

JUNE 2002

GCE Advanced Level

MARK SCHEME

MAXIMUM MARK : 40

SYLLABUS/COMPONENT :9701 /6

**CHEMISTRY
(OPTIONS (A2))**



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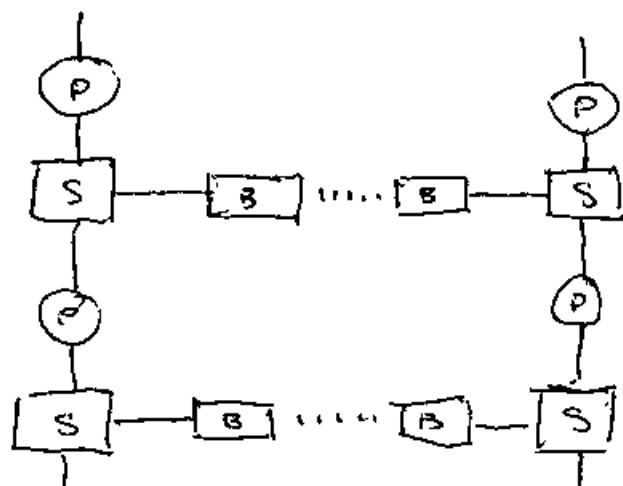
Biochemistry

1. (a) The three-dimensional shape / how structure folds or coils (1)
 contains α -helix (1)
 [2]
- (b) - OH hydrogen bonding (1)
 or any polar group
 -CO₂⁻ or -NH₃⁺ ionic/electrostatic bonding (1)
 if no group: identified, 2 types of bonding score (1)
 [2]
- (c) (i) Ionic / acid-base / electrostatic (1)
 forms salts or complex ions e.g. -CO₂⁻ Ag⁺ (1)

 OR disulphide links (1)
 -CH₂ - S - Ag⁺ (1)
- (ii) Heat breaks the weakest bond first (1)
 van der Waals' or hydrogen bonds (1)
- (iii) Addition of H⁺ or OH⁻ breaks polar bonds / protein denaturation (1)
 ionic OR hydrogen bonds
 OR -CO₂⁻ + H⁺ $\Rightarrow$ -CO₂H (1)
 [6]

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2. (a)



All low specific
 bases
 NOT used
 P, S, B identified (1)
 Shape (1)
 AT / CG (1)
 on example
 H-bonds shown (1)
 check in (b)

[4]

- (b) DNA is the repository of genetic information (1)
- It can replicate itself (1)
- It contains a triplet code of bases (1)
- It unwinds to give a single strand which acts as a template (1)
- This forms m-RNA (1)
- t-RNA translates the code into a sequence of amino acid (1)
- and brings each amino acid in turn (1)
- [max 6]

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Environmental Chemistry

3. (a) SO₂ bond vibrations absorb in the IR region (1)

There is a change in dipole moment (1)

This process absorbs energy which would be re-radiated as heat back to the Earth's surface (1)

(could be on a diagram)

- (b) SO₂ is easily oxidised to SO₃ (1)

This dissolves in water to form sulphate ions (1)

Oxidising agents include O₂, O₃, NO₂ (one only) (1)

- (c) SO₂ + H₂O ⇒ H₂SO₃ ⇌ H⁺ + HSO₃⁻ only scores (1)

SO₂ is first oxidised to SO₃ (1)

Then this dissolves : SO₃ + H₂O ⇒ H₂SO₄ (1)

- (d) Powdered coal and limestone are fluidised by forcing gas through them (1)

On burning, the SO₂ is released and reacts with the limestone (1)

SO₂(g) + CaCO₃(s) ⇒ CO₂(g) + CaSO₃(s) (1)

[max 10]

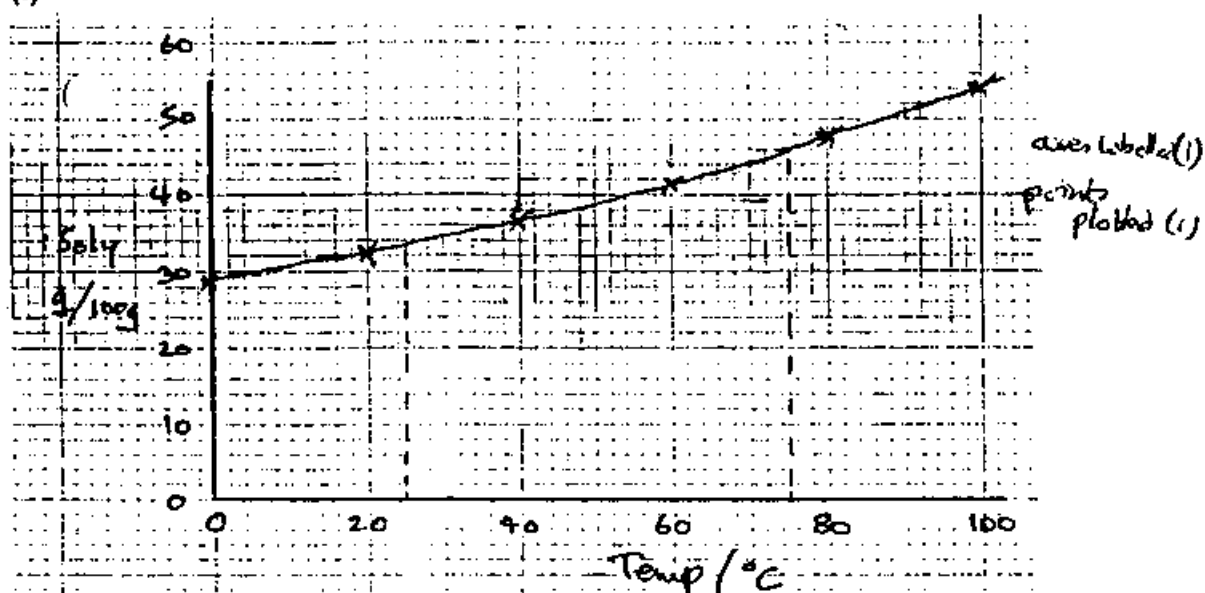
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4. (a) Rain water containing CO_2 attacks the limestone (1)
- This forms calcium hydrogencarbonate causing the rock to dissolve (1)
- Raised temperature or alkaline conditions cause HCO_3^- to precipitate as CO_3^{2-} / (low $[\text{CO}_2]$ shifts eqn to left) (1)
- $\text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightleftharpoons \text{Ca}(\text{HCO}_3)_2$ (1)
- or with Ca^{2+} ions [4]
- (b) (i) Root respiration releases carbon dioxide
- OR hydrogen ions occupying exchange sites released by the removal of nutrients by the growing plant. ^{are} ^ (1)
- CO_3^{2-} reacts with H^+ ions
- (ii) The calcium ions from the liming displace hydrogen ions from the exchange sites. (1)
- This provides long term protection by inhibiting the subsequent retention of hydrogen ions at the exchange sites
- OR by being able to release the calcium ions as carbonate to neutralise the soil solution. (1)
- (iii) Prevents the development of reducing conditions in the soil (1)
- Reduces the risk of ion deficiencies : by precipitation (1)
- low pH hinders processes which result in the breakdown of clay structures (1)
- low pH causes waterlogging of clay soils [6]

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Phase Equilibria

5. (a) (i)



penalise -1 if axes reversed

(ii) 75 °C – 45g ± 1.9 g; 25 °C – 33g ± 1g (1) [3]

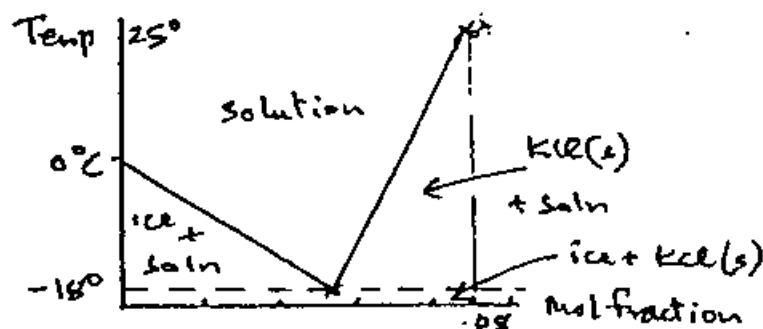
(b) (i) Crystallisation / crystals separate (1)
Allow solid or ppt

(ii) From (a)(ii) 12g of KCl separate from the solutions in 100g water (mark consequentially) (1) [2]

(c) Mole fraction is $\frac{\text{KCl}}{\text{H}_2\text{O}} = \frac{33/74.5}{100/18}$ (1) = 0.08 (1) [2]

Strictly should be 0.074, allow error for 2 only give part marks if 2 not scored.

(d)



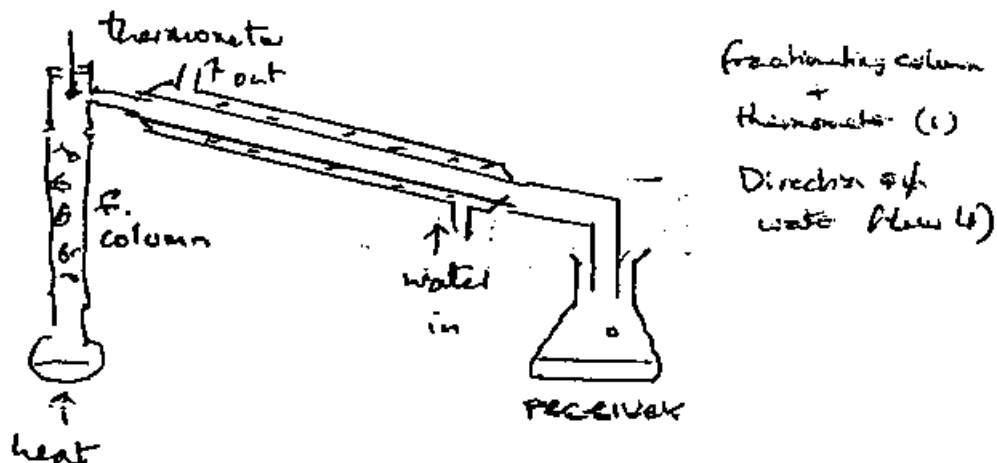
Sketch (1)

3 points (1)

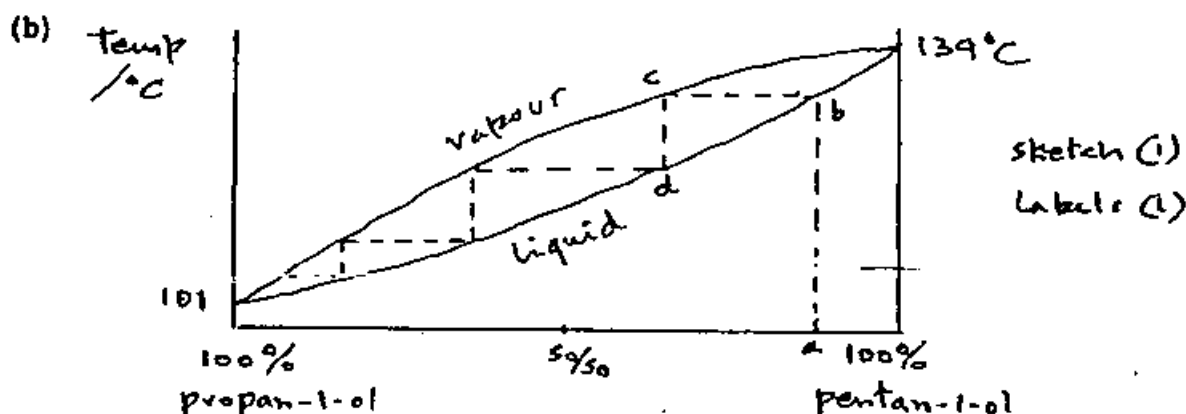
Areas (1) [3]

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6. (a)



[2]



Drawing azeotrope basis in 'sketch' mark

Liquid (a) boils (b) giving a vapour richer in the more volatile component (1)

This condenses to liquid (d) in the fractionating column (1)

Each horizontal line } represents a 'theoretical plate' (1)
 or line }
 or step [5]

(c) Propan-1-ol and water have similar intermolecular forces
 OR both form hydrogen bonds (1)

The larger hydrophobic C_5H_{12} of the pentan-1-ol prevents miscibility (1)

Intermolecular forces pentan-1-ol – pentan-1-ol and water – water are
 stronger than pentan-1-ol – water. (1)
 [3]

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Spectroscopy

7. (a) Make a mull with hydrocarbon / Nujol (1)
- Place between NaCl / KBr plates (1)
- OR Grind up with KBr (1)
- Compress under vacuum (1)
- OR Dissolve in solvent (1)
- Use double beam spectrometer with solvent blank (1)
- [2 x 2]
- (b) (i) Aspirin : -OH, C=O, C-O,  (1)
- Paracetamol : -OH, C=O, C-O,  -N-H (1)
- (ii) -N-H is the only difference, at $3100\text{-}3600\text{ cm}^{-1}$ (1)
- [3]
- (c) Nmr absorptions depend upon the proton environment (1)
- Aspirin has 7 protons in 3 (4) environments (1)
- Paracetamol has 9 protons in 4 (5) environments (1)
- Aspirin as 8 protons, paracetamol 9 protons (1)
- [3] max

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8. (a) (i) ^{13}C which gives the M+1 peak (1)
- (ii) Chlorine **OR** bromine (1)
- ^{35}Cl and ^{37}Cl , **OR** ^{79}Br and ^{81}Br (1)
- [3]
- (b) Ratio M : M+1 is 100 : 4.4 (1)
- No. of carbons, $n = \frac{4.4 \times 100}{100 \times 1.1} = 4$ (1)
- Allow any correct logic - calculation not essential* [2]
- (c) M_r of F is 72, hence peak at 57 is (M – 15) loss of CH_3 (1)
- Peak at 57 is $^+\text{CH}_2\text{CH}_2\text{CHO}$ allow $\text{C}_3\text{H}_5\text{O}$ (1)
- Peak at 29 is CH_3CH_2^+ allow C_2H_5 or CH_3O (1)
- Do NOT insist on charge* [3]
- (d) M_r of F is 72, hence peak at 44 is (M – 28)
- The alkene is therefore C_2H_4 (1)
- Thus the peak at 44 is caused by a $\text{C}_2\text{H}_4\text{O}$ fragment (1)
- [3]

Transition Elements

9. (a) Ligands possess $\dots$ pairs of electrons / *negative charge* (1)
- The orbitals pointing towards the ligands are higher in energy (1)
- [2]
- (b) (i) $[\text{Ar}]3d^7$ (1)
- (ii) Paramagnetic, since it contains (at least) one unpaired electron (1)
- allow partially filled orbitals* [2]

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- (c) (i) Co : 25.2/58.9 = 0.428 $\Rightarrow$ 1
 N : 24/14.0 = 1.714 $\Rightarrow$ 4
 H : 5.1/1.0 = 5.10 $\Rightarrow$ 12
 Cl : 45.6/35.5 = 1.29 $\Rightarrow$ 3 (1)

Empirical formula = $\text{CoN}_4\text{H}_{12}\text{Cl}_3$ (1)

Likely ligands = 4 x NH_3 and 2 x Cl (1)

From AgCl data one Cl^- is not a ligand (1)

- (ii) Oxidation number of cobalt = +3 (1)

- (iii) (1)

Diagram of *cis* form (1)

Diagram of *trans* form (1)

[max 6]

Names not required by structure
must be shown as 3-D.

10. (a) (i) Iron is oxidised to Fe^{2+} / $\text{Fe} - 2\text{e}^- \Rightarrow \text{Fe}^{2+}$ (1)

Electrons add to oxygen / $2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \Rightarrow 4\text{OH}^-$ (1)

The ions combine $\text{Fe}^{2+} + 2\text{OH}^- \Rightarrow \text{Fe}(\text{OH})_2$ (1)

Further oxidation occurs / $2\text{Fe}(\text{OH})_2 + \frac{1}{2}\text{O}_2 + \text{H}_2\text{O} \Rightarrow 2\text{Fe}(\text{OH})_3$ (1)
 to Fe^{3+}

- (ii) Magnesium has a more negative E° than iron

OR $E^\circ(\text{Mg}) = -2.38 \text{ V}$ (1)

So it is preferentially oxidised (1)

[6]

- (b) (i) $\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \Rightarrow 2\text{SO}_4^{2-} + \text{I}_2$ (1)

- (ii) Fe^{3+} is a homogeneous catalyst (1)

E° of +0.77 is lower than for $\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}$ but higher than for I_2/I^- (1)

$2\text{I}^- + 2\text{Fe}^{3+} \Rightarrow \text{I}_2 + 2\text{Fe}^{2+}$ (1)

$\text{S}_2\text{O}_8^{2-} + 2\text{Fe}^{2+} \Rightarrow 2\text{SO}_4^{2-} + 2\text{Fe}^{3+}$ (1)

[4] *over*