

**JUNE 2002**

**GCE Advanced Level**

**MARK SCHEME**

**MAXIMUM MARK : 40**

**SYLLABUS/COMPONENT :9701 /6**

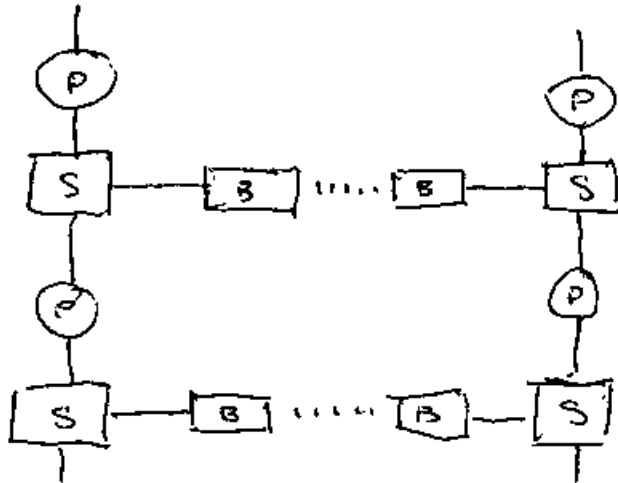
**CHEMISTRY  
(OPTIONS (A2))**

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### Biochemistry

1. (a) The three-dimensional shape / how structure folds or coils (1)  
 contains  $\alpha$ -helix (1)  
 [2]
- (b) - OH hydrogen bonding (1)  
 or any polar group  
 -CO<sub>2</sub><sup>-</sup> or -NH<sub>3</sub><sup>+</sup> 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. -CO<sub>2</sub><sup>-</sup> Ag<sup>+</sup> (1)
- 
- OR disulphide links (1)  
 -CH<sub>2</sub>-S-Ag<sup>+</sup> (1)
- (ii) Heat breaks the weakest bond first (1)  
 van der Waals' or hydrogen bonds (1)
- (iii) Addition of H<sup>+</sup> or OH<sup>-</sup> breaks polar bonds / protonation-deprotonation (1)  
 ionic OR hydrogen bonds  
 OR -CO<sub>2</sub><sup>-</sup> + H<sup>+</sup> ⇒ -CO<sub>2</sub>H (1)  
 [6]

2. (a)



*All low specific bases NOT what it*

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) SO<sub>2</sub> 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) SO<sub>2</sub> is easily oxidised to SO<sub>3</sub> (1)

This dissolves in water to form sulphate ions (1)

Oxidising agents include O<sub>2</sub>, O<sub>3</sub>, NO<sub>2</sub> (one only) (1)

*} allow equations*

(c) SO<sub>2</sub> + H<sub>2</sub>O ⇒ H<sub>2</sub>SO<sub>3</sub> ⇌ H<sup>+</sup> + HSO<sub>3</sub><sup>-</sup> only scores (1)

SO<sub>2</sub> is first oxidised to SO<sub>3</sub> (1)

Then this dissolves : SO<sub>3</sub> + H<sub>2</sub>O ⇒ H<sub>2</sub>SO<sub>4</sub> (1)

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

On burning, the SO<sub>2</sub> is released and reacts with the limestone (1)

SO<sub>2</sub>(g) + CaCO<sub>3</sub>(s) ⇒ CO<sub>2</sub>(g) + CaSO<sub>3</sub>(s) (1)

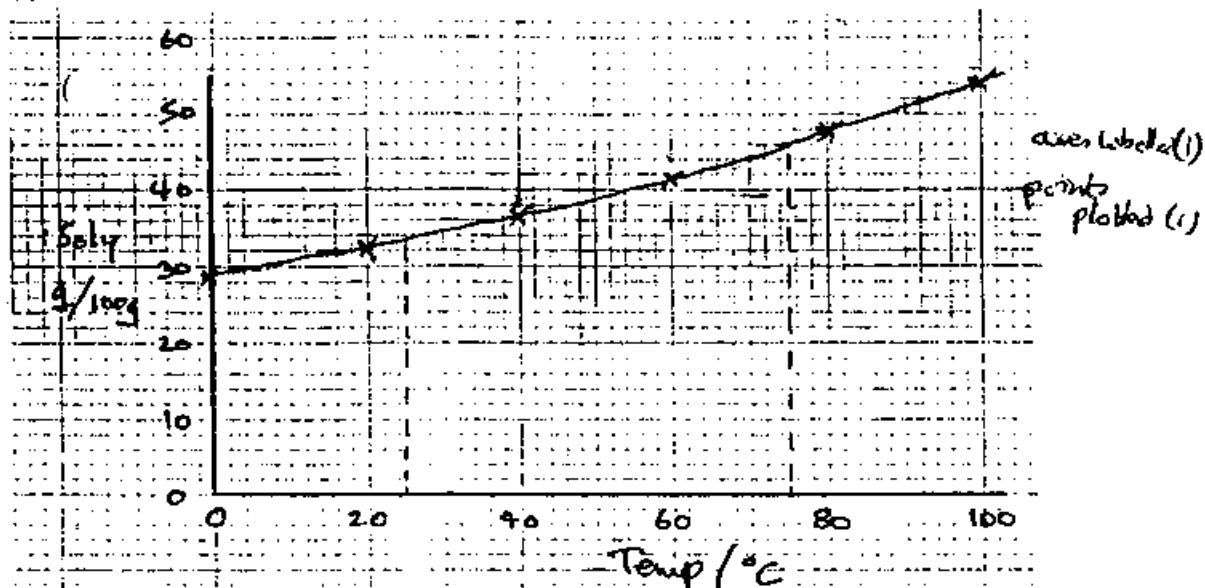
*[max 10]*

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4. (a) Rain water containing CO<sub>2</sub> attacks the limestone (1)
- This forms calcium hydrogencarbonate causing the rock to dissolve (1)
- Raised temperature or alkaline conditions cause HCO<sub>3</sub><sup>-</sup> to precipitate as CO<sub>3</sub><sup>2-</sup> / (low [CO<sub>2</sub>]) 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<sup>2+</sup> 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. (1)
- CO<sub>3</sub><sup>2-</sup> reacts with H<sup>+</sup> 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]

### Phase Equilibria

5. (a) (i)



penalise -1 if axes reversed

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

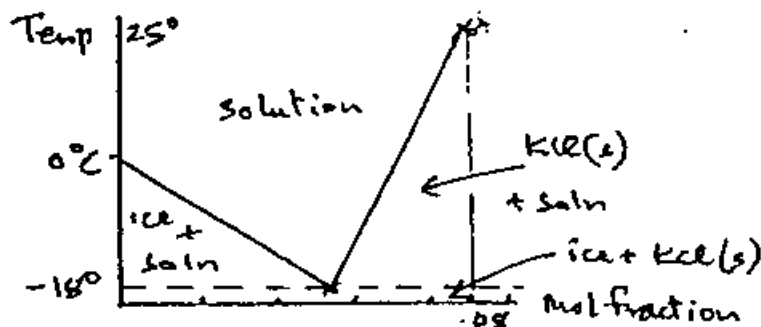
(b) (i) Crystallisation / crystals separate (1)  
 Allow solid or ppt

(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 (2)

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

(d)



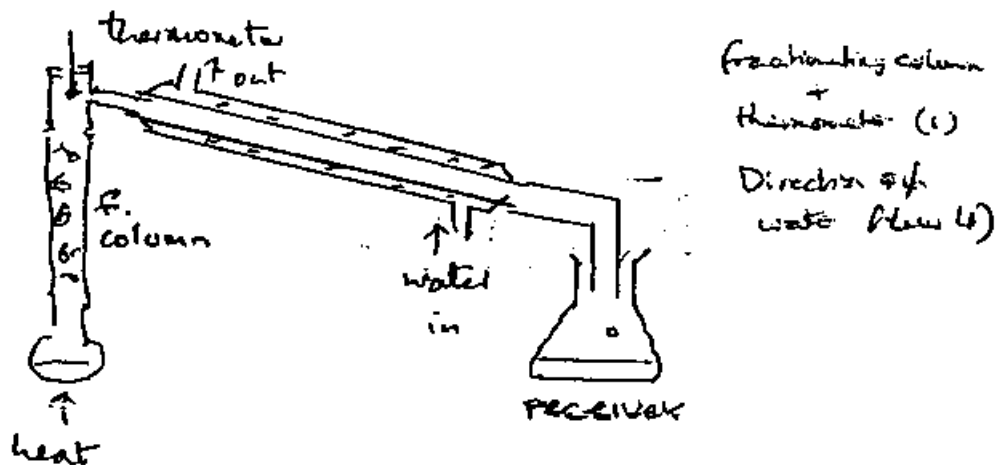
Sketch (1)

3 points (1)

Areas (1)

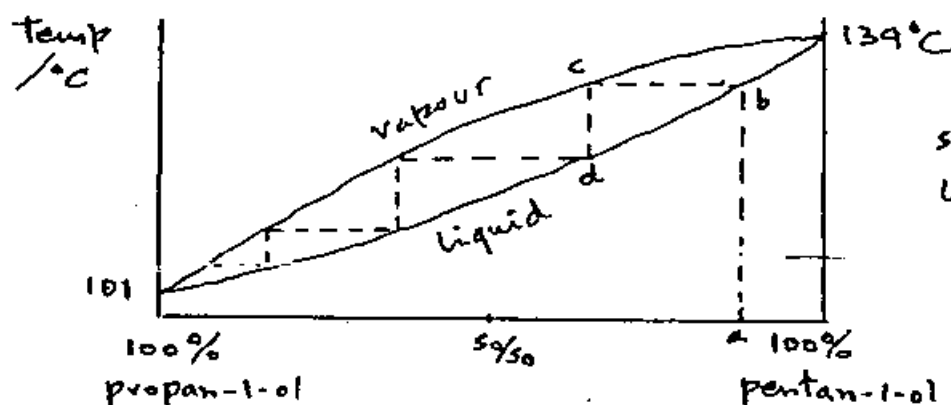
[3]

6. (a)



[2]

(b)



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 tie line } [5]  
 or step

(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 3100-3600 cm<sup>-1</sup> (1)  
 [3]

- (c) Nmr absorptions depend upon the proton environment (1)  
 Aspirin has 8 protons in 3 (4) environments (1)  
 Paracetamol has 9 protons in 4 (5) environments (1)

*Aspirin as 8 protons, paracetamol 9 protons* (3) <sup>[3] max</sup>



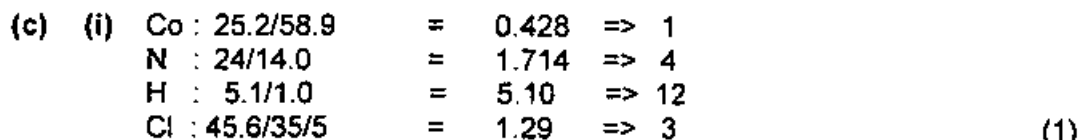
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8. (a) (i)  $^{13}\text{C}$  which gives the M+1 peak (1)
- (ii) Chlorine OR bromine (1)
- $^{35}\text{Cl}$  and  $^{37}\text{Cl}$ , OR  $^{79}\text{Br}$  and  $^{81}\text{Br}$  (1)
- [3]
- (b) Ratio M : M+1 is 100 : 4.4 (1)
- No. of carbons,  $n = \frac{4.4 \times 100}{100 \times 1.1} = 4$  (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  $\text{CH}_3$  (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  $\text{CH}_3\text{CH}_2^+$  allow  $\text{C}_2\text{H}_5$  or  $\text{C}_2\text{H}_4$  (1)
- Do Not insist on charge (3)
- (d)  $M_r$  of F is 72, hence peak at 44 is (M - 28) (1)
- The alkene is therefore  $\text{C}_2\text{H}_4$  (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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Empirical formula =  $\text{CoN}_4\text{H}_{12}\text{Cl}_3$  (1)

Likely ligands = 4 x  $\text{NH}_3$  and 2 x Cl (1)

From A level data one  $\text{Cl}^-$  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  $\text{Fe}^{2+}$  /  $\text{Fe} - 2\text{e}^- \Rightarrow \text{Fe}^{2+}$  (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  $\text{Fe}^{3+}$

(ii) Magnesium has a more negative  $E^\ominus$  than iron

OR  $E^\ominus(\text{Mg}) = -2.38 \text{ V}$  (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)  $\text{Fe}^{3+}$  is a homogeneous catalyst (1)

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