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**

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

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

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

2

(b) **(i)** **A**: platinum **C**: voltmeter
B: H^+(aq) *or* HCl(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) **$\times 10^{-13}$ mol^2dm^{-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 Cl^- 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.(Cl) > 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]

$E^{\ominus} = 1.77 - 0.54 = \mathbf{1.23}$ 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]

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

4

(d) since $E^{\ominus}(I_2/I^-)$ is +0.54V, tin will be oxidised to $\mathbf{Sn^{4+}}$ [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 + HCl(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