

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the November 2004 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 taken for Syllabus 9701 (Chemistry) in the November 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 4	60	44	39	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.



November 2004

GCE A LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/04

CHEMISTRY
Paper 4 (Structured Questions A2 Core)



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	A LEVEL – NOVEMBER 2004	9701	4

- 1 (a) (i) strong, because final pH is about 14 [1]
- (ii) $\text{pH} = 0.70 \Rightarrow [\text{H}^+] = 10^{-0.7} = 0.20 \text{ (mol dm}^{-3}\text{)}$ [1]
- $\therefore [\text{H}_2\text{SO}_4] = (0.10 \text{ mol dm}^{-3})$ ecf [1]
- (iii) (end point is at $34.0 \text{ cm}^3 (\pm 0.5 \text{ cm}^3)$, so)
- amount of H^+ used = $0.2 \times 25/1000 = 0.0050 \text{ mol}$ ecf from (ii) [1]
- moles of guanidine = moles of H^+ = 0.0050 mol
- [guanidine] = $0.005 \times 1000/34.0 = \mathbf{0.147} \text{ (mol dm}^{-3}\text{)}$ [1]
- allow range: $0.145 - 0.149$ ecf in 0.005 or 34.0
- (iv) $M_r = 8.68/0.147 = \mathbf{59}$ (allow range 58 – 60) ecf from (iii) [1] 6
- (b) (i) $\longrightarrow 7 \text{ CaSO}_4 + 3 \text{ Ca}(\text{H}_2\text{PO}_4)_2 + 2 \text{ HF}$ [1]
- (ii) M_r values: $\text{Ca}(\text{H}_2\text{PO}_4)_2 = 234.1$, $\text{H}_2\text{SO}_4 = 98.0$ [1]
- $234.1 \times 3 = \mathbf{702.3}$ $98 \times 7 = \mathbf{686}$ both [1]
- ecf from ratios in equation, and from M_r values
- \therefore mass of H_2SO_4 needed = $1.0 \times 686/702.3 = \mathbf{0.98} \text{ kg}$ [1]
- (correct answer = [3] marks. accurate value is: 0.977 kg.
Allow ecf from incorrect M_r or incorrect multipliers) 4
- (c) (i) A solution that **resists** changes in pH [NOT: results in **no** pH change] [1]
- when **small amounts** of H^+ or OH^- are added [1]
- (ii) $\text{pH} = -\log_{10}(6.3 \times 10^{-8}) + \log_{10}(0.1/0.2) = \mathbf{6.9}$ [1]
- or $[\text{H}^+] = (6.3 \times 10^{-8}) \times 0.2/0.1 = 1.26 \times 10^{-7}$
- $\therefore \text{pH} = -\log_{10}(1.26 \times 10^{-7}) = \mathbf{6.9}$ 3
- Total 13**
- 2 (a) $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \longrightarrow 2\text{H}_2\text{O}$ (or equation $\div 2$) [1] 1
- (b) \oplus [1] 1
- (c) 1.23 (V) (ignore sign) [1] 1
- (d) a better/larger salt bridge or a diaphragm or larger (area of) electrodes
or increase concentrations/pressure [1] 1

Page 2	Mark Scheme	Syllabus	Paper
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- (e) time = $400 \times 24 \times 60 \times 60 = 34\,560\,000$ seconds [1]
charge = current \times time = $0.01 \times 34\,560\,000 = 345\,600$ C ecf [1]
moles of H = $345\,600/96\,500 = 3.6$ mol \therefore mass of H = **3.6 g** ecf [1] 3

- (f) advantages: less pollution/ CO_2 / NO_x etc. or cleaner by-products
less dependence on fossil fuels/finite resources any one [1]
disadvantages: more expensive (to develop or to run)
takes up more space
poor power-to-volume ratio
hydrogen is difficult to store or to transport any one [1]
NOT hydrogen is explosive/flammable 2

Total 9

- 3 solubilities **decrease** down the group [1]
hydration energy of the cation decreases [1]
lattice energy stays the same, or decreases less than H.E. [1]
making $\Delta H_{\text{solution}}$ more endothermic or H.E. no longer able to overcome -L.E. [1] 4

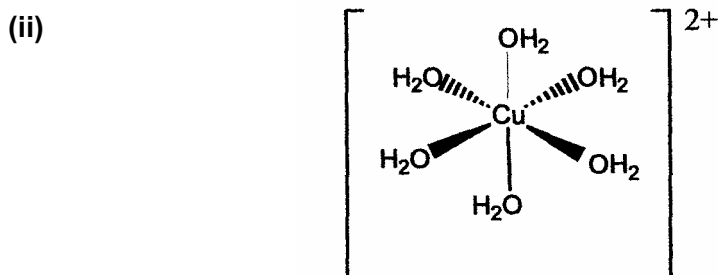
Total 4

- 4 (a) an element forming one or more ions with a partially filled/incomplete d-shell [1] 1
(b) (i) almost no change (allow *slight* increase or *slight* decrease) [1]
(ii) density should increase [1]
because A_r is increasing but size/volume/radius stays the same [1]

(allow partial ecf from b (i)) 3

- (c) $3d^9$ [1] 1

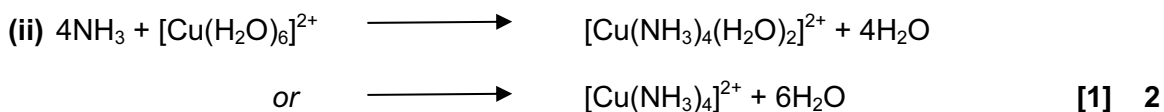
- (d) (i) an ion formed when a ligand (datively) bonds to a (central metal) cation [1]



[1] 2

Page 3	Mark Scheme	Syllabus	Paper
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(e) (i) dark/deep/navy/royal/Oxford blue or purple [NOT Prussian blue or lilac or mauve] [1]



(f) CuCl_4^{2-} is produced [1]

the equilibrium is **reversible** or \rightleftharpoons in equation [1]

Cl^- ligands **replace/exchange** with H_2O ligands (in words) [1]

(the following equation is worth the first two marks)



Total 12

5 (a) (i) $\text{AlCl}_3/\text{FeCl}_3/\text{Al}/\text{Fe}/\text{I}_2$ (+ heat) [aq negates] (N.B. NOT AlBr_3 etc.) [1]

(or names)

(ii) (sun)light/hf/UV (aq negates) [1] 2

(b) $\text{SOCl}_2/\text{PCl}_3/\text{PCl}_5$ [aq negates] [1]

(or names) 1

(c) (i) $\text{C} > \text{B} > \text{A}$ (i.e. a mark in the penultimate box) [1]

(ii) (*acyl chloride fastest*) highly δ^+ carbon atom joined to 2 electronegative atoms

or addition-elimination mechanism is possible [1]

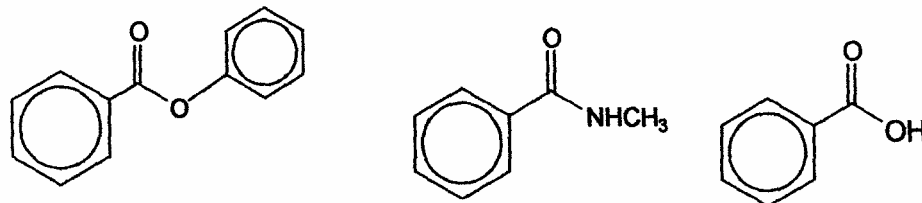
(*aryl chloride slowest*) delocalisation of lone pair over ring \Rightarrow stronger C-Cl bond

or impossibility of 'backside' attack on the C-Cl bond [1] 3

Page 4	Mark Scheme	Syllabus	Paper
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- | | | | |
|-----|---------------------|-------------------|----------------|
| (d) | $C_6H_5-CO_2C_6H_5$ | $C_6H_5-CONHCH_3$ | $C_6H_5-CO_2H$ |
| | [1] | [1] | [1] |

OR



3

Total 9

- 6 (a) (i) E [1]
- (ii) $CH_3CH_2CH_2CO_2^-(Na^+)$ [NOT $C_3H_7COO-Na$ or C_3H_7COOH] [1]

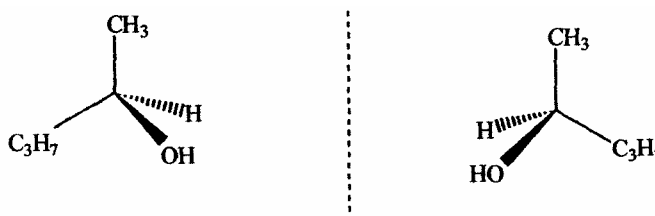
[but allow $CH_3CH_2CH_2CO_2Na$]

CH_3 or name [1] 3

- (b) the alcohol from E has four different groups around a carbon atom [1]

∴ it is chiral/asymmetric or it is produced as a 50:50 mixture of mirror images [1]

or its mirror images are non-superimposable



formulae: [1]

the alcohol from D has 2 identical groups on its central carbon atom [1]

4 max 3

Total 6

- 7 (a) orange colour disappears/bromine is decolourised (NOT discoloured, or goes clear) [1]

(white) precipitate/solid/crystals is formed [1] 2

Page 5	Mark Scheme	Syllabus	Paper
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- (b) e.g. add neutral FeCl_3 (aq) – violet colour with phenol
- or add universal indicator – red/orange colour with phenol
- or add Na metal – fizzing/ H_2 evolved with phenol
- or add NaOH (aq) to the pure compound – phenol would dissolve
- or add H^+ (aq) to the pure compound – phenylamine would dissolve
- or add HNO_2 at room temperature – phenylamine would produce gaseous N_2 .
- or add HNO_2 at 5°C , followed by an alkaline solution of phenol – phenylamine would produce a coloured (orange) dye **[1] 1**
- (c) **IV** KMnO_4 + heat **[1]**
- V** $\text{HNO}_3 + \text{H}_2\text{SO}_4$ **[1]** (both) conc^d and at $50^\circ\text{C} < T < 60^\circ\text{C}$ **[1]**
- VI** $\text{Sn} + \text{HCl}$ (NOT LiAlH_4) **[1] 4**
- Total 7**