UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level and GCE Advanced Subsidiary Level

MARK SCHEME for the May/June 2006 question paper

9701 CHEMISTRY

9701/04

Paper 4

Maximum raw mark 60

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*.

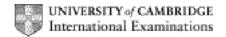
All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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.

• CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the May/June 2006 question papers for most IGCSE and GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



	Page 1		Mark Scheme		Paper
			GCE A/AS Level – May/June 2006	9701	04
1	(a)	(i)	order w.r.t. NO = 2 order w.r.t. O_2 = 1	[1] [1]	
		(ii)	rate = $k[NO]^2[O_2]$	[1]	
			taking the first row: $k = rate/([NO]^2[O_2])$ = 0.020/(0.005 ² x 0.005) = 1.6 x 10 ⁵ units = mol ⁻² dm ⁶ sec ⁻¹	ecf [1] ecf [1]	
		(iii)	rate = $k[NO]^2[O_2]$ = 1.6 x 10 ⁵ x 0.0025 ² x 0.0025 = 2.5 x 10 ⁻³ (mol dm ⁻³ s ⁻¹)	ecf [1]	[6]
	(b)	(i)	homogeneous	[1]	
		(ii)	$ NO + \frac{1}{2}O_2 \longrightarrow NO_2 $ $ SO_2 + NO_2 \longrightarrow SO_3 + NO $ $ (SO_3 + H_2O \longrightarrow H_2SO_4) $	[2]	[3]
					[Total: 9]
2	(a)	(i)	$K_{\rm sp} = [{\rm Ca}^{2^+}][{\rm SO_4}^{2^-}]$	[1]	
			units are: mol ² dm ⁻⁶	ecf [1]	
		(ii)	[CaSO ₄] = $\sqrt{K_{sp}}$ = 5.5 x 10⁻³ (5.477 x 10 ⁻³)(mol dm ⁻³)	ecf [1]	
		(iii)	$n(CaSO_4)$ in 100 dm ³ = 5.5 x 10 ⁻³ x 100 = 0.55 moles	cf from (ii) [1]	
			$M_{\rm r}({\rm CaSO_4}) = 136.1$		
		(if th	Thus mass(CaSO ₄) = 0.55 x 136.1 = 74.8g $(0.55 \times M_r)$ ne accurate [CaSO ₄] is held throughout the calculation, ans = 7	[1] 74.5g)	[5]
	(b)	(i)	down the group: the $\Delta H_{\rm solution}$ becomes more endothermic; both lattice energy and $\Delta H_{\rm hydration}$ become less (exothermic); due to ionic radius (of M ²⁺) increasing; but $\Delta H_{\rm hydration}$ changes more than lattice energy <i>any three point</i>	nts [3]	
		(ii)	$K_{\rm sp} = [{\rm Ba}^{2^+}][{\rm SO_4}^{2^-}] = (9 \times 10^{-6})^2 = 8.1 \times 10^{-11}$	NO ecf [1]	
					[4]
	(c)	(i)	LE is the energy change when 1 mole of (ionic) solid	[1]	
			is formed from its gaseous ions	[1]	
		(ii)	$LE(BaSO_4) < LE(MgSO_4)$, due to larger radius of Ba^{2+} bot	h points [1]	[3]
					[Total: 12]
					=

Paç	je z	wark Scheme	Syllabus	Paper
		GCE A/AS Level – May/June 2006	9701	04
(а) (i)	+2, +3, +4, +5 (ignore 0 and +1)	all four [1]	
	(ii)	[Ar]3d ²	[1]	[2
(b) (i)	take a fixed amount/aliquot/pipette-full of the Fe ²⁺ solution	[1]	•
		titrate with KMnO ₄ in the burette	[1]	
		until the first permanent pink colour (or change from colourless to	o pink) [1]	
		repeat until two titres are within 0.1 cm ³	[1]	
		$MnO_4^- + 8H^+ + 5Fe^{2+} \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ (or molecular equn.)	[1]	
	(ii)	$n(MnO_4^-) = 0.02 \times 14/1000 = 2.8 \times 10^{-4} \text{ moles}$	[1]	
		$n(Fe^{2+})$ in 25 cm ³ = 2.8 x 10 ⁻⁴ x 5	(x 5) [1]	
		(= 1.4 x 10 ⁻³ moles) $n(Fe^{2+})$ in 100 cm ³ = 1.4 x 10 ⁻³ x 4	(x 4) [1]	
		$(= 5.6 \times 10^{-3} \text{ moles})$ mass of Fe in 2.0 g ore = 5.6 x 10^{-3} x 55.8		
		= 0.31 g percentage = 100 x 0.31/2 = 15.6% (use of 55.8 or 56 and %)	[1]	ro
10	\	$Cu^{2+}(aq)$ or $[Cu(H_2O)_6]^{2+}$	[4]	[9
(C) (1)		[1]	
	(ii)	pale blue ppt . (of $Cu(OH)_2(s)$) [ignore any refs. to iron hydroxic (which dissolves to give)	des] [1]	
		a deep blue solution	[1]	
		which contains [Cu(NH ₃) ₄] ²⁺ ions (can be read into equn, below	w) [1]	
		formed by ligand displacement or an equation such as	[1]	
		$Cu(OH)_2 + 4NH_3 \longrightarrow [Cu(H_2O)_4]^{2+} + 2OH^{-}$		
		or $[Cu(H_2O)_6]^{2+} + 4NH_3 \longrightarrow [Cu(H_2O)_4]^{2+} + 6H_2O$		[5

Mark Scheme

Page 2

[Total: 16 max 14]

Syllabus

Paper

Page 3	Mark Scheme	Syllabus	Paper
	GCE A/AS Level – May/June 2006	9701	04

4 (a) $HClor H_2SO_4 or H^+$ or acid

[1]

[1]

conc(if HCl only)/dilute/aqueous + heat

[2]

(b) two rings only (1 ring around the α -C of tyrosine & 1 around the α -C of lysine) [1]

[1]

(c) [†]NH₃CH₂CO₂ (or displayed formula)

[1]

(d) (i) $NH_2CH_2CO_2^-(Na^+)$ (either $-CO_2^-Na^+$ or $-CO_2Na$ but NOT -CO-O-Na) [1]

[4]

[1]

(ii) $(Na^+)^-O-C_6H_4-CH_2CH(NH_2)CO_2^-(Na^+)$

[1] + [1]

(iii) $(Ct)^{+}NH_{3}(CH_{2})_{4}CH(NH_{3}^{+})CO_{2}H(Ct)$

[1] + [1]

[1]

(iv) $HO-C_6H_2Br_2-CH_2CH(NH_2)CO_2H$ (if shown, Br at 2,6 to OH group)

[6]

(e)

structure [1]

at least one peptide group identified [1]

[2]

(f) (i) e.g.

$$- CH_2 - NH - CO - NH - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH - CO - NH - CH_2 - CH_2 - NH - CO - NH - CH_2 - CH_2 - NH - CH_2 - CH_2 - NH - CO - NH - CH_2 - CH_2 - NH - CH_2 - CH_$$

(ii)

$$HO_2C$$
 CO_2H $H_2N-CH_2-CH_2-NH_2$ [1] [1] [1]

[Total: 15 max 14]

Page 4		Mark Scheme	Syllabus	Paper
		GCE A/AS Level – May/June 2006	9701	04
(a)	l:	HNO ₃ + H ₂ SO ₄ (or names)	[1]	
		(both) conc. and at $50^{\circ}\text{C} < T < 60^{\circ}\text{C} \checkmark$	[1]	
	II:	KMnO ₄ (+OH ⁻) + heat	[1]	
	III:	Sn + (conc) HCl	[1]	
	IV:	CH ₃ CH ₂ OH (or name)	[1]	
		+ c. H ₂ SO ₄ + heat	[1]	[6]
(b)				[6]
		$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	+ H+	
		intermediate, including ⊕ NO₂⁺ at start and H⁺ at finish (no marks for curly arrows, but if present, they must be in correct	[1] [1] ct direction)	[2]
(c)	(i)	ester and (primary) amine	[2]	
	(ii)		points [1]	
		(()		[3]
			j	Total: 11]
	(a)	(a) : : : V: (b)	GCE A/AS Level – May/June 2006 (a) I: HNO ₃ + H ₂ SO ₄ (or names) (both) conc. and at 50°C < T < 60°C ✓ II: KMnO ₄ (+OH⁻) + heat III: Sn + (conc) HC1 IV: CH ₃ CH ₂ OH (or name) + c. H ₂ SO ₄ + heat (b) CH ₃ (c) intermediate, including ⊕ NO ₂ ⁺ at start and H⁺ at finish (no marks for curly arrows, but if present, they must be in correct (c) (i) ester and (primary) amine	(a) I: HNO ₃ + H ₂ SO ₄ (or names) [1] (both) conc. and at 50°C < T < 60°C ✓ [1] II: KMnO ₄ (+OH') + heat [1] III: Sn + (conc) HCI [1] IV: CH ₃ CH ₂ OH (or name) [1] + c. H ₂ SO ₄ + heat [1] (b) (b) (c) (i) ester and (primary) amine [2] (ii) more basic: amine group is not adjacent to benzene ring (or lone pair (on N) is not delocalised)