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

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

The minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

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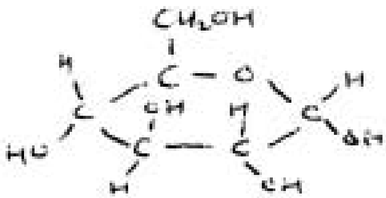
Biochemistry

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-CH2
         |
R-COO-CH
         |
R-COO-CH2
```
[1]

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

(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 ----------------->

<-------------------$\mathrm{A}l\mathrm{O}_6$ 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]**

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]**

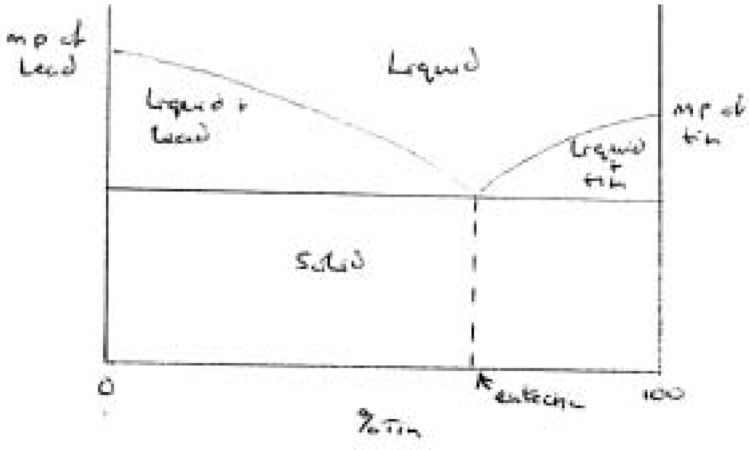
(ii) The strength of bonds formed with the stationary phase **[1]**
The M_r of the component **[1]**

(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]**

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]**

(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 °C/low temp **[1]**
$Ni(s) + 4CO(g) \rightleftharpoons Ni(CO)_4(l)$

then the carbonyl is decomposed by heating to >200 °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]**

(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]**

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(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]