

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) $M_r(\text{AgBr}) = 108 + 79.9 = 187.9$ [1]

moles = $2.5 \times 10^{-12} / 187.9 = 1.33 \times 10^{-14}$

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

2

- (b) (i) A: platinum C: voltmeter
 B: $\text{H}^+(\text{aq})$ or $\text{HCl}(\text{aq})$ or $\text{H}_2\text{SO}_4(\text{aq})$ D: silver (wire)
 (ignore concentration) 4 x [1]

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

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

units [1]

7



(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) $\text{LE}(\text{AgCl})$ 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 $r_{\text{Cl}^-} < r_{\text{Br}^-}$ or ionised electron nearer to nucleus
 or less shielding etc. or in terms of I.E. $(\text{Cl}) > \text{I.E.}(\text{Br})$

1

total: 14

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- 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° value. [1]

Two examples of F₂/F⁻, Cl₂/Cl⁻; Br₂/Br⁻, I₂/I⁻ quoted [1]

(data: F₂/F⁻ = +2.87V
Cl₂/Cl⁻ = +1.36V
Br₂/Br⁻ = +1.07V
I₂/I⁻ = +0.54V)

2

- (c) (i) H₂O₂ + 2I⁻ + 2H⁺ → I₂ + 2H₂O
or H₂O₂ + 2KI + 2H⁺ → 2K⁺ + I₂ + 2H₂O [1]

$$E^{\circ} = 1.77 - 0.54 = 1.23 \text{ V} \quad [1]$$

- (ii) Cl₂ + SO₂ + 2H₂O → 2Cl⁻ + SO₄²⁻ + 4H⁺
or Cl₂ + SO₂ + 2H₂O → 2HCl + H₂SO₄ [1]

$$E^{\circ} = 1.36 - 0.17 = 1.19 \text{ V} \quad [1]$$

4

- (d) since E°(I₂/I⁻) is +0.54V, tin will be oxidised to Sn⁴⁺ [1]
(E° for Sn²⁺/Sn = -0.14V and E° for Sn⁴⁺/Sn²⁺ = +0.15V)

Thus: Sn + 2I₂ → SnI₄ [1]

2

total: 10

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

conductivity: graph showing (Si (+ Ge): medium) [1]
 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 CO₂ [2CO + O₂ → 2CO₂] [1]
 or CO reduces Fe₂O₃ [3CO + Fe₂O₃ → 3CO₂ + 2Fe]
- (ii) e.g. PbO₂ decomposes on heating [2PbO₂ → 2PbO + O₂] [1]
 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. [1]
 (any one use + one relevant property)

1

- (d) (i) amphoteric [1]

(ii) e.g. SnO + 2HCl → SnCl₂ + H₂O [1]

e.g. SnO + 2NaOH → Na₂SnO₂ + H₂O [1]

3

total: 13

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

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

Page 5	Mark Scheme	Syllabus	Paper
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- 4 (a) $\text{HO-C}_6\text{H}_4\text{-NH}_2 + 2\text{AgBr} + 2\text{OH}^- \rightarrow \text{O=C}_6\text{H}_4\text{=O} + \text{H}_2\text{O} + \text{NH}_3 + 2\text{Ag} + 2\text{Br}^-$ [1]
 (or $\text{C}_6\text{H}_7\text{NO}$) (or $\text{C}_6\text{H}_4\text{O}_2$) **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 $\text{H}_2\text{N-C}_6\text{H}_4\text{-O}^- \text{Na}^+$ or $\text{H}_2\text{N-C}_6\text{H}_4\text{-ONa}$ [1]
F is $\text{HO-C}_6\text{H}_4\text{NH}_3^+ \text{Cl}^-$ or $\text{HO-C}_6\text{H}_4\text{NH}_3\text{Cl}$ [1]
G is $\text{HO-C}_6\text{H}_2\text{Br}_2\text{-NH}_2$ up to $\text{HO-C}_6\text{Br}_4\text{-NH}_2$ (ignore orientation) [1]
3
- (d) (i) $\text{HNO}_3(\text{aq})$ or dil HNO_3 (**NOT** conc., and **NOT** + conc. H_2SO_4) [1]
 (ii) reduction [1]
 (iii) $\text{Sn} + \text{HCl}(\text{aq})$ [1]
3
- (e) (i) phenol, amide [1] + [1]
 (ii) CH_3COCl or $(\text{CH}_3\text{CO})_2\text{O}$ [1]
3
- total: 12**

Page 6	Mark Scheme	Syllabus	Paper
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- 5 (a) (i) addition (polymerisation) [1]
- (ii) condensation (polymerisation) [1]
- 2**
- (b) hydrogen bonding [1]
- 1**
- (c) (i) $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CO}_2\text{H}$ [1]
- (ii) ester (accept "covalent") [1]
- 2**
- (d) (i) heat with H_3O^+ or heat with $\text{OH}^-(\text{aq})$ [1]
- (ii) $\text{H}_2\text{N}-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{NH}_2$ or $\text{H}_3\text{N}^+-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{NH}_3^+$ [1]
- $\text{HO}_2\text{C}-\text{CH}(\text{OH})-\text{CH}(\text{OH})-\text{CO}_2\text{H}$ or $^-\text{O}_2\text{C}-\text{CH}(\text{OH})-\text{CH}(\text{OH})-\text{CO}_2^-$ [1]
- (allow bonus mark if the acid/base forms are consistent with the reagent used for the hydrolysis) [1]
- 4 max 3**
- (e) (i) $\text{NC}-\text{CH}_2-\text{CO}_2^- \text{K}^+$ [1]
- (ii) II: $\text{H}_2 + \text{Ni}$ or Na in ethanol [allow LiAlH_4] [1]
- III: dilute HCl or H_2SO_4 or $\text{H}^+(\text{aq})$ [1]
- 3**
- total: 11**