UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education – Advanced Subsidiary Level and Advanced Level

CHEMISTRY

Paper 2 Structured Questions AS Core

9701/02
October/November 2004

1 hour 15 minutes

Candidates answer on the Question Paper.
Additional Materials:
Data Booklet

Candidate Name

Centre Number

Candidate Number

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces provided at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
You may lose marks if you do not show your working or if you do not use appropriate units.

DO NOT WRITE IN THE BARCODE.

DO NOT WRITE IN THE GREY AREAS BETWEEN THE PAGES.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given on this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
4	
5	
TOTAL	

This document consists of **11** printed pages and **1** blank page.

1 Hydrogen iodide dissociates into its elements according to the equation below.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

(a) Write the expression for the equilibrium constant, K_c.

[1]

(b) At 120 °C the equilibrium mixture contains 1.47 mol dm^{-3} of HI(g), 0.274 mol dm^{-3} each of H_2(g) and I_2(g).

Calculate the value of K_c for the equilibrium at 120 °C.

[1]

(c) Suggest and explain why it would be more difficult to determine K_c for this equilibrium at room temperature.

.....

.....

.....

.....[2]

(d) **(i)** Explain how enthalpy changes, ΔH values, for covalent bonded molecules can be calculated from bond energies.

.....

.....

(ii) Use bond energies from the *Data Booklet* to calculate ΔH for the following dissociation.

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$$2HI(g) \rightarrow H_2(g) + I_2(g)$$

[3]

(e) HI dissolved in water behaves as a strong acid.

(i) Explain what is meant by a ***strong*** *acid*.

.....

(ii) Complete the equation.

$$HI + H_2O \rightarrow \text{.....} + \text{.....}$$

(iii) Identify the conjugate base of HI in this equation.

.....[3]

[Total : 10]

2 The table below gives data on some oxides of elements in Period 3 of the Periodic Table.

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oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_3
melting point / K	1193	3125	2345	1883	853	290
boiling point / K	1548	3873	3253	2503	–	318

(a) Write an equation for the reaction of aluminium with oxygen to form aluminium oxide.

.....[1]

(b) Drawing diagrams where appropriate, suggest in terms of structure and bonding, explanations for the following.

(i) the high melting point and boiling point of Al_2O_3

(ii) the low boiling point of SO_3

(iii) the melting point of SiO_2 is much higher than that of P_4O_{10}

[7]

(c) Water was added to each of the oxides in the table.

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Choosing a suitable oxide in each case, write an equation for the formation of

(i) an alkaline solution, ...

(ii) an acidic solution. .....[2]

[Total : 10]

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3 (a) (i) Describe, with the aid of a fully labelled diagram, the industrial electrolysis of brine (aqueous NaC*l*). State what the electrodes are made of and show clearly the inlet and the outlets.

(ii) Write equations for the reactions at each electrode, giving state symbols.

anode .....

cathode .....

(iii) Explain in terms of changes in oxidation number why redox processes take place at the electrodes.

anode .....

cathode .....

(iv) Name the chemical which is produced in solution by this electrolysis.

.....

(v) Suggest **two** large scale uses of this chemical.

.....

.....

[10]

(b) Hydrochloric acid is manufactured by burning the hydrogen formed in this electrolysis in chlorine and dissolving the product in water.

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(i) Construct an equation for the burning of hydrogen in chlorine.

.....

(ii) When the product of **(i)** dissolves in water there is a change in bonding. Explain with the aid of an equation what change in bonding has occurred.

[2]

(c) Describe, with the aid of equations including state symbols, what happens when

(i) hydrochloric acid is added to aqueous silver nitrate,

.....

.....

(ii) an excess of aqueous ammonia is added to the resulting mixture.

.....

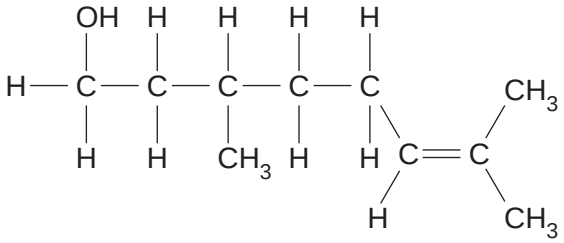
.....

.....[5]

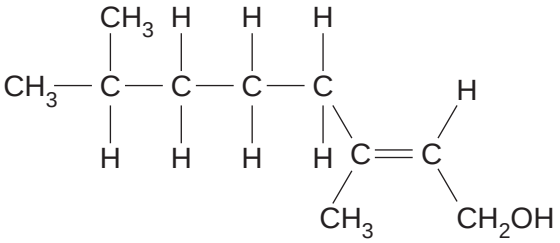
[Total : 17]

[Turn over

4 Some perfumes and scents of flowers and fruit contain compounds which are structural isomers. Two such examples are citronellol and geraniol.



citronellol



geraniol

(a) Confirm that citronellol and geraniol are isomers by calculating their molecular formula and their relative molecular mass, M_r.

(i) Molecular formula .....

(ii) M_r .....[2]

(b) Name two functional groups present in **both** molecules.

(i) .....

(ii) .....[3]

Citronellol and geraniol also show stereo isomerism.

(c) On the diagram of the structure of citronellol above, draw a circle around a chiral carbon atom. [1]

(d) **(i)** Draw the other *cis-trans* isomer of geraniol. [In parts **(d)** and **(f)** use R – to represent a part of the molecule.]

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(ii) Explain why geraniol has no optical isomers.

.....

.....[2]

(e) State what you would expect to see if citronellol was reacted with aqueous bromine.

.....

.....[1]

(f) Draw structures of the organic products when geraniol reacts with each of the following reagents.

(i) an excess of $H^+ / Cr_2O_7^{2-}$ under reflux

(ii) ethanoic acid in the presence of an acidic catalyst

(iii) hydrogen bromide, HBr

[4]

[Total : 13]

5 2-Hydroxypropanoic acid (lactic acid), $CH_3CH(OH)CO_2H$, can be prepared in a two-stage synthesis from ethanal, CH_3CHO.

(a) In the first stage, ethanal reacts with hydrogen cyanide, HCN, in the presence of an NaCN catalyst to produce a cyanohydrin.

(i) Write an equation for the reaction of ethanal and HCN, giving the displayed formula of the product.

(ii) State what type of reaction this is.

.....

(iii) Describe the mechanism of this reaction.

[5]

(b) In the second stage, the product from **(a)** is converted into lactic acid.

(i) Write the equation for this stage.

.....

(ii) State what type of reaction this is.

.....[2]

(c) In this synthesis 4.40 g of ethanal were used and at the end 5.40 g of lactic acid were obtained.

Calculate the percentage yield of lactic acid.

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[3]

[Total : 10]

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