JUNE 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/04

CHEMISTRY
Theory 2 (Structured Questions)

UNIVERSITY of CAMBRIDGE
International Examinations

1 **(a)** $Mg^{2+} + 2e^- \longrightarrow Mg$ [1]

(b) chlorine/Cl_2 [1]

(c) smaller A_r [1]
larger (atomic/ionic) radius/size [1]

(d) **(i)** the energy change when **1 mol** of solid compound [1]
is formed from its **gaseous ions** [1]

(ii) $Mg^{2+}(g) + 2Cl^-(g) \longrightarrow MgCl_2(s)$ *charges + balancing* [1]
state symbols [1]

(e) **(i)** LE ($MgCl_2$) is greater than LE (NaCl) [1]
(because) Mg^{2+} has higher charge / smaller radius than Na^+ [1]

(ii) LE ($MgCl_2$) is greater than LE ($CaCl_2$) [1]
(because) Mg^{2+} is smaller than Ca^{2+} [1]

(f) LE = 349 – 122 – 494 – 107 – 411

= **-785** (kJ mol^{-1}) [3]

correct answer = [3], with – [1] for one error. OR mark as follows:
use of all 5 ΔH values, with x1 multipliers [1]
correct signs for all ΔH values [1]
negative sign in answer [1]

Total = [15]

2 (a) covalent (*giant* or *macro*) negates, as also does any reference to ionic bonding) [1]
(*simple <u>molecular</u> is not enough – look for <u>covalent</u>*)

tetrahedral [1]

(b) (i) plotting (allow ±1°) [1]
138 – 151°C (stated in numbers, or read from the graph) [1]

(ii) (b. pt. increases due to) larger intermolecular / van der Waals / induced dipole (NOT permanent dipole) / attractions [1]

due to the larger no. **of electrons** *or* more shells **of electrons** (in MX_4) [1]

(c) (i) Si has empty low-lying orbitals *or* empty d-orbitals (C does not) [1]

(ii) $SiCl_4 + 2H_2O \longrightarrow SiO_2 + 4HCl$ [1]

[*or* $SiCl_4 + 4H_2O \longrightarrow Si(OH)_4 + 4HCl$ etc.]

(iii) (yes), because Ge also has empty (low lying d-) orbitals [1]

(d) (i) $SiCl_4 + 2Zn \longrightarrow Si + 2ZnCl_2$ [NOT ionic equation] [1]

(ii) mass = 250 x 2 x 65.4/28.1

= **1164** (g) (actually 1163.7 – but allow 1160) [2]

*allow e.c.f from the stoichiometry of the candidate's equation e.g. allow **582**g for [2] marks if the equation shows the stoichiometry to be 1:1. But if 582g is obtained because the candidate forgot to apply the stoichiometry as given in the equation, award only [1] mark.*

correct answer = [2], with – [1] for one error. OR marks as follows:
use of 2:1 ration [1]
correct use of A_r data for Si and Zn [1]

Total = [12]

3

- heterogeneous: different phases/states *or* homogeneous: same phase/state
- (heterogeneous): adsorption onto the surface
- the correct allocation of the terms *heterogeneous* and *homogeneous* to the two exemplar

- *example of heterogeneous, e.g.* Fe (in the Haber process)
- *equation, e.g.* $N_2 + 3H_2 \longrightarrow 2NH_3$

- *example of homogeneous, e.g.* Fe^{3+} (in $S_2O_8^{2-} + I^-$)
- *equation, e.g.* $S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$
- *how catalyst works, e.g.* $Fe^{3+} + I^- \longrightarrow Fe^{2+} + ½I_2$

[*OR example:* *$FeCl_3$* (in Friedel-Crafts or chlorination etc. with CH_3Cl, Cl_2, Br_2)
equation, $C_6H_6 + Cl_2 \longrightarrow C_6H_5Cl + HCl$
mode of action $FeCl_3 + Cl_2 \longrightarrow FeCl_4^- + Cl^+$]

Total = [8]

[space for writing other examples ***using iron or its compounds*** *you may come across. If in doubt consult your TL.*
Mark as follows:
For heterogeneous: example [1] equation [1]
for homogeneous: example [1] equation [1] mode of action [1]
candidates should include ***one*** *example of* ***each*** *mode of catalysis]*

4 (a) (i) $H\overset{O}{\overset{\|}{C}}NHC_3H_7$ *or* $CH_3\overset{O}{\overset{\|}{C}}NHC_2H_5$ *or* $C_2H_5\overset{O}{\overset{\|}{C}}NHCH_3$ *or* $C_3H_7\overset{O}{\overset{\|}{C}}NH_2$ [1]

[for propyl groups allow C_3H_7 or $CH_3CH_2CH_2$ or $(CH_3)_2CH$]

(ii) boil/heat/reflux with dil/aq. H_2SO_4/H^+/OH^- *or* with H_3O^+ [1]

(iii) $RCONHR' + H_2O \longrightarrow RCO_2H + R'NH_2$
(R and R' = H or alkyl)

or $RCONHR' + OH^- \longrightarrow RCO_2^- + R'NH_2$

or $RCONHR' + H_3O^+ \longrightarrow RCO_2H + R'NH_3^+$ [2]

[award [2] for a balanced equation with the same R groups as in (i).If [2] cannot be awarded, apply the following part-marks: [1] *for –CONH- → -CO_2H + NH_2-*
[1] *for all four R groups consistent with (i)]*

(b) (i) $C_2H_5\overset{O}{\overset{\|}{C}}\text{-}Cl$ [1]

(ii) $C_2H_5CO_2H$ + $SOCl_2$ *or* PCl_5 *or* PCl_3 (or names) [1]

(iii) $C_2H_5COCl + C_2H_5OH \longrightarrow C_2H_5CO_2C_2H_5 + HCl$ [1]

Total = [7]

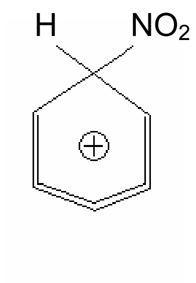
5 (a) (i) Cl_2 + $AlCl_3$ etc. (UV *or* aq negates) [1]

(ii) Br_2 + $AlCl_3$ *or* $AlBr_3$ etc. [1]

(iii) HNO_3 + H_2SO_4 [1]
conc. + 50° < T < 60° [1]

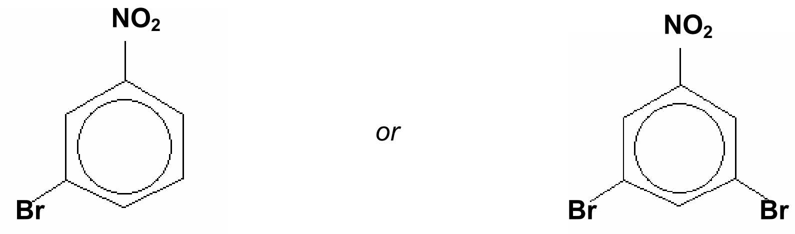
(b) (i) A^+ = NO_2^+ *or* nitronium ion [1]

(ii) B is



[1]

(c) (i)



[1]

(ii)

[1]

Total = [8]

6 (a) (i) $NH_3^+CH_2CO_2^-$ [1]

(b) (i) $NH_2CH(CH_3)CO_2H$ + HCl → $ClNH_3CH(CH_3)CO_2H$ [1]

(ii) $NH_2CH(CH_2OH)CO_2H$ + NaOH → $NH_2CH(CH_2OH)CO_2Na$ + H_2O [1]

N.B. charges not needed, and deduct only [1] for incorrect side chains
Allow ionic equations

(c)

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                 O                O                 O
                 ||               ||                ||
----NHCH2C-NHCH(CH3)C-NHCH(CH2OH)C---
                PB               PB
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Correct CO-NH bonding (at least one C=O shown) [1]
At least one PB (peptide bond) labeled) [1]
3 residues [1]

(the 3 residues don't all have to be different, but must all be either gly, ala or ser)

(d) condensation *or* polyamide [1]

(e) deducting 18 from each M_r value [1]
*(M_r value of 3-residue fragment = **215** if this has been done; otherwise M_r = 269)*

dividing 600,000 by the M_r value [1]
*(this would give **2791** if 18 had been deducted from each M_r, or 2230 if not)*

multiplying the answer by 3 (since there are 3 amino acids per residue) [1]
*(correct answer is **8732**. If no 18 had been deducted, answer is 6691)*

Possible likely answers:			
	8732 (±10)	➔	[3]
	6691 (±10)	➔	[2]
	2791 (±10)	➔	[2]
	2230 (±10)	➔	[1]

[if the answer is none of these, you can award part marks, as above.]

Total = [10]