

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

NOVEMBER 2002

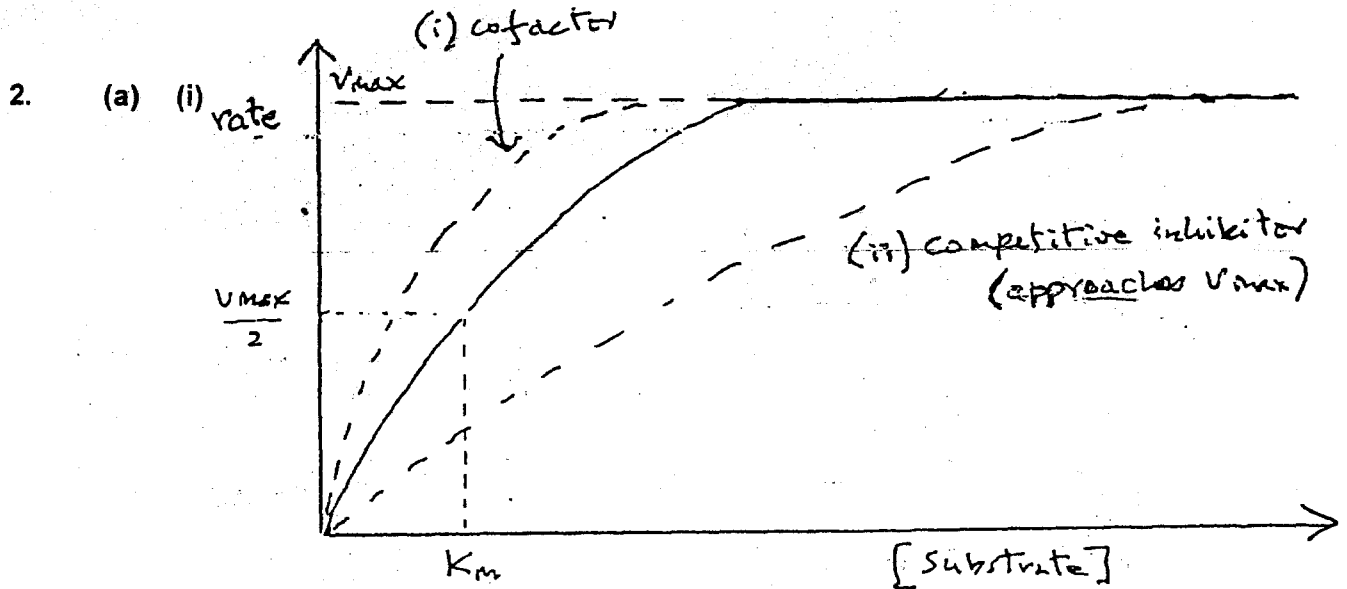
GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 40

SYLLABUS/COMPONENT :9701 /6

**CHEMISTRY
(OPTIONS (A2))**



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]

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Environmental Chemistry

3. (a) Increased use of fertilisers (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)

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4. (a) Lack of flammability / inertness to combustion
 Suitable volatility / easily liquefied
 Lack of reactivity towards other chemicals present
 Non-toxic
 [max 2]
- (b) $\text{CFCl}_3 \Rightarrow \text{CFCl}_2\cdot + \text{Cl}\cdot$ (1)
 $\text{Cl}\cdot + \text{O}_3 \Rightarrow \text{ClO}\cdot + \text{O}_2$ (1)
 $\text{ClO}\cdot + \text{O} \Rightarrow \text{Cl}\cdot + \text{O}_2$ (1)
- $\text{Cl}\cdot$ 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]

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Phase Equilibria

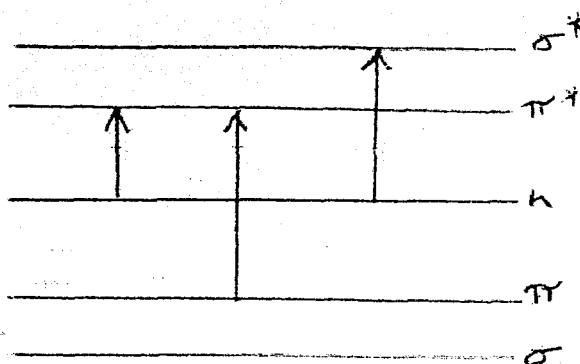
5. (a) As the molecules gain energy (1)
the forces between them become much weaker (1)
The magnitude of the change is proportional to ΔH_{vap} (1)
[max 2]
- (b) (i) H_2O has a high b.p. due to hydrogen bonding (1)
Diagram of water showing 2 H-bonds per molecule (1)
 H_2S to H_2Te have similar intermolecular dipole-dipole forces / van der Waals' (1)
- (ii) $\text{H}_2\text{O} : \frac{40.7}{373} = 0.109$ $\text{H}_2\text{S} : \frac{18.7}{213} = 0.088$
 $\text{H}_2\text{Se} : \frac{19.3}{243} = 0.079$ $\text{H}_2\text{Te} : \frac{23.2}{268} = 0.087$
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]

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6. (a) (i) Partition coefficient = $\frac{[X]_{\text{solvent 1}}}{[X]_{\text{solvent 2}}}$ (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 $20x = 25(4.0 \times 10^{-4} - x)$
 $45x = 10^{-2}$
 $x = 2.2 \times 10^{-4} \text{ mol}$ (1)
- Hence the concn of I_2 in the solvent is $20 \times 2.2 \times 10^{-4} \text{ mol dm}^{-3}$
or $4.4 \times 10^{-3} \text{ mol dm}^{-3}$ (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 $N_2 = 0.79 \times 23.6 = 18.6 \text{ cm}^3 \text{ dm}^{-3}$ (1)
Solubility of $O_2 = 0.20 \times 48.9 = 9.8 \text{ cm}^3 \text{ dm}^{-3}$ (1)
- (iii) % N_2 is $\frac{18.6}{18.6 + 9.8} = \frac{18.6}{28.4} = 65.5\%$ (1)
And hence % $O_2 = 34.5\%$ (1)
[**4**]

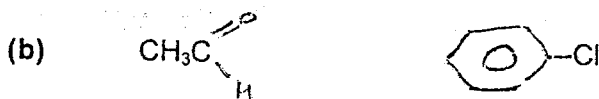
Spectroscopy

7. (a)



-1 for every line over 3

(3 x 1)
[3]



(2 x 1)
[2]

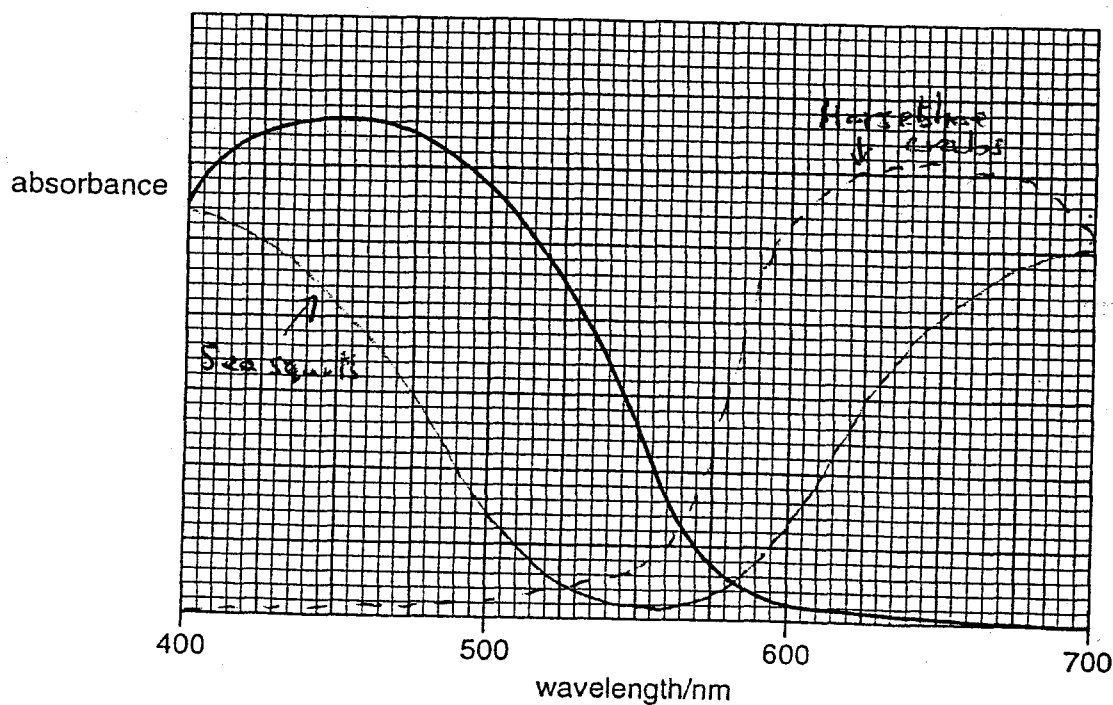
-1 for every incorrect over 2

- (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
(allow longer chromophore / greater delocalisation / conjugation) (1)

[3]

(d)



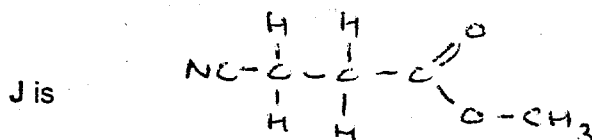
[2]

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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)



Or ester isomers of the above, NOT –OH / –NH₂ containing isomers(1)
[3]

- (c) (i) Peak is at M – 15, hence CH₃ has been lost (1)
- (ii) T to U is a loss of 30, suggests loss of CH₂O or –CH₂NH₂ (1)
- (iii) Ratio of M : M+1 gives $n = \frac{0.11 \times 100}{2.5 \times 1.1}$ or 4 carbons (1)

If K is saturated, it will contain 8 hydrogens (C₄H₈O_x) (1)

This leaves a mass of 32 for the oxygen

Hence K is C₄H₈O₂ (1)
[max 4]

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Transition Elements

9. (a) Labelled diagram is acceptable (1)
- Impure copper anode, pure copper cathode (1)
- Copper is transferred to the cathode (or equations) (1)
- $\text{CuSO}_4(\text{aq})$ 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 $\text{S}_2\text{O}_3^{2-} = 0.1 \times 20/1000 = 2 \times 10^{-3} \text{ mol}$ (1)
- moles of $\text{I}_2 = 1 \times 10^{-3}$ (1)
- moles of $\text{Cu}^{2+} = 2 \times 10^{-3}$ (1)
- Mass of copper = $63.5 \times 2 \times 10^{-3} \text{ g}$
 $= 0.127 \text{ g}$
- Hence % copper = 50.8% (1)
- [4]

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10. (a) $[\text{Ar}]3d^4$ [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 : $4\text{MnO}_4^{2-} - 4e^- \Rightarrow 4\text{MnO}_4^-$ $E^\circ = 0.56\text{V}$ (1)

$5\text{MnO}_4^{2-} + 8\text{H}^+ \Rightarrow \text{Mn}^{2+} + 4\text{MnO}_4^- + 4\text{H}_2\text{O}$ (1)

$E^\circ_{\text{cell}} = +1.74 - 0.56 = +1.18\text{V}$ (1)

(ii) Oxidation no = +5 (1)

$8\text{H}^+ + 3\text{MnO}_4^{3-} \Rightarrow 2\text{MnO}_2 + \text{MnO}_4^- + 4\text{H}_2\text{O}$
(1 for correct formulae, 1 for balancing)(2)

[6]