CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 40

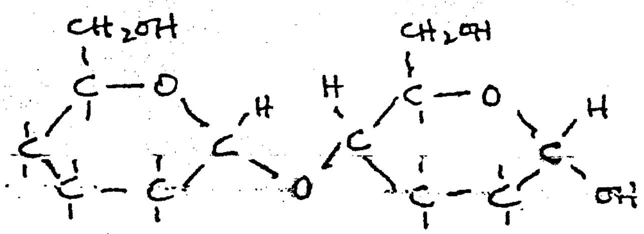
SYLLABUS/COMPONENT :9701 /6

CHEMISTRY
(OPTIONS (A2))

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Biochemistry

1. **(a)** **(i)**



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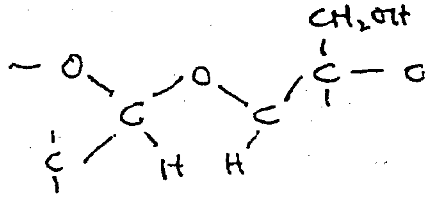


(2 x 1)

(ii) Chiral / anomeric / optically active centre is created since rotation is possible at C_1 (1)

[3]

(b) Hydrogen bonding (1)

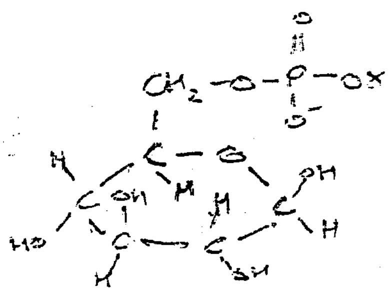
C – O – H | | | | | | | O (with two H atoms on the O) (1)

[2]

(c) **(i)** glucose + ATP => glucose-6-phosphate + ADP (1)

an enzyme / hexokinase / glucokinase is needed (1)

(ii)



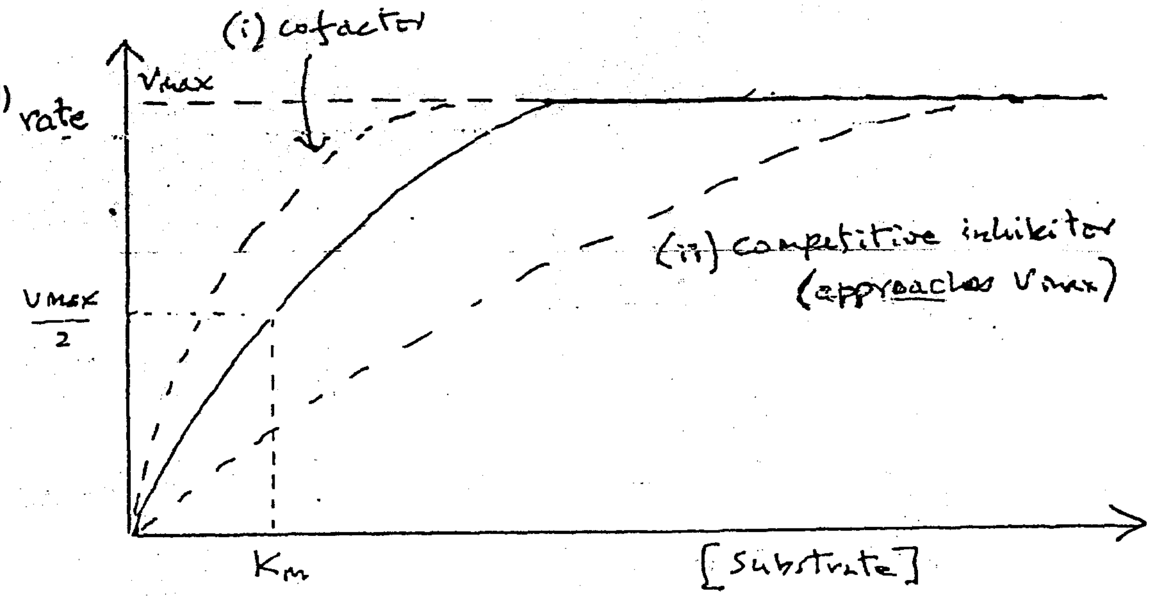
(1)

(iii) Glucose-6-phosphate is a competitive/reversible inhibitor (1)

It fits into the active site on the enzyme/similar shape to glucose (1)

[5]

2. **(a)** **(i)**



Axes labelled (1)
Graph (1)
V_{max} and V_{max} / 2 indicated (1)

(ii) Check lines on sketch above for $V_{max}/2$ to give K_m as [S] (1)

(iii) The value of K_m shows the efficiency / effectiveness of the enzyme / affinity of the enzyme for the substrate / strength of the enzyme-substrate bond (1)

Small values for K_m indicate very efficient systems (1)
[6]

(b) **(i)** Correct line on sketch (1)
Competes for active sites on the enzyme (1)

(ii) Correct line on sketch (1)
Increase the efficiency of the enzyme (1)
[4]

Environmental Chemistry

3. **(a)** Increased use of fertilsers (1)

Leaching / runoff of soluble compounds such as nitrates (1)

This increases the growth of algae (1)

When these die and decay they use up dissolved oxygen / eutrophication (1)
[4]

(b) Water from the Baltic is less dense due to lower salinity **and** higher temperatures (**both** required) (1)

(c) Nutrient levels are greatest in the North Sea water in which the algae grow (1)

The 'jump' layer is not as mobile as the surface waters / little or no mixing (1)
[2]

(d) The algal decomposition mainly affects the deeper waters reducing the oxygen content (1)

Oxygen loss is less significant at the surface (1)

The smaller the cod populations, the fewer herrings are eaten (1)

Cod are found at greater depths where the oxygen loss is greatest (1)
[max 2]

(e) This shows severely reducing conditions / a large oxygen loss. (1)

4\. (a) Lack of flammability / inertness to combustion

Suitable volatility / easily liquefied

Lack of reactivity towards other chemicals present

Non-toxic

[max 2]

(b) $CFCl_3$ => $CFCl_2•$ + Cl• (1)

Cl• + O_3 => ClO• + O_2 (1)

ClO• + O => Cl• + O_2 (1)

Cl• is recycled, and can thus destroy many ozone molecules (1)

[4]

(c) (i) It breaks down more easily (1)

(ii) CFC-11 must have a shorter residence time than CFC-12 (1)

CFC-12 must have a very long residence time (> 100 years) (1)

[max 2]

(d) HCFCs are more readily destroyed in the troposphere (1)

The C—H bond is more readily attacked, and this promotes the breakdown of the molecule (1)

Polarisation of the C-H bond (1)

[max 2]

Phase Equilibria

5. **(a)** As the molecules gain energy (1)

the forces between them become much weaker (1)

The magnitude of the change is proportional to ΔH_{vap} (1)
[max 2]

(b) **(i)** H_2O has a high b.p. due to hydrogen bonding (1)

Diagram of water showing 2 H-bonds per molecule (1)

H_2S to H_2Te have similar intermolecular dipole-dipole forces / van der Waals' (1)

(ii) H_2O : $\frac{40.7}{373} = 0.109$ H_2S : $\frac{18.7}{213} = 0.088$

H_2Se : $\frac{19.3}{243} = 0.079$ H_2Te : $\frac{23.2}{268} = 0.087$

Four values (1)

For similar bonding, b.p. and ΔH_{vap} are proportional (1)

Water has a higher ratio due to different / stronger hydrogen bonding (1)
[max 5]

(c) **(i)** $P = P_A \times X_A$
The vapour pressure exerted by a gas is proportional to its mole fraction (1)

(ii) Law holds only for similar intermolecular forces / H_2S and H_2Se both have van der Waals' forces (1)

H_2O and H_2S have different forces (1)
[3]

6. (a) (i) Partition coefficient = $\frac{[X]_{solven 1}}{[X]_{solvent 2}}$ (1)

(ii) $K = \frac{1.0 \times 10^{-2}}{4.0 \times 10^{-3}} = 2.5$ (1)

(iii) Let x mol of iodine be dissolved by the solvent

Then $(4.0 \times 10^{-4} - x)$ mol I_2 remain in 100 cm^3 water (1)

And x mol I_2 are present in 50 cm^3 of solvent (1)

$2.5 = \frac{[\text{Concn in solvent}]}{[\text{ Concn in water }]} = \frac{20x}{10\,(4.0 \times 10^{-4} - x)}$ (1)

This gives $20x = 25\,(4.0 \times 10^{-4} - x)$

$45x = 10^{-2}$

$x = 2.2 \times 10^{-4}$ mol (1)

Hence the concn of I_2 in the solvent is $20 \times 2.2 \times 10^{-4}$ mol dm^{-3}

or 4.4×10^{-3} mol dm^{-3} (1)

[max 6]

(b) (i) The solubility of a gas in a liquid is proportional to the (partial) pressure of the gas (1)

(ii) Solubility of N_2 = 0.79 x 23.6 = 18.6 cm^3 dm^{-3} (1)

Solubility of O_2 = 0.20 x 48.9 = 9.8 cm^3 dm^{-3} (1)

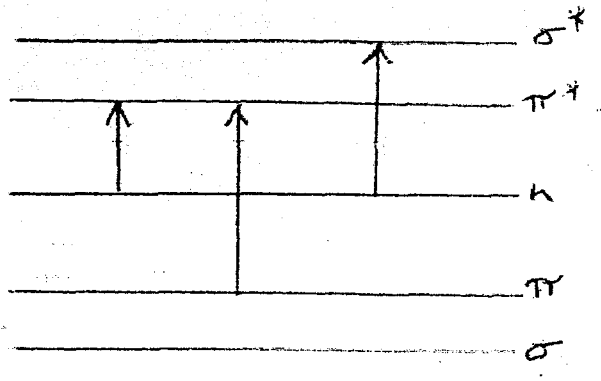
(iii) % N_2 is $\frac{18.6}{18.6 + 9.8} = \frac{18.6}{28.4} = 65.5\%$

And hence % O_2 = 34.5% (1)

[4]

Spectroscopy

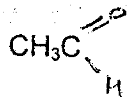
7. **(a)**

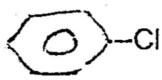


-1 for every line over 3 (3 x 1)

[3]

(b)





(2 x 1)

[2]

-1 for every incorrect over 2

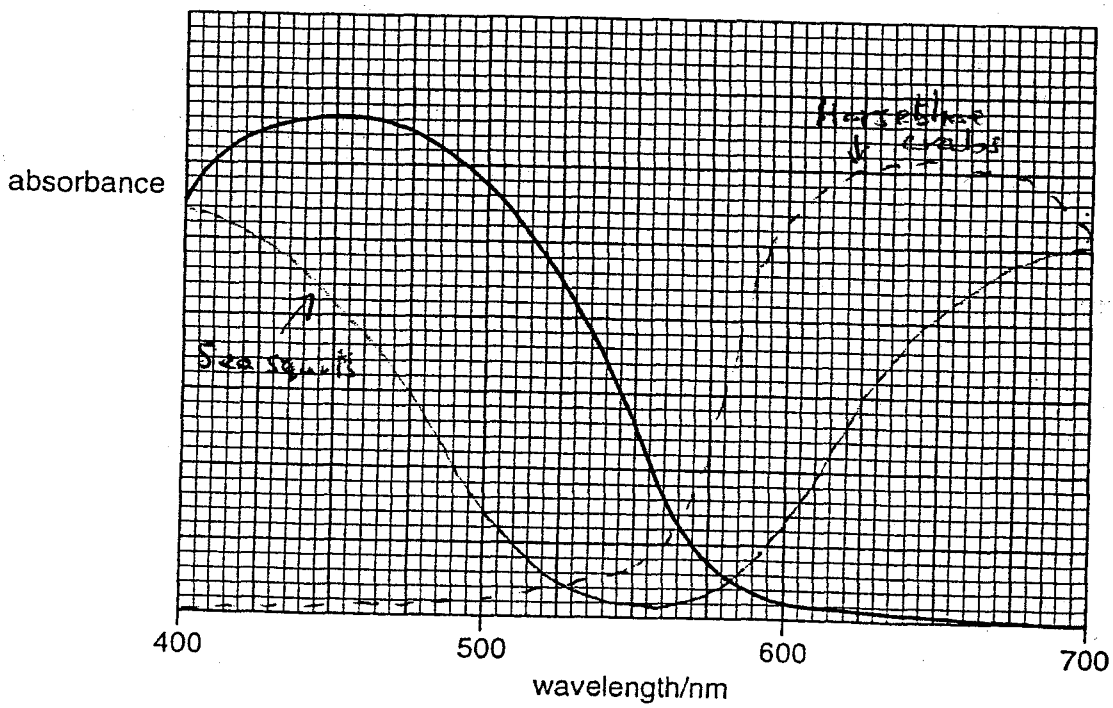
(c) **(i)** Diphenylmethanone will absorb at lower energy (longer wavelength) (1)

(ii) Energy levels are closer together (1)

hence less energy is required for transitions (1)
(allow longer chromophore / greater delocalisation / conjugation)

[3]

(d)



[2]

8. **(a)** **(i)** A suspension of an organic solid (1)

in a hydrocarbon oil / Nujol (1)

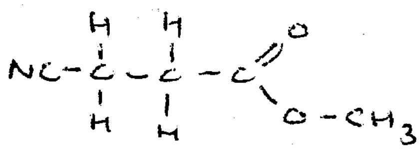
(ii) Ethanol shows a strong IR absorption due to –OH (1)

It absorbs water which would attack the NaCl plates (1)
[max 3]

(b) **Q** -C≡N **R** C==O **S** –C--O-

(3 correct 2 marks
2 correct 1 mark)

J is



Or ester isomers of the above, NOT –OH / $-NH_2$ containing isomers(1)
[3]

(c) **(i)** Peak is at M – 15, hence CH_3 has been lost (1)

(ii) **T** to **U** is a loss of 30, suggests loss of CH_2O or $-CH_2NH_2$ (1)

(iii) Ratio of M : M+1 gives n = $\dfrac{0.11 \times 100}{2.5 \times 1.1}$ or 4 carbons (1)

If **K** is saturated, it will contain 8 hydrogens ($C_4H_8O_x$) (1)

This leaves a mass of 32 for the oxygen

Hence **K** is $C_4H_8O_2$ (1)
[max 4]

Transition Elements

9. **(a)** Labelled diagram is acceptable

Impure copper anode, pure copper cathode (1)

Copper is transferred to the cathode (or equations) (1)

$CuSO_4(aq)$ is the electrolyte (1)

Silver settles as the metal in the anode sludge (1)

Because E° is more +ve than Cu^{2+} (1)

Ni / Zn goes into solution as M^{2+} (1)

Because their E° is more negative than Cu^{2+} (1)

[max6]

(b) **(i)** Brass, with zinc; bronze, with tin etc (1)

(ii) moles of $S_2O_3^{2-}$ = 0.1 x 20/1000 = 2 x 10^{-3} mol (1)

moles of I_2 = 1 x 10^{-3}

moles of Cu^{2+} = 2 x 10^{-3} (1)

Mass of copper = 63.5 x 2 x 10^{-3} g

= 0.127 g

Hence % copper = 50.8% (1)

[4]

10. **(a)** [Ar]$3d^4$ [1]

(b)

Mn(II) colourless OR pale pink

Mn(III) red

Mn(VI) green

Mn(VII) purple 4 correct, 3 marks
3 correct, 2 marks etc

[3]

(c) **(i)** From Data Book : $4MnO_4^{2-} - 4e^- \Rightarrow 4MnO_4^-$ $E° = 0.56V$ (1)

$5MnO_4^{2-} + 8H^+ \Rightarrow Mn^{2+} + 4MnO_4^- + 4H_2O$ (1)

$E°_{cell} = +1.74 - 0.56 = +1.18V$ (1)

(ii) Oxidation no = +5 (1)

$8H^+ + 3MnO_4^{3-} \Rightarrow 2MnO_2 + MnO_4^- + 4H_2O$
(1 for correct formulae, 1 for balancing) (2)

[6]