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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level and GCE Advanced Subsidiary Level

MARK SCHEME for the May/June 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 initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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 minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

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Biochemistry

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

```
                 O        CH3  O
                 ‖         |   ‖
NH2 – CH2 – C- NH -CH – C-NH – CH2 – COOH
```
[1]

Displayed structure **[1]**

One peptide linkage shown **[1]**

(ii) Condensation **[1]** **[4]**

(b) **(i)** Weak intermolecular forces of attraction (1) Van der Waals (1) **[2]**

(ii) No attraction/ffinity for water **[1]**

Non-polar structure **[1]** **[4]**

(c) **(i)** Both contain the polyamide structure/-CONH- **[1]**

(ii) Bullet proof vests ; body armour; ropes; airbags; kayaks; gloves; skis; run-flat tyres; shields for jet engines; helmets; racquets; clothing any **one** **[1]** **[2]**

2 **(a)** Diagram: **[1]**

R end – van der Waals forces **[1]**

Phosphate end - ionic/polar **[1]** **[3]**

(b) **(i)** van der Waals interactions/dipole –dipole interactions/temporary dipoles/hydrophobic interactions **[1]**

with the hydrocarbon part of the bilayer **[1]**

(ii) Disrupt it/distort it/weakens the interactions between the bilayers **[1]** **[3]**

(c) K^+ moves into cell, Na^+ moves out of cell **[1]**

This occurs by active transport **[1]**

ATP/adenosine triphosphate provides the energy **[1]**

Integral proteins in the membrane are used **[1]** **[4]**

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Environmental Chemistry

3 **(a)** $Cl_2 + H_2O \rightarrow HOCl + HCl$ / $Cl_2 + H_2O == ClO^- + 2H^+ + Cl^-$ **[1]**

HOC*l* is an oxidising agent which kills bacteria/ClO^- is an oxidising agent which kills bacteria **[1]** **[2]**

(b) Dissolved chlorine will react with organic pollutants in water **[1]**

(c) **(i)** Water softener/removes magnesium or calcium ions from water (as insoluble magnesium or calcium phosphate) **[1]**

(ii) Phosphate encourages growth of algae and bacteria to form an algal bloom **[1]**

Algal bloom prevents sunlight from reaching plants lower down in water so they stop photosynthesising and die **[1]**

Bacteria feeding on dead plants multiply and their respiration uses up all the available dissolved oxygen **[1]**

(iii) $Al^{3+} + PO_4^{3-} \rightarrow AlPO_4$ **[1]**

Moles of $AlPO_4$ = 4.00/ecf from wrong formula or molar ratio **[1]**
Concentration = 0.004 mol dm^{-3}/ecf from wrong number of moles **[1]** **[7]**

4 **(a)** **(i)** $Si_2AlO_9^{7-}$ **[1]**

(ii) Cations can be adsorbed onto surface of clay/attraction between the negative clay and the cation **[1]**

Plants need certain cations such as potassium and by attraction to clay they cannot be washed out of soil easily **[1]** **[3]**

(b) **(i)** Any **two** from
Hydrogen ions adsorbed onto surface of clay / attraction between hydrogen ion and negative clay **[1]**

Some cations attached to clay can raise pH because cation is replaced by proton from water **[1]**

Other cations such as aluminium can lower pH when replaced by hydrogen ion from water **[1]**

(ii) If H^+ is low RCO_2H dissociates to produce H^+/dissociation equilibrium moves to the right **[1]**

If $[H^+]$ is high RCO_2H forms $RCO_2H_2^+$ **[1]** **[4]**

(c) Any **three** from
Liming involves adding calcium hydroxide or calcium carbonate to soil **[1]**

$OH^- + H^+ \rightarrow H_2O$/$CO_3^{2-} + H^+ \rightarrow HCO_3^-$/more complex equations involving clay **[1]**

Can reduce nitrogen content of the soil/$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ **[1]**

Efficiency of liming reduced by acid surges caused by melting of ice containing acidic water **[1]** **[3]**

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Phase Equilibria

5 **(a)** **(i)** V.P. of **A** = vapour pressure of A on own x mol fr. of **A** **[1]**

OR $P_A = P_A x_A$

(ii) 0.3 x 48 = 14.4 **[1]**
0.7 x 36 = <u>25.2</u> **[1]**
39.6 k Pa

(iii) Raoult's law obeyed **[1]**

components are similar/ideal mixture/components not interact **[1]** **[5]**

(b) **(i)** Molecules attract each other OR dipoles align **[1]**
Stronger intermolecular forces than components

(ii)

OR Interact in 1:1 ratio **[1]** **[2]**

(c) pure propanone **[1]**

since this has lowest b.p. OR highest VP
OR is most volatile
(allow discussion of b.p./composition curves) **[1]**

Then azeotrope or 0.50 composition **[1]** **[3]**

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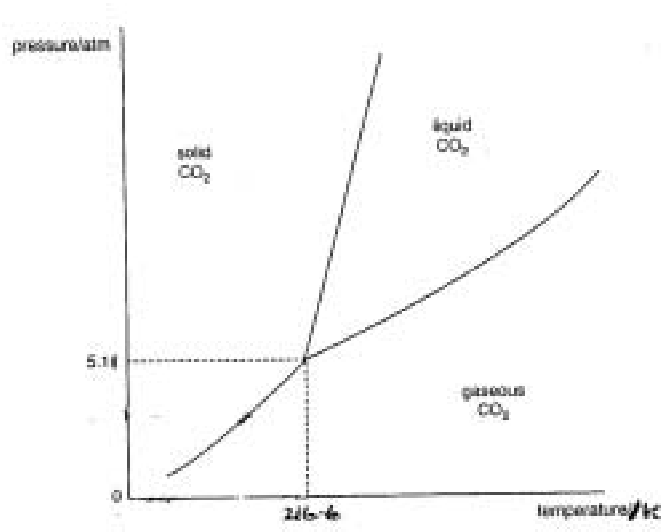
6 (a)



both axes [1]
solid/liquid slope [1]
areas [1]
T.P. (1) values or label [1]
shape [1] **[5]**

(b) (i) line drawn at 298K or indicated **[1]**

value of 60 atm indicated **[1]**

[Explanation **without ref to diagram** only scores **[1]**]

(ii) CO_2 expands from over 60 atm to 1 atm cools **[1]**

to below triplet point, explains solid **[1]** **[4]**

(c) The solid/liquid line has a positive slope for CO_2 rather than the negative slope of water **[1]** **[1]**

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Spectroscopy

7	**(a)**	Two absorptions		**[1]**	
		Asymmetric bend (or diagram)		**[1]**	
		Asymmetric stretch (or diagram)		**[1]**	**[3]**
	(b)	**(i)**	$1710\ cm^{-1}$ – C=O	**[1]**	
			$2260\ cm^{-1}$ – C≡N	**[1]**	
			$3200\ cm^{-1}$ – O–H	**[1]**	
		(ii)	NC-CH_2-CH_2-CO_2H	**[1]**	**[4]**
	(c)	Nmr		**[1]**	
		+ indication of absorptions (CH_2 ~ 1.3 δ, -O-H ~ 4.5 δ)		**[2 x 1]**	
		OR Mass spectrometry		**[1]**	
		+ two examples of likely fragmentations e.g. M-28 (loss of CN) and M-17 (loss of –OH)		**[2 x 1]**	**[3]**
8	**(a)**	Structure **II**		**[1]**	
		A peak at $3450\ cm^{-1}$ is characteristic of -OH would be seen for structure **II**		**[1]**	**[2]**
	(b)	**(i)**	Triplet-quartet is characteristic of a CH_3 next to CH_2 group	**[1]**	
			Standard 1,3,3,1 and 1,2,1 diagrams	**[1]**	
		(ii)	Singlet (1) at δ 2.0 – 3.8 (1)	**[2]**	
		(iii)	Deuterium oxide will exchange protons with -OH group in structure **II**	**[1]**	
			Since deuterium does not absorb in this part of the spectrum the –OH peak would disappear	**[1]**	**[6]**
	(c)	Structure **II** will show $(M\text{-}17)^+$ - loss of OH			
		Structure **I** will show $(M\text{-}31)^+$ loss of CH_3O			
		Structure **II** will show $(M\text{-}43)^+$ loss of C_3H_7			any **two** **[2]**

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Transitions Elements

9 **(a)** **(i)** somewhere between 4% and 20% chromium **[1]**

(ii) Cr forms its oxide/Cr_2O_3 on the steel's surface **[1]**

which is impermeable to oxygen/hard **[1]** **[3]**

(b) **(i)** Cr = 33.6/52 = 0.646
O = 20.6/16 = 1.288
Cl = 45.8/35.5 = 1.290 **[1]**

thus **A** is CrO_2Cl_2 **[1]**

O.N. of chromium = +6 **[1]**

(ii) orange solution contains $Cr_2O_7^{2-}$ **[1]**

$2CrO_2Cl_2 + 3H_2O \longrightarrow Cr_2O_7^{2-} + 6H^+ + 4Cl^-$ **[1]**

white ppte is $AgCl$ *or* $Ag^+ + Cl^- \longrightarrow AgCl(s)$ **[1]**

yellow solution contains CrO_4^{2-} **[1]**

$Cr_2O_7^{2-} + 2OH^- \longrightarrow 2CrO_4^{2-} + H_2O$ **[1]**
[8 max 7] **[7]**

10 **(a)** colour dues to absorption of visible light **[1]**

d-orbitals are split into two sets at different energies **[1]**

photon is absorbed when an electron is promoted to higher orbital **[1]** **[3]**

(b) **(i)** $[Fe(SCN)]^{2+}$ is formed - this is red **[1]**

F^- is a stronger ligand than SCN^- *or* ligand exchange occurs **[1]**

$[FeF_6]^{3-}$ is colourless *or* energy gap between d-orbitals is large **[1]**

(ii) reduction occurs **[1]**

to VO^{2+} (which is blue) **[1]**

$SO_2 + 4H^+ + 2VO_3^- \longrightarrow SO_4^{2-} + 2VO^{2+} + 2H_2O$ **[1]**

(further reduction to) V^{3+} (which is green) **[1]**

$Sn^{2+} + 4H^+ + 2VO^{2+} \longrightarrow Sn^{4+} + 2V^{3+} + 2H_2O$ **[1]**
[8 max 7] **[7]**

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