

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 =  $\Delta H_f$  - (all the rest)  
 =  $-100 - (731 + 285 + 112 - 325)$   
 (=  $-100 - 731 - 285 - 112 + 325)$   
 =  $-903 \text{ kJ mol}^{-1}$  (-[1] for each error of sign or maths) [2]

(iii)  $\text{LE}(\text{AgCl})$  should be higher/more negative,  
 due to size/radius of  $\text{Cl}^-$  being less than that of  $\text{Br}^-$  (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<sup>-3</sup>)

2

- (b) The stronger the halogen is as an oxidising agent, the more positive is its E° value. [1]

Two examples of F<sub>2</sub>/F<sup>-</sup>, Cl<sub>2</sub>/Cl<sup>-</sup>; Br<sub>2</sub>/Br<sup>-</sup>, I<sub>2</sub>/I<sup>-</sup> quoted [1]

(data: F<sub>2</sub>/F<sup>-</sup> = +2.87V  
Cl<sub>2</sub>/Cl<sup>-</sup> = +1.36V  
Br<sub>2</sub>/Br<sup>-</sup> = +1.07V  
I<sub>2</sub>/I<sup>-</sup> = +0.54V)

2

- (c) (i) H<sub>2</sub>O<sub>2</sub> + 2I<sup>-</sup> + 2H<sup>+</sup> → I<sub>2</sub> + 2H<sub>2</sub>O  
or H<sub>2</sub>O<sub>2</sub> + 2KI + 2H<sup>+</sup> → 2K<sup>+</sup> + I<sub>2</sub> + 2H<sub>2</sub>O [1]

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

- (ii) Cl<sub>2</sub> + SO<sub>2</sub> + 2H<sub>2</sub>O → 2Cl<sup>-</sup> + SO<sub>4</sub><sup>2-</sup> + 4H<sup>+</sup>  
or Cl<sub>2</sub> + SO<sub>2</sub> + 2H<sub>2</sub>O → 2HCl + H<sub>2</sub>SO<sub>4</sub> [1]

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

4

- (d) since E°(I<sub>2</sub>/I<sup>-</sup>) is +0.54V, tin will be oxidised to Sn<sup>4+</sup> [1]  
(E° for Sn<sup>2+</sup>/Sn = -0.14V and E° for Sn<sup>4</sup>/Sn<sup>2</sup> = +0.15V)

Thus: Sn + 2I<sub>2</sub> → SnI<sub>4</sub> [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  
[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<sub>2</sub> [2CO + O<sub>2</sub> → 2CO<sub>2</sub>] [1]  
or CO reduces Fe<sub>2</sub>O<sub>3</sub> [3CO + Fe<sub>2</sub>O<sub>3</sub> → 3CO<sub>2</sub> + 2Fe]
- (ii) e.g. PbO<sub>2</sub> decomposes on heating [2PbO<sub>2</sub> → 2PbO + O<sub>2</sub>] [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 → SnCl<sub>2</sub> + H<sub>2</sub>O [1]

e.g. SnO + 2NaOH → Na<sub>2</sub>SnO<sub>2</sub> + H<sub>2</sub>O [1]

3

total: 13

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

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

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  $\text{NH}_3$  [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  $\text{HNO}_3$  (**NOT** conc., and **NOT** + conc.  $\text{H}_2\text{SO}_4$ ) [1]  
 (ii) reduction [1]  
 (iii)  $\text{Sn} + \text{HCl}(\text{aq})$  [1]  
**3**
- (e) (i) phenol, amide [1] + [1]  
 (ii)  $\text{CH}_3\text{COCl}$  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  $\text{H}_3\text{O}^+$  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  $\text{Na}$  in ethanol [allow  $\text{LiAlH}_4$ ] [1]
- III: dilute  $\text{HCl}$  or  $\text{H}_2\text{SO}_4$  or  $\text{H}^+(\text{aq})$  [1]
- 3**
- total: 11**