes/stabilises colloidal systems (1)

D is deoxyribose (1)

It is found in DNA (1)

E is glucose-6-phosphate (1)

It is formed in glycolysis/at the start of the Krebs cycle/in metabolism/ activates glucose/inhibitor for glycolysis (1)

[5 x 2]

Environmental Chemistry

3. **(a)** The high positive charge of the aluminium ions (1)

causes the coordinated water molecules to lose a hydrogen ion to the soil solution/polarises H-O bond. (1)

Diagram or formula of aluminium ion produced (1)
Accept $[Al(H_2O)_5OH]^{2+}$ or $[Al(H_2O)_4OH]^{+}$

[3]

(b) **(i)** anaerobic (reducing) (1)

(ii) hydrogen ions are required to remove the oxide ions from the sulphate ions or (1)

$S^{2-} + H_2O = HS^- + OH^-$

hence the water becomes more alkaline*

(iii) aluminium hydroxide is precipitated (1)
accept equation + state symbol
thereby leaving the water more acidic*
(*1 mark for both of these stated)

(iv) $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$ (1)
Allow $CO_3^{2-} + 2H^+ = CO_2 + H_2O$
or $CO_3^{2-} + H^+ = HCO_3^-$

[5]

(c) Organic matter from the wetlands will utilise dissolved oxygen to form carbon dioxide (1)

This means that the water is making heavy demands on the available oxygen and the water can then be said to have a high BOD (1)

[2]

4 **(a)** $O_2(g) \rightarrow O(g) + O^*(g)$ (1)

$O^*(g) + O_2(g) + M(g) \rightarrow O_3(g) + M^*(g)$ (1)

M is an inert third body such as $N_2(g)$ (1)

$O_3(g) \rightarrow O(g) + O_2(g)$ (1)

$O_3(g) + O(g) \rightarrow 2O_2(g)$ (1)

An equilibrium is therefore established which is $2O_3(g) \rightarrow 3O_2(g)$ (1)

[5 max]

(b) $Cl_2(g) \rightarrow 2Cl\bullet(g)$ (1)

$Cl\bullet + O_3(g) \rightarrow ClO\bullet(g) + O_2(g)$ (1)

$ClO\bullet(g) + O(g) \rightarrow Cl\bullet(g) + O_2(g)$ (1)

$Cl\bullet$ is therefore a catalyst (1)

[3 max]

(c) $NO_2(g)$ can react with the $ClO\bullet(g)$ to form $ClONO_2$ and will therefore break the propagation cycle above. (1)

This means $Cl\bullet(g)$ is no longer regenerated and less ozone is destroyed (1)

[2]

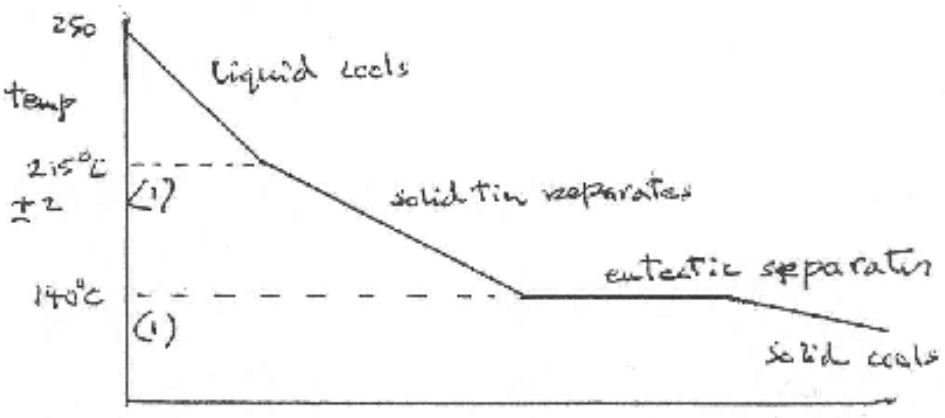
Phase Equilibria

5. **(a)** **(i)** Graph plotted and lines drawn
Axes labelled (1)
Areas – two metal + liquid areas (1)
– liquid + solid areas (1)

(ii) 140 ± 4 °C and 40 ± 3% tin (2 x 1)

[5]

(b)



Shape of cooling curve to 140°C (ecf from candidate's graph) (1)

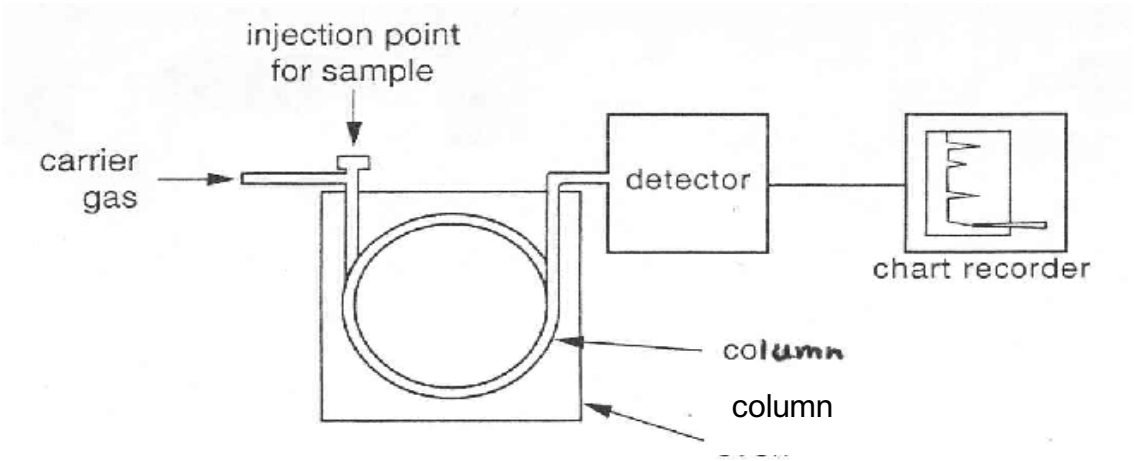
Any two sections labelled correctly (1)

[4]

(c) One of: solder; lead shot; bronzes; aluminobronzes (1)

[1]

6. (a) (i)



Injection and carrier gas (1)

Column and oven (1)

Detector and recorder (1)

(ii) Adsorption/partition (1)

[4]

(b) (i) Propanone, butanone, ethanol, pentan-3-one, propan-2-ol
5 correct ⇒ 3 marks; 4 correct ⇒ 2 marks; 3 correct ⇒ 1 mark
-1 for each of methanol, pentan-2-one or cyclohexanone (max 3)

(ii) 50 - 150°C (1)

(iii) Hydrophilic/polar (1)

Since alcohol OH groups are more strongly adsorbed than ketones (1)

[6]

Spectroscopy

7. **(a)** Colour results from d-electrons absorbing energy as they move from lower to higher energy levels (1)

d-orbitals are split due to repulsion/ligand field argument (1)

by ligands of electrons in $d(x^2-y^2)$ and $d(z^2)$ orbitals (1)

$[Cu(H_2O)_6]^{2+}$ has vacant d-orbitals allowing promotion (1)

$[Zn(H_2O)_6]^{2+}$ has no vacant orbitals (1)

[5]

(b) **(i)** $\pi \rightarrow \pi^*$ (1)
$n \rightarrow \pi^*$ (1)
$n \rightarrow \sigma^*$ (1)

(ii) $n \rightarrow \sigma^*$ (1)

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

more than one absorption scores 0

[5]

8. **(a)** ***From mass spectrum***

Ratio of M : M+1 peaks shows no. of carbons is

16.5 : 1.47 = 100 : 1.1 (1)

$n = \frac{1.47 \times 100}{16.5 \times 1.1} = 8$ (1)

From ir spectrum

Peak at 3050 – 3400 cm^{-1} could be OH (or NH) (1)

Not broad or rounded, suggest not OH (1)

Peak at 1600 – 1680 cm^{-1} suggests C=O (1)

From nmr spectrum

Compound contains 3 proton environments (1)

Peak at 7.4 δ – aromatic ring (1)

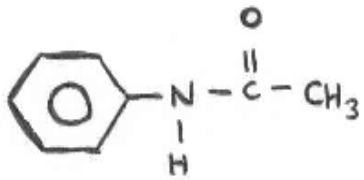
Peak at 2.1 δ – CH_3 (1)

Peak at 3.1 δ which disappears in D_2O – labile H/N-H (1)

[max 8]

(b) Functional groups – amide (C=O, N-H) (1)

Suggests **Q** is (1)



NOT a disubstituted ring

[2]

Transition Elements

9. **(a)** $Ni + 4CO \rightarrow Ni(CO)_4$ (1)

$Ni(CO)_4$ is a liquid and is purified by distillation (1)

$Ni(CO)_4 \rightarrow Ni + 4CO$ (1)

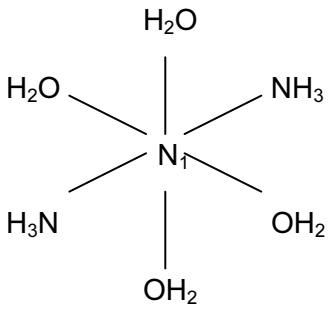
CO is recycled (1)

[4]

(b) Use: Catalyst in the hydrogenation of vegetable oils to margarine (1)
Reason: Heterogeneous catalyst – uses d-orbitals to complex (1)
Any other viable use accepted, mark independent of property/reason

[2]

(c)



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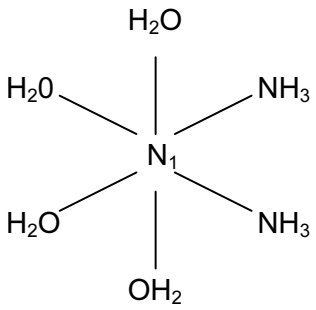
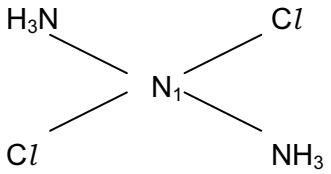


Cis

Octahedral (2 x 1)



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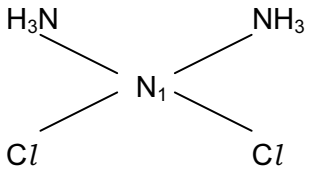

Cis

Square planar (2 x 1)

[4]

10. **(a)** Cu^{I} has d^{10} configuration/no gaps in upper orbitals (1)

Cu^{II} has d^{9} configuration/has space for promotion of an electron (1)

[2]

(b) **(i)** The formation of a higher and a lower oxidation state from an intermediate one/simultaneous oxidation and reduction (1)

(ii) $2Cu^{+} \rightarrow Cu^{2+} + Cu$ (1)

$E_{cell} = 0.52 - 0.15 = 0.37$ V (1)

[3]

(c) **(i)** $Cu^{2+} + 2I^{-} \rightarrow CuI + \frac{1}{2}I_2$ (1)

white solid brown solution (1)

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^{-}$ (1)

(ii) $CuCl_2 + 2HCl + Cu \rightarrow 2H[CuCl_2]$ or similar (1)

Blue Cu^{2+} to colourless/white Cu^{+} (1)

$HCuCl_2 \rightarrow CuCl + HCl$ (1)

M_r $CuCl = 99$, hence $\frac{35.5}{99} = 35.9\%$ chlorine (1)

[6]

[10 max]