

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/04

CHEMISTRY
Theory 2 (Structured Questions)

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- 1 (a) The EMF of a cell made up of the test electrode and a standard hydrogen electrode. [1]
 EMF measured under standard conditions of T, P and concentration [1]
- 2**
- (b) (i) $E_{\text{left}} = E_{\text{right}} - E_{\text{cell}} = 0.34 - 0.76 = -0.42 \text{ (V)}$ [1]
 (ii) \longrightarrow (arrow from left to right) [1]
 (iii) I pink/red solid/ppt *or* copper will be formed *or* blue solution fades *or* M dissolves/corrodes [1]
 $\text{Cu}^{2+} + \text{M} \rightarrow \text{Cu} + \text{M}^{2+}$ [1]
 II hydrogen/gas evolved *or* M dissolves (do not allow "M dissolves" for [2] marks in both I and II) [1]
 $\text{M} + 2\text{H}^+ \rightarrow \text{M}^{2+} + \text{H}_2$ [1]
- 6**
- (c) (i) polarity of d. c. source: \ominus is on the left, \oplus is on the right [1]
 electrolyte is $\text{Cu}^{2+}(\text{aq})/\text{CuSO}_4/\text{CuCl}_2/\text{Cu}(\text{NO}_3)_2$ etc. *or* name [1]
 (ii) moles of Cu = $0.5/63.5 = 7.87 \times 10^{-3}$ [1]
 moles of e^- = $2 \times 7.87 \times 10^{-3} = 1.57 \times 10^{-2}$
 no. of coulombs = $96500 \times 1.57 \times 10^{-2} = 1517 \text{ (C)}$ [1]
 ecf in $n(e^-)$
 time = $1520/0.5 = 5034 \text{ seconds} = 50.7 \text{ min}$ [1]
 ecf in coulombs
- 5**
- Total 13**

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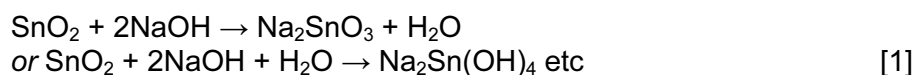
- 2 (a) (i) $K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$ [1] units: $\text{mol}^2\text{dm}^{-6}$ [1] ecf
- (ii) $[\text{Ba}^{2+}] = \sqrt{(1.3 \times 10^{-10})} = 1.14 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}$ [1]
- (iii) BaCO_3 can react with/dissolve in the acid/HCl in the stomach [1]
 (or unbalanced equation showing, e.g. $\text{BaCO}_3 + \text{HCl} \rightarrow$)
- 4**
- (b) (i) $K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2$ [1] units: $\text{mol}^3\text{dm}^{-9}$ [1] ecf
- (ii) calling $[\text{Mg}^{2+}] = x$, then $K_{sp} = x(2x)^2 = 4x^3 \Rightarrow x = \sqrt[3]{(K_{sp}/4)}$ [1]
 $\therefore [\text{Mg}^{2+}] = \sqrt[3]{(2 \times 10^{-11}/4)} = 1.7 \times 10^{-4} \text{ (mol dm}^{-3}\text{)}$ [1]
 allow ecf for use of $\sqrt[3]{}$
- (iii) % left = $100 \times (1.7 \times 10^{-4})/(0.054) = 0.32\%$
 \therefore % extracted = **99.7** (%) [1]
- 5**
- (c) (i) $\Delta H_r = \Delta H_f^\ominus(\text{Mg}^{2+}) + 2\Delta H_f^\ominus(\text{Cl}^-) - \Delta H_f^\ominus(\text{MgCl}_2)$
 $= -467 + 2(-167) - (-641)$
 $= -160 \text{ (kJ mol}^{-1}\text{)}$ [1]
- (ii) highly exothermic enthalpy change of solution
 or ΔH_{sol} is very negative [1]
- 2**
- (d) mention of hydration enthalpy and lattice enthalpy [1]
 hydration enthalpy decreases more than does lattice enthalpy
 or
 enthalpy change of solution or ΔH_{sol} becomes
 less negative/more positive [1]
- 2**
- Total: 13, max 12**

Page 3	Mark Scheme	Syllabus	Paper
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- 3 (a) (i) simple/discrete covalent/molecular [1]
- (ii) giant/macro covalent/molecular (NOT atomic) [1]
- (iii) (giant) ionic [1]
- a general statement that strong attraction means high m.pt.
and weak means low [1]

4

- (b) (i) $\text{CO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$
or $\text{CO}_2 + \text{NaOH} \rightarrow \text{NaHCO}_3$ [1]
(this mark is negated if candidate states that SiO_2 dissolves/reacts)



(if neither of the above marks can be awarded, allow CO_2 and SnO_2 dissolve/react but SiO_2 does not, for [1])

- (ii) CO_2 and SiO_2 - no reaction [1]



4

- (c) $\text{PbO}_2 + 4\text{HCl} \rightarrow \text{PbCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ [1]

$E_{\text{cell}} = 1.47 - 1.36$
 $= 0.11$ (V) [for 1 M HCl] [1]

or

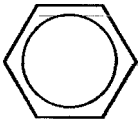


$E_{\text{cell}} = 1.69 - 1.36$
 $= 0.33$ (V) [for 1 M HCl] [1]

2


Total: 10, max 9

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- 4 (a) $\text{Cl}_2 + \text{light/heat}$ (aq negates) [1]
1
- (b) $\text{Cl}_2 + \text{AlCl}_3/\text{FeCl}_3/\text{Fe}$ etc. (aq negates) [1]
1
- (c)
- 

CO_2H
- [1]
1
- (d) $\text{NaOH} + \text{I}_2(+ \text{aq})$ (or $\text{I}^- + \text{OCl}^- + \text{aq}$) [1]
C: (pale) yellow ppt.
D: no reaction (both) [1]
2
- (e) mass of CN needed = $0.03 \times 60 = 1.8\text{g}$ [1]
 $M_r = 154.5, \therefore \text{amount} = 1.8/154.5 = \mathbf{0.0117}$ (mol) (allow **0.012**) ecf [1]
2
- (f) (i) increasing ease: $\text{H} < \text{D} < \text{G}$ [1]
(ii) chlorine on the aryl ring is very inert or strong C-Cl bond or overlap between Cl lone pair and π bond on ring (OWTTE) [1]
chlorine on C=O is reactive because of highly δ^+ carbon atom bonded to electronegative O and Cl (OWTTE) [1]
3
- Total 10**

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- 5 (a) (i) $\text{SOCl}_2/\text{PCl}_5/\text{PCl}_3/\text{P} + \text{Cl}_2$ (aq negates) [1]
- (ii) $\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{O}^- \text{Na}^+$ (or $\text{C}_6\text{H}_5\text{ONa}$) + H_2O [1]
- (iii) J = $\text{C}_6\text{H}_5\text{OCOCH}_3$ [1]
- K = CH_3CONH_2 [1]
- 4
- (b) (i) condensation [1]
- (ii) $\text{ClCOCH}_2\text{CH}_2\text{COCl} + 2\text{HOCH}_2\text{CH}_2\text{OH} \rightarrow$ [1]
- $\text{HOCH}_2\text{CH}_2\text{OCOCH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_2\text{OH} (+ \text{H}_2\text{O})$ [1]
- 3
- (c) (i) polyamide or nylon (allow condensation) [NOT peptide or protein] [1]
- (ii)
- HO_2C  CO_2H (or dichloride) $\text{NH}_2(\text{CH}_2)_4\text{NH}_2$
- [1] + [1]
- 3
- Total 10**
- 6 (a) (i) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$ or $[\text{Ar}] 4s^2 3d^2$ (or vice versa) [1]
- (ii) two of TiCl_2 , TiCl_3 , TiCl_4 [1]
- 2
- (b) (i) blue solution is formed [1]
- containing $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ [1]
- (ii) NH_3 replaces H_2O ligands or forms $[\text{Cu}(\text{NH}_3)_4]^{2+}$ [1]
- (or $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$) [1]
- which is deep blue/purple [1]
- 4
- Total 6**