**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*.

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

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

**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**<br>**CHEMISTRY**<br>**Paper 4 (Structured Questions A2 Core)** |

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**1** **(a)** **(i)** strong, because final pH is about 14 **[1]**

**(ii)** (pH = 0.70) ⇒ $[H^+] = 10^{-0.7}$ = 0.20 (mol $dm^{-3}$) **[1]**

∴ $[H_2SO_4]$ = (0.10 mol $dm^{-3}$) ecf **[1]**

**(iii)** (end point is at 34.0 $cm^3$ ($\pm$ 0.5 $cm^3$), so)

amount of $H^+$ used = 0.2 x 25/1000 = 0.0050 mol ecf from **(ii)** **[1]**

moles of guanidine = moles of $H^+$ = 0.0050 mol

[guanidine] = 0.005 x 1000/34.0 = **0.147** (mol $dm^{-3}$) **[1]**

*allow range: 0.145 – 0.149* ecf in 0.005 or 34.0

**(iv)** $M_r$ = 8.68/0.147 = **59** (*allow range* 58 – 60) ecf from **(iii)** **[1]** **6**

**(b)** **(i)** ⟶ **7** $CaSO_4$ + **3** $Ca(H_2PO_4)_2$ + **2** HF **[1]**

**(ii)** $M_r$ values: $Ca(H_2PO_4)_2$ = 234.1, $H_2SO_4$ = 98.0 **[1]**

234.1 x 3 = **702.3** 98 x 7 = **686** both **[1]**

ecf from ratios in equation, and from $M_r$ values

∴ mass of $H_2SO_4$ needed = 1.0 x 686/702.3 = **0.98** 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)** pH = $-\log_{10}(6.3 \times 10^{-8}) + \log_{10}(0.1/0.2)$ = **6.9** **[1]**

or $[H^+] = (6.3 \times 10^{-8}) \times 0.2/0.1 = 1.26 \times 10^{-7}$

∴ pH = $-\log_{10}(1.26 \times 10^{-7})$ = **6.9** **3**

**Total 13**

**2** **(a)** $O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$ (or equation ÷ 2) **[1]** **1**

**(b)** ⊕ **[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**

**(e)** time = 400 x 24 x 60 x 60 = 34 560 000 seconds **[1]**

charge = current x time = 0.01 x 34 560 000 = 345 600 C ecf **[1]**

moles of H = 345 600/96 500 = 3.6 mol ∴ 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 $\Delta H_{solution}$ 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]**

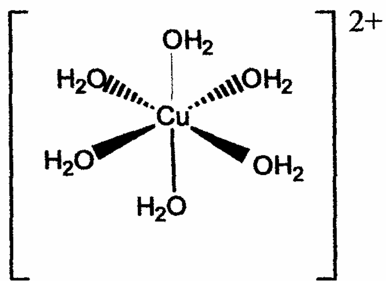
because $A_r$ is increasing but size/volume/radius stays the same **[1]**

(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]**

**(ii)**




**[1]** 2

**(e)** **(i)** dark/deep/navy/royal/Oxford blue *or* purple [NOT Prussian blue or lilac or mauve] **[1]**

**(ii)** $4NH_3 + [Cu(H_2O)_6]^{2+} \longrightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 4H_2O$

*or* $\longrightarrow [Cu(NH_3)_4]^{2+} + 6H_2O$ **[1]** **2**

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

the equilibrium is **reversible** *or* ⇌ in equation **[1]**

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

(the following equation is worth the first two marks)

$[Cu(H_2O)6]^{2+} + 4Cl^- \rightleftharpoons [CuCl_4]^{2-} + 6H_2O$ **3**

**Total 12**

**5** **(a)** **(i)** $AlCl_3$/$FeCl_3$/Al/Fe/$I_2$ (+ heat) [aq negates] (N.B. NOT $AlBr_3$ etc.) **[1]**

(or names)

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

**(b)** $SOCl_2$/$PCl_3$/$PCl_5$ [aq negates] **[1]**

**(**or names) **1**

**(c)** **(i)** C > B > A (i.e. a mark in the penultimate box) **[1]**

**(ii)** (*acyl chloride fastest*) highly $\delta$+ carbon atom joined to 2 electronegative atoms

*or* addition-elimination mechanism is possible **[1]**

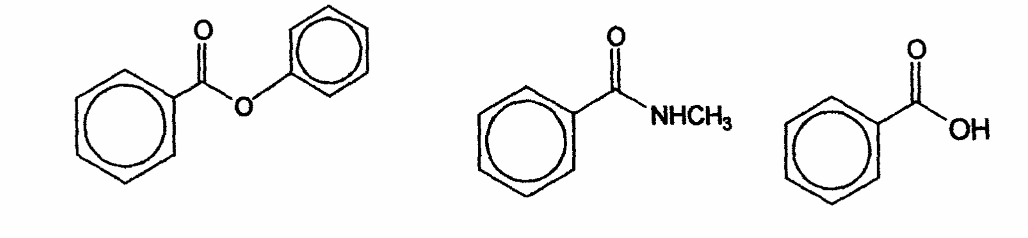
(*aryl chloride slowest*) delocalisation of lone pair over ring ⇒ stronger C-C*l* bond

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

**(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]**

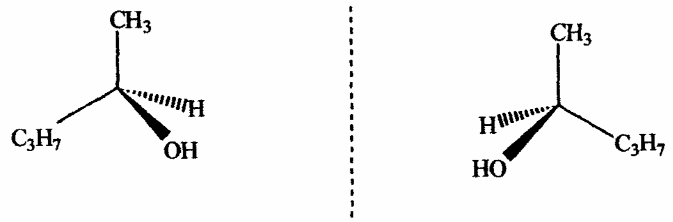
[but allow $CH_3CH_2CH_2CO_2Na$]

$CHI_3$ *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**

**(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** $HNO_3 + H_2SO_4$ **[1]** (both) conc[d] and at 50 °C < T < 60 °C **[1]**

**VI** Sn + HCl (NOT $LiAlH_4$) **[1]** **4**

**Total 7**