UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the June 2005 question paper

9701 CHEMISTRY

9701/04 **Paper 4 (Structured Questions A2 Core), 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*.

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Grade thresholds for Syllabus 9701 (Chemistry) in the June 2005 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 4	60	45	40	22

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

June 2005

GCE A LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/04

CHEMISTRY
Paper 4 (Structured Questions A2 Core)

UNIVERSITY of CAMBRIDGE
International Examinations

1 **(a)** **(i)** Ammeter/galvanometer **[1]**

Clock/watch/timer (**or** rheostat) **[1]**
(For items above 2 in number, e.g. voltmeter, penalise **[1]**)

(ii) Diagram to show ammeter (allow symbol) in circuit, and **[1]**
complete circuit with ⊖ terminal of power pack connected to LH electrode **[1]**

(iii) Volume/amount of hydrogen/gas **[1]**

Time **[1]**

Current/amps/ammeter reading
(ignore extra measurements) **[1]**

Part (a): [7]

(b) **(i)** $F = L \times e$ **[1]**

(ii) $L = 9.63 \times 10^4 / 1.6 \times 10^{-19}$ = **6.02×10^{23}** (**must** show working) **[1]**

Allow 6.0 but not 6 or 6.01 **Part (b): [2]**

Total: [9]

2 **(a)** The **power/index/exponent** to which a **concentration** term is raised in a **rate equation**

or ^{a} in rate = **k**$[A]^a$ (k is needed – or can use rate $\alpha [A]^a$) **[1]**

Part (a): [1]

(b) **(i)** 1st order w.r.t. propanone **[1]**

Zero order w.r.t. H^+ ions **[1]**

1st order w.r.t. CN^- ions **[1]**

(ii) Rate = k [propanone][CN^-] (e.c.f. from **(i)**) **[1]**

(iii) Mechanism **B** (**or A** – see grid below), with the first (**or** second – see grid below) step being the slow step, **[1]**

(since H^+ does not appear in rate equation) it must be involved **after** the slow step **or** [H^+] is not involved in slow step **[1]**

Grid for e.c.f. in first mark of **(iii)**

Deductions in (i) or (ii)			E.C.F. deductions in (iii)	
[Propanone]	[CN^-]	[H^+]	Mechanism	Slow step
1	1	0	B	1st
1	0	1	A	1st
1	1	1	A **or** B	2nd
Any other			No e.c.f. mark can be awarded	

Part (b): [6]

Total: [7]

3 **(a)** **(i)** It is an endothermic reaction, **or** taking in heat **[1]**

It has a high activation energy/E_a **[1]**

(ii) $MgCO_3$ will decompose at a **lower** temperature/needs less energy **[1]**

Mg^{2+} is a smaller (ion) than Ca^{2+} **or** Mg^{2+} has high charge density **[1]**

So polarises/distorts the anion CO_3^{2-} ion more easily
[*or* LE(MgO) > LE(CaO)] **[1]**

Part (a): [5]

(b) $\Delta H = 82 - 178 =$ **-96** (kJ mol^{-1}) **[1]**

Part (b): [1]

(c) $[CaMg(CO_3)_2 \longrightarrow CaO + MgO + 2CO_2]$

$M_r(CaMg(CO_3)_2) = 40.1 + 24.3 + 24 + 96 =$ **184.4** **[1]**

$M_r(2CO_2) = 2 \times 44 =$ **88**

$\therefore$ % loss in mass = $100 \times \frac{88}{184.4} =$ **47.7%** (e.c.f. in 184.4) **[1]**

Allow 48%. Also allow 48.8% if $M_r = 184$

Part (c): [2]

Total: [8]

4 **(a)** **(i)** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$ **or** [Ar] $3d^6 4s^2$ **[1]**

(ii) Coloured compounds/ions/solutions/ppts; paramagnetic; variable oxidation state/valency/more than one ion; dense metals; high melting point metals; are catalysts; form complexes **(ANY 2) [1] + [1]**

Part (a): [3]

(b) **(i)** $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ **[1]**

$E^\ominus = 1.52 - 0.77 = 0.75V$ (allow e.c.f. 0.90V for MnO_2 **[1]**

(ii) MnO_4^- is purple/**highly** coloured **[1]**

End point is **first** (permanent) pink colour **or** colourless-to-pink (Allow yellow-to-pink but **not** purple-to-pink) **[1]**

Part (b): [4]

(c) Water molecules are ligands, in that they coordinate/form **dative bonds** (to the Fe ion) with their (lone**) pairs** of electrons **or** lone pairs are donated. **[1]**

A complex ion is an ion/Fe^{3+} surrounded by/joined to ligands **or** $[Fe(H_2O)_6]^{3+}$ **[1]**

Part (c): [2]

(d) **(i)** Haemoglobin transports oxygen in the **blood or** from **lungs** (to tissues) **[1]**

(ii) CO forms stronger bonds to Hb/Fe^{2+} than does O_2 **or** CO has higher affinity **or** bonds irreversibly **or** forms more stable complex **[1]**

Part (d): [2]

(e) Reagent: $I_2 + OH^-$ **[1]**

Observations - ethanol: yellow **ppt**./antiseptic smell; methanol: no change **[1]**

Part (e): [2]

Total: [13]

5 **(a)** $K_a = [RCO_2^-][H^+]/[RCO_2H]$ **[1]**

Part (a): [1]

(b) **(i)** The more chlorine atoms in the molecule, the stronger the acid, **[1]**

due to the electron-withdrawing (inductive) effect of Cl... **[1]**
either...stabilising the anion, **or** spreading (-) charge more,
or...weakening the O-H bond in the acid, **or**...increasing ionisation,
or…facilitates H^+ donation
or…causing the equilibrium $RCO_2H \rightleftharpoons RCO_2^- + H^+$ to lie further to the right.
Mark is conditional on reference to the effect of presence of chlorine. **[1]**

(ii) $[H^+] = \sqrt{(0.1 \times 1.4 \times 10^{-3})}$ = 0.0118 (mol dm^{-3}) allow 0.012 **[1]**

$\therefore$ $pH = -\log_{10}(0.0118)$ = **1.93** Allow 1.9 or 1.92 e.c.f. **[1]**

(iii) $pK_a = -\log_{10}(5.5 \times 10^{-2})$ = **1.26** Allow 1.3 **[1]**

Part (b): [6]

(c) **(i)** Cl_2(**aq**) $AlCl_3$ or UV negates **[1]**

(ii) Electrophilic substitution **or** addition-elimination **[1]**

Nucleophilic substitution **or** electrophilic substitution on OH group
If neither mark is awarded, could give "salvage" mark for substitution x2 **[1]**

(iii) **Either:** add Br_2(**aq**) phenol decolourises it, or gives a white ppt.
or: add $FeCl_3$(**aq**) phenol give a purple colour
or: add NaOH(**aq**) phenol dissolves
or: add UI solution phenol goes yellow/orange (**A** stays green)
or: add "diazonium"to solution in OH^-
phenol gives orange/red colour
(in each case, **A** give no reaction)

or: add $Cr_2O_7^{2-}/H^+$/warm **A** changes colour from orange to green
or: add MnO_4^-/H^+/warm **A** changes from purple to colourless
or: add $PCl_5/POCl_3/PCl_3/SOCl_2$ **A** gives fumes
or: add CH_3CO_2H + conc. H_2SO_4 **A** gives fruity smell

(in each case, no change with phenol)

Test + reagents **[1]** **Both** observations **[1]**

Part (c): [5]

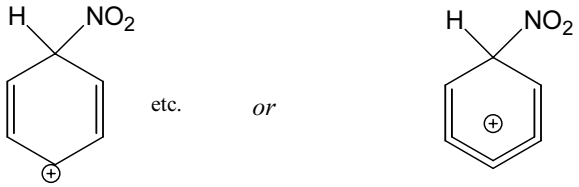
Total: [12]

6 **(a)** **(i)** Electrophilic substitution **or** nitration **[1]**

(ii) $HNO_3 + H_2SO_4$ **[1]**

(both) conc., and at 50°C ≤ T ≤ 60°C **[1]**

(iii) NO_2^+ **[1]**



Any ⊕ on NO_2 or H negates **[1]**

H^+ **[1]**

Part (a): [6]

(b) **(i)** Reduction **[1]**

(ii) Sn/Fe/Zn/$SnCl_2$ + HCl/H^+/H_2SO_4 (but not conc. H_2SO_4)
or H_2 + Ni/Pt (**not** $LiAlH_4$) **[1]**

Part (b): [2]

(c) PCl_5/PCl_3/$SOCl_2$/$POCl_3$ (+ heat) aq negates **[1]**

Part (c): [1]

(d) **(i)** An amide, **not** peptide **[1]**

(ii) Heat with H_3O^+ **or** heat with OH^-(**aq**)

Or warm (**not** heat/reflux) with aqueous amidase/peptidase/protease **not** enzyme/trypsin/chymotrysin/pepsin/papain etc. **[1]**

Part (d): [2]

Total: [11]