UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2006 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 instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

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.

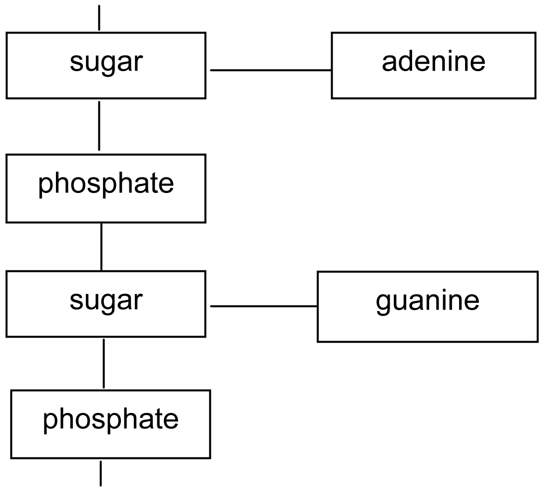
Mark schemes must be read in conjunction with the question papers and the report on the examination.

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2006 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

1 (a) (i)



1 for sugar/phosphate chain
NOT ribose
1 for two bases (A,T,C,G)
NOT uracil

[2]

(ii) transcription of base sequences(1)
translation into amino acid sequences(1) [2]

(iii) DNA is a double strand, RNA a single strand)
DNA contains deoxyribose, RNA contain ribose) [any 2]
DNA contains thymine, RNA contain uracil) [2]

[6]

(b) (i) The overall 3D shape (1) is stabilised by:
electrostatic/ionic interactions;
hydrogen bonding;
disulphide linkages;
van der Waals' forces – any **two** (1)

[2]

(ii) Mercury breaks the disulphide bonds/linkages/ $-CH_2-S-S-CH_2-$ (1)
$-CH_2-S-S-CH_2- + 2Hg^+ \rightarrow 2\ -CH_2-S-Hg$ (1)

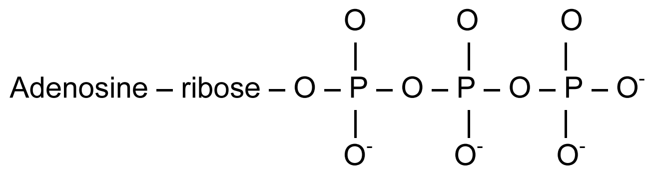
OR Mercury forms salts with carboxylic acid groups (1)
$-CO_2H + Hg^+ \rightarrow -CO_2Hg + H^+$ (1)

NB If Ag^+ used, penalise once

[2]

[4]

2 (a) (i)



All 4 O^- needed [1]

(ii) High concentration of negative charge (on the triphosphate group) (1) causes repulsion OR less repulsion in ADP (1) [2]

(iii) ATP + H_2O → ADP + P(i) [1]

(iv) Breakdown of glucose / glycolysis / citric acid (Krebs) cycle [1]

(v) Synthesis (of material) / muscle contraction / transport across cell membranes [1]

[6]

(b) Substrate moves from low to high concn. (1) against the concn gradient (1)

Energy comes from ATP (1)

Na^+/K^+ pump / uses Na^+-K^+- ATPase (1)

Use of channel/transport protein (1)

K^+ moves into cell OR Na^+ moves out of cell (1)

[4 max]

Environmental Chemistry

3 (a) (i) Rate = k[O] $[O_2]$

$= 3.9 \times 10^{5} \times 3.0 \times 10^{-14} \times 1.3 \times 10^{-4}$

$= 1.52 \times 10^{-12}$ (1) mol dm^{-3} s^{-1}(1) (*NB ecf from rate expression*) [2]

(ii) Any **two** of:
Photodissociation of NO_2 / $NO_2 \rightarrow NO + O$ (1)

Photodissociation of O_3 / $O_3 \rightarrow O_2 + O$ (1)

Photodissociation of O_2 / $O_2 \rightarrow 2O$ (1) [2]

[4]

(b) CFCs are highly inert / do not react with water or oxygen (1)

CFCs break down to give $Cl^{\bullet}$ / or suitable equation (1)

$O_3 + Cl^{\bullet} \rightarrow O_2 + ClO$
OR $ClO + O_3 \rightarrow Cl^{\bullet} + 2O_2$
OR $ClO + O \rightarrow Cl^{\bullet} + O_2$ (1)

Takes time for CFCs to reach the stratosphere (1)

[3 max]

(c) Any **two** from:

$NO + O_3 \rightarrow NO_2 + O_2$

$OH + O_3 \rightarrow HO_2 + O_2$

$O_3 \rightarrow O_2 + O$ (2)

And some idea of chemical equilibrium in unpolluted atmosphere i.e. rate of ozone formation equals rate of ozone loss (1)

[3]

4 **(a)** Fewer plastics were available for e.g. packaging / more expensive / fewer uses for plastics / paper or cardboard were more common **[1]**

(b) Any **three** from:

Saves a finite resource e.g. trees, metals etc. (1)

Reduces environmental damage during extraction of raw materials (1)

Materials are difficult to sort e.g. de-inking paper (1)

May use more energy to recycle than to extract a particular material (1)

[max 3]

(c) **(i)** Any **four** from:

Increase in atmospheric pollution (**named gas**) (1)

Temperature needs to be controlled to avoid dioxin formation (1)

Gases need to be 'scrubbed' to remove toxic/acid gases (1)

Waste needs to be sorted (1)

Some solid waste is not combustible (1)

[max 4]

(ii) Organic waste is reduced / decomposed by micro-organisms (1) under anaerobic conditions (1) [2]

[6]

Phase Equilibria

5 (a) (i) Mixture is partitioned (1)
between the coated powder - stationary phase (1)
and the carrier gas - mobile phase (1).

Different components are held more or less strongly on the stationary phase (1).

The oven ensures a constant temperature (1) (or that each component is flushed through the system).

[4 max]

(ii) One of helium, argon, nitrogen **[1]**

(b) Alcohol (1)
Drugs (in blood / urine) (1)
Explosives (1)

[2 max]

(c) (i) Water and ethanol (order not important) **[1]**

(ii) First eluted is on the right (1)
Order is due to strength of bonding to stationary phase / accept approx boiling point order (1)

[2]

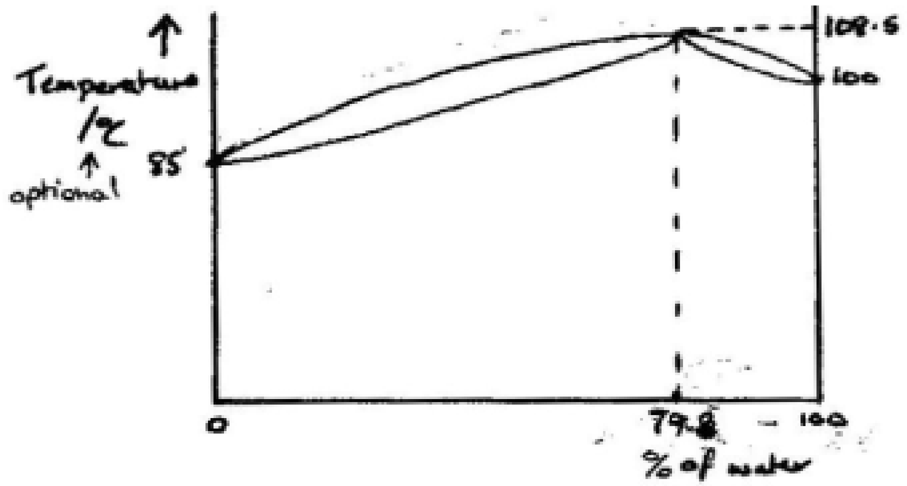
6 **(a)** Mixture shows negative deviation from Raoult's law (1)
Mixture has a vapour pressure lower than ideal behaviour predicts (1)
This is caused by stronger interaction between the two molecules (1)
In this case the forces between **A** and **B** are stronger than between **A** and **A** molecules or between **B** and **B** molecules. (1)

[3 max]

(b) An azeotrope is a mixture with constant boiling point (1)
that produces a vapour with the same composition as the liquid (owtte) (1)

[2]

(c)



Sketch (1),
axes labelled (1)
correct b.p.s and azeotrope composition shown (1)
Liquid and vapour curves labelled (1)
Explanation of why the residue is the azeotrope (1)

[5]

Spectroscopy

7 (a) (i) 84 is the M peak, 86 the (M+2) peak due to the isotope of ^{37}Cl, (1) and 88 due to the second ^{37}Cl atom present in **A**. (1)

(ii) Ratio is 3 : 1 and is due to the loss of a C*l* atom from **A** (1)

(iii) Calculation to show no of carbons $\left(\frac{0.55}{51} \times \frac{100}{1.1}\right)$ (1)

A is CH_2Cl_2 (1)

[max 4]

(b) Only one carbon atom is present
OR ^{13}C is only 1.1% of naturally occurring carbon (1) **[1]**

(c) Nitrogen (1) from the air (1) **[2]**

(d) ^{79}Br : ^{81}Br is approx 1 : 1 (1)

So the ratio of the M : M+2 : M+4 peaks would be 1 : 2 : 1 (1)

Thus the M+4 peak would be relatively larger too (1) **[3]**

8 (a) C_5H_{12} is saturated / contains only sigma bonds (or opposite argument) (1)

C_4H_8O will contain lone pair / pi electrons (1)

Only C_4H_8O will produce absorptions in the u.v./visible range (1)

Due to $\pi \rightarrow \pi^*$/ $n \rightarrow \pi^*$ / $n \rightarrow \sigma^*$ electron transitions (1)

[Max 3]

(b) Infra red spectrum shows strong C=O peak at 1720 cm^{-1} (1)

N.m.r. spectrum shows 3 proton environments (1)

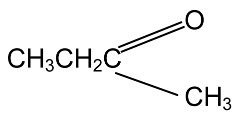
Total number of protons = 8 (check in final structure in not stated) (1)

There are 3 identical protons with no adjacent protons (2.0 δ) (1)

There is a $-CH_2CH_3$ group (1.0 δ and 2.4 δ) (1)

Description of splitting pattern (1)

This suggests **E** is



(1)

[7]

Transition Metals

9 (a) (i) +6, green (1)

(ii) Mn(II), Mn(IV) and Mn(VII) (1)

(iii) e.g. heat MnO_2 and MnO_4^- in alkaline solution

OR $MnO_2 + 2MnO_4^- + 4OH^- \rightarrow 3MnO_4^{2-} + 2H_2O$ (1)

[Allow heat MnO_2 with MOH/$MClO_3$ or MNO_3 where M is Na or K]

[3]

(b) (i) $E^{\ominus}$ values $O_2 + H^+/H_2O = +1.23V$; $Fe^{3+}/Fe^{2+} = +0.77V$ (1)

thus $E_{cell} = +0.46V$ – it's positive so the reaction occurs (1)

(ii) $E^{\ominus}$ values $O_2 + H_2O\ /OH^- = +0.40V$; $Fe(OH)_3/(Fe(OH)_2 = -0.56V$ (1)

thus $E_{cell} = +0.96V$ – it's more positive than **(i)** so the reaction occurs more easily (1)

[4]

(c) $n(MnO_4^-) = 0.02 \times 20.5 / 1000 = 4.1 \times 10^{-4}$ moles (1)

$MnO_4^- : Fe^{2+} = 1 : 5$, hence $n(Fe^{2+}) = 5 \times 4.1 \times 10^{-4}$
$= 2.05 \times 10^{-3}$ moles in 25 cm^3 (1)

This equals $10 \times 2.05 \times 10^{-3}$ or 2.05×10^{-2} moles in 250 cm^3

Original $n(FeSO_4) = 6.95/(55.9 + 32 + 64 + 7 \times 18) = 0.025$ moles (1)

Thus % of Fe^{2+} oxidised = $100 \times (0.025 – 0.0205)/0.025 = 18\%$ (1)

[max 3]

10 (a) **(i)** e.g. AlNiCo (or alnico) – used in magnets
Monel – corrosion resistant
Nichrome – resistance wire
Cupro-nickel – coinage etc. (1)

(ii) e.g. Hydrogenation of vegetable oils
Reforming of hydrocarbons (ethene to ethane) (1)

[2]

(b) **(i)** Polydentate – can form more than one (dative) bond per molecule of ligand (1)

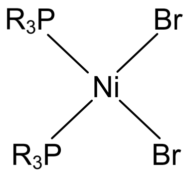
(ii) They contain lone pairs of electrons (1)
on oxygen and sulphur (1)

(iii) Coordination number 6 (1)
Octahedral (1)

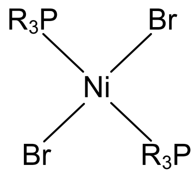
(iv) Coordination number 4 (1)
Tetrahedral (or square planar) (1)

[6 max]

(c) Formulae clearly showing *cis* and *trans* isomers (1)



cis



trans

Geometrical OR *cis*/*trans* (or correct label under one isomer) (1)

[2]