UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE A Level

MARK SCHEME for the November 2005 question paper

9701 CHEMISTRY

9701/06 **Paper 6** **maximum raw mark 40**

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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.

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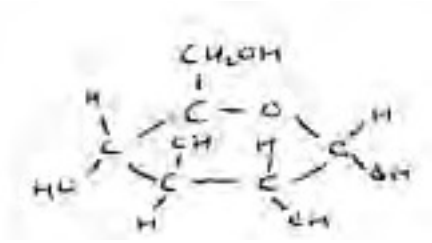
Biochemistry

1 **(a)** glucose



Needs to show ring structure and H or –OH **[1]**

(b) **(i)** $C_{12}H_{22}O_{11} + H_2O \rightarrow 2C_6H_{12}O_6$ **[1]**

(ii) Acid + water **[1]**
Boil/reflux **[1]**

Enzymes (allow named enzyme) **[1]**
15-45 °C **[1]**

(c) α- and β-pyranose (1-4 glucose) forms **[1]**
OR different optical isomerism at C_1

Both **C** and **D** are polymers OR polysaccharide **[1]**

C is found in starch or glycogen (α-amylose), **D** is cellulose)
)
C is used for storage, **D** has use as a structural polymer) 4 x ½ and round down **[2]**

2 **(a)** **(i)** Alkene, carboxyl 2 x **[1]**

R-COO-CH_2
|
R-COO-CH
|
R-COO-CH_2 **[1]**

(b) **(i)** No. of moles of oleic acid in 1 g = $\frac{3.5 \times 10^{-3}}{3} = 1.17 \times 10^{-3}$ **[1]**

Hence M_r of oleic acid = 855 **[1]**

[Calculation from adding atoms = 884]

(ii) Energy store (allow insulation in cold climates, formation of lipids) **[1]**

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(c) **(i)** Two of A, D, E, K 2 x **[1]**

(ii) **One of:**

A – oily fish, dairy products, carrots/fruit
D – oily fish, milk, eggs (sunlight)
E – green vegetables, vegetable oils
K – brassicas, wholegrain cereals, egg yolk **[1]**

One of:

A – night blindness, dry eyes
D – rickets, poor bone formation
E – abnormal cellular membranes
K – prolonged coagulation time in newborn infants **[1]**

Environmental Chemistry

3 **(a)** **(i)** Silicon/oxygen sheets are composed of tetrahedral **[1]**
Aluminium/oxygen sheets are composed of octahedral **[1]**

(ii)

<----------SiO_4 layer ---------->

<----------$Al O_6$ layer ---------->

<----------SiO_4 layer ---------->

[1]

(iii) Any **two** points :

- Normal 2:1 clays have hydrogen bonds between layers
- On drying, hydrogen bonds between layers break
- This causes contraction and cracking, since layers are strong

[2 x [1]]

(b) Clays have a negative charge on their surface **[1]**

This is due to substitution of Si by Al (or Al by Mg) **[1]**

Plants may take K^+ ions out of solution, these are replaced by ion-exchange from the clay/clays act as a reservoir of cations **[1]**

(c) Cation exchange could replace H^+ ions with Cs^+ ions **[1]**

Large Cs^+ ions not easily displaced **[1]**

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4 **(a)** To absorb in the infra-red region of the spectrum a molecule must have a changing dipole **[1]**

Oxygen and nitrogen are symmetrical whereas methane and carbon dioxide possess changing dipoles **[1]**

(b) Cement manufacture **[1]**

$CaCO_3 \rightarrow CaO + CO_2$ **[1]**

(c) **(i)** Carbon dioxide dissolves in cold oceans **[1]**

It establishes equilibria forming HCO_3^- and CO_3^{2-} ions (or equations) **[1]**

Some CO_2 is taken up by phytoplankton and enters the food chain **[1]**

Some CO_3^{2-} ions react with Ca^{2+} ions to from insoluble $CaCO_3$ **[1]**

(ii) Oceans 'store heat' helping maintain global temperatures **[1]**

Oceans affect weather patterns, particularly wind and rainfall **[1]**

Transfers energy from one region to another via the Water Cycle **[1]**

[Max 6]

Phase Equilibria

5 **(a)** Allow : column containing stationary phase **[1]**
liquid under high pressure (mobile phase) **[1]**
detector/recorder **[1]**

(b) **(i)** It is in order of the components leaving the column **[1]**

(ii) The strength of bonds formed with the stationary phase **[1]**
The M_r of the component **[1]**

(iii) Area under peak **A** = 6 x 40/2 = 120
Area under peak **B** = 6 x 10/2 = 30
Area under peak **C** = 10 x 30/2 = 150 **[1]**

Total area = 300 units hence **A** = 40%, **B** = 10% and **C** = 50% **[1]**

(iv) The alcohol would take longer to be eluted **[1]**
It would form stronger H-bonds with the stationary phase **[1]**

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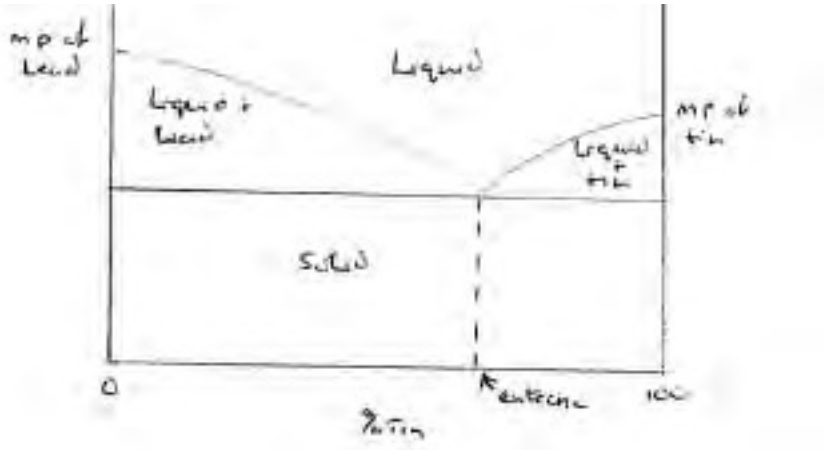
6 (a)



Axes (1)
m.p.'s (1)
eutectic (1)
3 areas (1)

[4]

(b) (i) Alloy has a lower m.p.
Plumber's solder solidifies over a range
Electrician's solder has a sharp m.p. (f.p.)
Alloy is stronger than metals
Melting point can be varied by changing composition

Any 3 points

(ii) Hardness/durability/resistance to wear
Colour can be varied by composition
Resistance to corrosion
Difficult to forge

Any 3 points

[6]

Spectroscopy

7 (a) (i) ^{13}C
(ii) ^{81}Br
(iii) Two ^{81}Br atoms in molecule

3 x **[1]**

(b) M+2 : M+4 ratio would be 2 : 1 **[1]**

^{79}Br and ^{81}Br are present in equal proportions in bromine, there are two ways of producing M+2, but only one of producing M+4 **[1]**

(c) (i) Hydrolyse the ester **[1]**
Analyse the products and look for the molecule containing ^{18}O **[1]**

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(ii) Place the pure ester in the mass spectrometer and examine the fragmentation pattern **[1]**

Look for a fragment with a mass two units more than the corresponding unlabelled fragment. **[1]**

If it is at *m/e* 59 then structure **K** is correct (or if at *m/e* 33, structure **L**) **[1]**

8 **(a)** Bending (1) and stretching (1) frequencies of bonds in the molecule are in this region of the spectrum **[2]**

(b) Although plastics contain mainly carbon and hydrogen, different plastics contain different (functional) groups **[1]**

Bonds in the groups absorb in different regions of the spectrum **[1]**

(c) **P** – 700 cm^{-1} caused by C-Cl ; plastic is pvc **[2 x 1]**

Q – 3300 cm^{-1} caused by N-H ; plastic is nylon/polyamide **[2 x 1]**

R – 1750 cm^{-1} caused by C=O ; plastic is *Terylene*/polyester **[2 x 1]**
OR 1150 cm^{-1}

Transition Elements

9 **(a)** **(i)** impure nickel heated with CO at 50 ^{o}C/low temp **[1]**
$Ni(s) + 4CO(g) \rightleftharpoons Ni(CO)_4(l)$

then the carbonyl is decomposed by heating to >200 ^{o}C **[1]**
$Ni(CO)_4(l) \rightleftharpoons Ni(s) + 4CO(g)$ (both equations) **[1]**

The CO is recycled. **[1]**

(ii) anode: $Ni(s) - 2e^- \longrightarrow Ni^{2+}(aq)$
cathode: $Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$ (both) **[1]**

copper too unreactive to dissolve at anode
OR $Cu^{2+}/Cu = 0.34V$ whereas $Ni^{2+}/Ni = -0.25V$ **[1]**

so the copper falls to the bottom as “anode sludge” **[1]**

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(b) $[Ni(H_2O)_2(NH_3)_4]^{2+}$ is octahedral: cis-trans isomers **[1]**

diagrams of the two isomers **[1]**

$[Ni(CN)_2(R_3P)_2]$ must be tetrahedral [i.e. NOT square planar] as only one isomer **[1]**

10 **(a)** Paramagnetism is due to the presence of unpaired electrons. **[1]**

Fe^{2+} is d^6, hence 4 unpaired electrons (assume high spin)
Fe^{3+} is d^5, hence 5 unpaired electrons (assume high spin) **[1]**

Hence Fe^{3+} is the more paramagnetic **[1]**

(b) Add $SCN^-(aq)$ **[1]**

If Fe^{3+} present, a blood red colouration **[1]**

Add $[Fe(CN)_6]^{3-}(aq)$ **[1]**

If Fe^{2+} present, a deep blue colour/ppte **[1]**

(c) **(i)** $S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$ **[1]**

(ii) Fe^{3+} is a homogeneous catalyst **[1]**

E^o of +0.77V is lower than that for $S_2O_8^{2-}/SO_4^{2-}$
but higher than that for I_2/I^- **[1]**

$2I^- + 2Fe^{3+} \longrightarrow I_2 + 2Fe^{2+}$
$S_2O_8^{2-} + 2Fe^{2+} \longrightarrow 2SO_4^{2-} + 2Fe^{3+}$ (both) **[1]**

[4 max 3]

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