UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the November 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*.

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

CIE is publishing the mark schemes for the November 2005 question papers for most IGCSE and GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

UNIVERSITY *of* CAMBRIDGE
International Examinations

1 **(a)** M_r(AgBr) = 108 + 79.9 = 187.9 [1]

moles = 2.5 x 10^{-12}/187.9 = 1.33 x 10^{-14}

no. of ions = 1.33 x 10^{-14} x 6 x 10^{23} = **8.0 x 10^{9}** ions (correct ans = [2]) [1]

2

(b) **(i)** **A**: platinum **C**: voltmeter
B: H^+(aq) *or* HC*l*(aq) *or* H_2SO_4(aq) **D**: silver (wire) 4 x [1]
(ignore concentration)

(ii) (As [Ag^+] decreases), the potential will decrease/become more negative [1]

(iii) K_{sp} = [Ag^+][Br^-] = $(7.1 \times 10^{-7})^2$ = **5.0**(41) **x 10^{-13} mol^{2}dm^{-6}** [1]

units [1]

7

(c) **(i)** $Ag^+(g) + Br^-(g) \longrightarrow AgBr(s)$ [1]

(ii) LE = ΔH_f - (all the rest)

= -100 – (731 + 285 + 112 – 325)

(= -100 - 731 - 285 - 112 + 325)

= **-903** kJ mol^{-1} (-[1] for each error of sign or maths) [2]

(iii) LE(*AgCl*) should be higher/more negative,
due to size/radius of C*l*$^-$ being less than that of Br^- (both) [1]

4

(d) **more** energy needed, since $r_{Cl^-} < r_{Br^-}$ *or* ionised electron nearer to nucleus
or less shielding etc. *or* in terms of I.E.(C*l*) > I.E.(Br)

1

total: 14

2 **(a)** The EMF of a cell made up of the test electrode and a standard hydrogen electrode. [1]
(*or* the EMF of the electrode compared to the S.H.E.)

EMF measured under standard conditions of T, (P) and concentration. [1]
(*or* at 298K and 1 mol dm^{-3})

2

(b) The stronger the halogen is as an oxidising agent, the more positive is its $E^{\ominus}$ value. [1]

Two examples of F_2/F^-, Cl_2/Cl^-; Br_2/Br^-, I_2/I^- quoted [1]

(data: F_2/F^- = +2.87V
Cl_2/Cl^- = +1.36V
Br_2/Br^- = +1.07V
I_2/I^- = +0.54V)

2

(c) **(i)** $H_2O_2 + 2I^- + 2H^+ \longrightarrow I_2 + 2H_2O$
or $H_2O_2 + 2KI + 2H^+ \longrightarrow 2K^+ + I_2 + 2H_2O$ [1]

$E^{\ominus}$ = 1.77 - 0.54 = **1.23** V [1]

(ii) $Cl_2 + SO_2 + 2H_2O \longrightarrow 2Cl^- + SO_4^{2-} + 4H^+$
or $Cl_2 + SO_2 + 2H_2O \longrightarrow 2HCl + H_2SO_4$ [1]

$E^{\ominus}$ = 1.36 – 0.17 = **1.19** V [1]

4

(d) since $E^{\ominus}(I_2/I^-)$ is +0.54V, tin will be oxidised to **Sn^{4+}** [1]
($E^{\ominus}$ for Sn^{2+}/Sn = -0.14V and $E^{\ominus}$ forSn^4/Sn^2 = +0.15V)

Thus: $Sn + 2I_2 \longrightarrow SnI_4$ [1]

2

total: 10

3 (a) (i) melting point: graph showing (Si (+ Ge): medium)
and C: higher than Si/Ge [1]
Sn + Pb: lower than Si/Ge [1]

conductivity: graph showing (Si (+ Ge): medium)
and C: lower (or higher!) than Si/Ge [1]
Sn + Pb: higher than Si/Ge [1]
[for your information, the actual figures are shown below]

(ii) Sn, Pb (and C(graphite)) have delocalised electrons/metallic bonds [1]
Si, Ge (and C(diamond)) have localised electrons/covalent bonds [1]
[for [2] marks carbon has to be mentioned once, and the allotrope mentioned must fit in with the conductivity shown]

6

(b) (i) e.g. CO burns to give CO_2 [$2CO + O_2 \longrightarrow 2CO_2$]
or CO reduces Fe_2O_3 [$3CO + Fe_2O_3 \longrightarrow 3CO_2 + 2Fe$]

(ii) e.g. PbO_2 decomposes on heating [$2PbO_2 \longrightarrow 2PbO + O_2$]
two valid examples [1]
two balanced equations [1] + [1]
[two valid and balanced equations warrants [3] marks]

3

(c) use: pottery/china/porcelain etc + property: hardness, high melting point, insulator etc.
(any one use + one relevant property) [1]

1

(d) (i) amphoteric [1]

(ii) e.g. $SnO + 2HCl \longrightarrow SnCl_2 + H_2O$ [1]

e.g. $SnO + 2NaOH \longrightarrow Na_2SnO_2 + H_2O$ [1]

3

total: 13

(Actual figures for (a) (i):)

element	m.pt./°C	conductivity
C(graph)	3652	2×10^{3}
C(dia)	3550	1×10^{-15}
Si	1410	2×10^{-2}
Ge	937	2×10^{-2}
Sn	232	9×10^{4}
Pb	328	5×10^{4}

4 **(a)** $HO\text{-}C_6H_4\text{-}NH_2 + 2AgBr + 2OH^- \rightarrow O{=}C_6H_4{=}O + H_2O + NH_3 + 2Ag + 2Br^-$ [1]
(*or* C_6H_7NO) (*or* $C_6H_4O_2$)

1

(b) rodinol should be **less basic** than NH_3 [1]

because the lone pair on N is delocalised over/overlaps with the aryl ring [1]

2

(c) **E** is $H_2N\text{-}C_6H_4\text{-}O^-\ Na^+$ *or* $H_2N\text{-}C_6H_4\text{-}ONa$ [1]

F is $HO\text{-}C_6H_4NH_3^+\ Cl^-$ *or* $HO\text{-}C_6H_4NH_3Cl$ [1]

G is $HO\text{-}C_6H_2Br_2\text{-}NH_2$ up to $HO\text{-}C_6Br_4\text{-}NH_2$ (ignore orientation) [1]

3

(d) **(i)** HNO_3(aq) or dil HNO_3 (**NOT** conc., and **NOT** + conc. H_2SO_4) [1]

(ii) reduction [1]

(iii) Sn + HC*l*(aq) [1]

3

(e) **(i)** phenol, amide [1] + [1]

(ii) CH_3COCl *or* $(CH_3CO)_2O$ [1]

3

total: 12

5 **(a)** **(i)** addition (polymerisation) [1]

(ii) condensation (polymerisation) [1]

2

(b) hydrogen bonding [1]

1

(c) **(i)** $HO_2CCH_2CH_2CO_2H$ [1]

(ii) ester (accept "covalent") [1]

2

(d) **(i)** heat with H_3O^+ *or* heat with OH^-(aq) [1]

(ii) $H_2N\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}NH_2$ *or* $H_3N^+\text{-}CH_2\text{-}CH(OH)\text{-}CH_2\text{-}NH_3^+$ [1]

$HO_2C\text{-}CH(OH)\text{-}CH(OH)\text{-}CO_2H$ *or* $^-O_2C\text{-}CH(OH)\text{-}CH(OH)\text{-}CO_2^-$ [1]

(allow bonus mark if the acid/base forms are consistent with the reagent used for the hydrolysis) [1]

4 max 3

(e) **(i)** $NC\text{-}CH_2\text{-}CO_2^-\ K^+$ [1]

(ii) **II:** H_2 + Ni *or* Na in ethanol [allow $LiAlH_4$] [1]

III: dilute HCl *or* H_2SO_4 *or* H^+(aq) [1]

3

total: 11