UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Specimen for 2007

GCE A LEVEL

MARK SCHEME
MAXIMUM MARK: 100
SYLLABUS/COMPONENT: 9701/04 CHEMISTRY PRACTICAL

Section A

1 (a) (i) 2 x 80g of Br_2 produce 24 dm^3 of CO_2 (1)

Thus 3.2 g of Br_2 will produce $\frac{3.2 \times 24}{2 \times 80}$ = 0.48 dm^3 (1)

(ii) Colorimetrically : withdraw samples periodically (1)
measure absorbance (1)
plot absorbance against time (1)
OR
Iodometrically : oxidising I^- to I_2 (1)
by Br_2 (1)
titrating with thiosulphate (1)

(Allow titration of H^+ or evolution of CO_2 if some mention of solubility.)

[5]

(b) (i) Reaction has a constant half-life (1)
evidence from graph that t(1/2) is constant (1)

(ii) Rate = $[Br_2]$ (1)

(iii) At least two measurements of half-life from first graph (1)
Calculation of mean (say 200 secs) (1)

[5]

Total :10

2 (a) The standard enthalpy change of formation of a compound is the enthalpy change when one mole of a compound is formed (under standard conditions) (1) from its elements in their standard states. (1) **[2]**

(b) Suitable cycle clearly labelled showing all three values **[2]**

(c) (i) 298 kJ mol^{-1} (1)

(ii) In Data Booklet Si-C*l* bond energy is 210 kJ mol^{-1}.
$SiCl_4$ is not a gas under standard conditions (1)

[2]

(d) (i) $SiCl_3H + H_2 \longrightarrow Si + 3HCl$ (1)

(ii) From the Data Booklet, E_{Si-Cl} = 359, E_{H-Cl} = 431, E_{H-Br} = 366 kJ mol^{-1}
Per Si-hal bond, for $SiCl_3H$, ΔH= 359 - 431 = -72, for $SiBr_3H$, ΔH = 298 - 366 = -68 (1)
therefore the reaction with $SiBr_3H$ will be less exothermic i.e. overall reaction would be more endothermic (1)
OR $\Delta H_{reaction}$: for $SiCl_3H$, $\Delta H_{reaction}$ = + 96, and for $SiBr_3H$, $\Delta H_{reaction}$ = +108 (1)
therefore overall reaction is more endothermic (1)

(iii) Manufacture of semiconductors (or equivalent) (1)

[4]

Total : 10

3 **(a)** $CaCO_3 \longrightarrow CaO + CO_2$ (1)

$CaO + H_2O \longrightarrow Ca(OH)_2$ (1)

[2]

(b) To neutralise acid soils (1)
To improve soil 'quality' by precipitating clays (or equivalent) (1)

[2]

(c) The temperature increases (1)
As the Group is descended, the cation increases in size (1)
Thus ability of the cation to polarise the anion decreases, increasing the stability of the carbonate. (1)

[3]

(d) **(i)** $CaMg(CO_3)_2 + 4HCl \longrightarrow CaCl_2 + MgCl_2 + 2CO_2 + 2H_2O$ (1)

(ii) M_r of dolomite is 40 + 24 + (2 x 60) = 184 (1)

184 g of dolomite should produce 2 x 44 g of CO_2

Hence 1 g of dolomite should give $\frac{88}{184}$ g of CO_2 = 0.478 g

% purity of the dolomite is $\frac{0.450 \, x \, 100}{0.478}$ = 94.1% (1)

[3]

Total : 10

4 **(a)** **(i)** [Ar] $3d^{10}$ $4s^1$

(ii) [Ar] $3d^{10}$

(iii) [Ar] $3d^9$ **[2]**

(b) Any four of the following points:
- colour due to absorption of certain visible frequencies
- d-orbitals are split into two groups by presence of ligands
- light absorbed when e^- moves from lower to higher orbital
- this needs a gap in the higher orbital, so d^{10} in Cu(I) is not coloured
- if $CuCl_2$ is blue, then photons absorbed must be red ones **[4]**

(c) **(i)** $[Cu(H_2O)_6]^{2+} + 2OH^- \longrightarrow [Cu(H_2O)_4(OH)_2] + 2H_2O$
$(NH_3 + H_2O \longrightarrow NH_4^+ + OH^-)$
$[Cu(H_2O)_4(OH)_2] + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{2+} + 2OH^- + 4H_2O$
(*or* $\rightarrow$ $[Cu(NH_3)_4(H_2O)_2]^{2+}$) (2)

(ii) These are *ligand exchange* reactions.
H_2O is exchanged for OH^-, and H_2O and OH^- are exchanged for NH_3. (2) **[4]**

[Total : 10]

5 **(a)** Van der Waals forces increase with the number of electrons present (1)
Since this allows larger dipoles and hence stronger attractive forces (1)
[2]

(b) **(i)** Description of Cl^-, Br^-, and I^- with conc sulphuric acid 3 x (1)
Use of $E^{\ominus}$ (1)

(ii) Description of HC*l*, HBr and HI 3 x (1)
Use of $E^{\ominus}$ (1) **[8]**

Total : 10

6 **(a)**

element	%	A_r	% / A_r	ratio
C	40.0	12	3.33	1
H	6.65	1	6.65	2
O	53.3	16	3.33	1

[1]

(b) **(i)** It contains an asymmetric carbon atom (1)

(ii) It contains a carboxylic acid group (1)

(iii) It contains a $CH_3CH(OH)$- or CH_3CO- group (1)
[3]

(c) Displayed formula of 2-hydroxypropanoic acid **[1]**

(d) Displayed formula of the ketone of the above **[1]**

(e) Displayed formula of the cyclic di-ester (1)
Ester (1) **[2]**

(f) Displayed formula of 3-hydroxypropanoic acid (1)
Compound C is $CH=CHCO_2H$ (1)
[2]

Total : 10

7 **(a)** **(i)** 1. amine 2. carboxylic acid

3. amide 4. ester (2)

(ii) 1. amine 2. carboxylic acid (1)
Both can form ions (both polar groups) by gain or loss of a proton from water
or form hydrogen bonds with water (1) **[4]**

(b) **(i)** Allow conc. HC*l* and heat **or** conc. NaOH and heat 2 x (1)

(ii) Diagrams of aspartic acid, phenylalanine and methanol 3 x (1) **[5]**

(c) It could be decomposed/hydrolysed during cooking **[1]**

Total :10

Section B

8 **(a)** 6 points from the following :

- 2 strands of DNA separate
- mRNA reads the 'code'/base sequence on the DNA
- mRNA moves out of the nucleus
- mRNA binds to the ribosome
- tRNA binds to amino acids
- amino acids are transferred to ribosome and joined to growing chain
- until Stop codon is reached **[6]**

(b) Each amino acid needs 3 bases to code for it (1)

3 x 129 = 387, which leaves 3 bases to code for Start and 3 for Stop (1) **[2]**

(c) **(i)** A variety of answers possible e.g.
- sickle cell disease
- thallassemia
- cystic fibrosis
- haemophilia etc. (1)

(ii) A suitable symptom e.g.
- Deformed red blood cells
- Restricts production of haemoglobin
- Mucous lining of lungs thickens
- Poor clotting of blood/bleeding under the skin (1) **[2]**

Total : 10

9 **(a)**

	%	%/A_r	Ratio				
C	78.7	6.56	8	)	Empirical formula		
H	8.2	8.2	10	) (1)	$C_8H_{10}O$	(1)	
O	13.1	0.82	1	)			

M_r = 122, hence this molecular formula
Molecular formula is $C_8H_{10}O$ (1) **[3]**

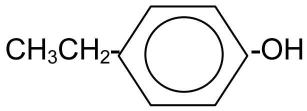
(b) 1.2δ - CH_3 (1)

2.5δ - CH_2 (1)

5.5δ - OH (1)

6.8δ aryl hydrogens x 4 (1)

Hence structure is



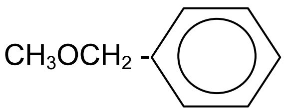
(1)

(or ethyl phenol isomers) **[5]**

(c) Peak at 5.5δ would disappear (1)

Due to rapid exchange with D^+ which does not absorb here (1) **[2]**

(d)



or isomers (1)

Two sensible suggestions (2) **[3]**

Total : 12

10 **(a)** Can be used as a fuel (for generating electricity) (1)

Can be hydrolysed (using acid or enzymes) and the sugars fermented (1) **[2]**

(b) Carbon dioxide **[1]**

(c) $(C_6H_{10}O_5)_n + nH_2O \rightarrow nC_6H_{12}O_6$ **[1]**

(d) Ethanol has an –OH group and so can be washed away
Gasoline is a hydrocarbon and is not soluble in water
Gasoline requires detergent which can add to the pollution
Ethanol is biodegradable
(any 3) **[3]**

Total : 7