Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY 9701/2

PAPER 2

MAY/JUNE SESSION 2002

1 hour

Candidates answer on the question paper.
Additional materials:
Data Booklet

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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.
A Data Booklet is provided.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
TOTAL	

This question paper consists of 11 printed pages and 1 blank page.

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Local Examinations Syndicate
[Turn over

For Examiner's Use

1 Sir James Jeans, who was a great populariser of science, once described an atom of carbon as being like six bees buzzing around a space the size of a football stadium.

(a) (i) Suggest what were represented by the six bees in this description.

.....

(ii) Explain (in terms of an atom of carbon) what stopped the bees from flying away from the space of the football stadium.

.....

.....

(iii) What is missing from Jeans' description when applied to an atom of carbon?

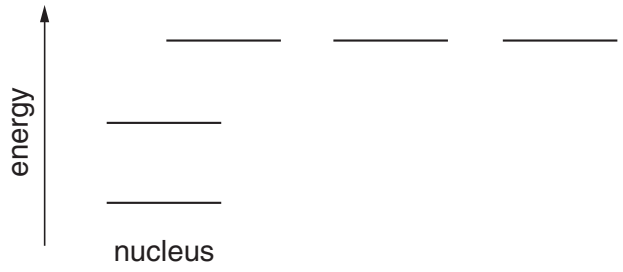
.....

.....

[3]

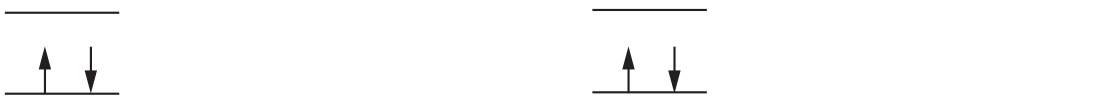
(b) The diagram below represents the energy levels of the orbitals in atoms of the second period, lithium to neon.

(i) Label the energy levels to indicate the principal quantum number and the type of orbital at each energy level.



(ii) In the space below, sketch the shapes of the two types of orbital.

(iii) Complete the electron configurations of nitrogen and oxygen on the energy level diagrams below, using arrows to represent electrons.



nitrogen

oxygen

(iv) Explain, with reference to your answer to **(iii)**, the relative values of the first ionisation energies of nitrogen and oxygen. The values are given in the *Data Booklet* and should be quoted in your answer.

.....

.....

.....

.....

[6]

(c) (i) State the formulae of the negatively charged ions formed by these elements in simple binary compounds (nitrides and oxides).

.....

(ii) Why do nitrogen and oxygen form negative ions, but not positive ions, in simple binary compounds?

.....

.....

.....

[2]

[Total : 11]

For Examiner's Use

2 Ethanol, C_2H_5OH, is a most important industrial chemical and is used as a solvent, a fuel and an intermediate in large scale organic synthesis.

Ethanol is prepared industrially by the reaction of ethene and steam in the presence of a catalyst.

$$C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(g)$$

The standard enthalpy change of the reaction can be determined by using the standard enthalpy changes of combustion, $\Delta H_c^{\ominus}$, at 298 K.

	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
$C_2H_4(g)$	–1411
$C_2H_5OH(l)$	–1367

(a) Calculate the standard enthalpy change for the following reaction.

$$C_2H_4(g) + H_2O(l) \longrightarrow C_2H_5OH(l)$$

[2]

(b) (i) Define the term *standard enthalpy change of combustion*.

.....

.....

.....

(ii) Explain why the state symbols for water and ethanol given in the equation in **(a)** have been changed from those quoted in the industrial process.

.....

.....

.....

(iii) Write the equation for the complete combustion of ethanol.

.....

[4]

(c) Ethanol is miscible with water because of hydrogen bonding between molecules of ethanol and water. Draw a diagram, including dipoles, to show the hydrogen bonding between a molecule of ethanol and a molecule of water.

[2]

[Total : 8]

[Turn over

3 Aluminium is the third most abundant element in the Earth's crust, occurring combined in many minerals.

(a) Name a mineral from which aluminium may be extracted.

.....[1]

(b) **(i)** Describe with the aid of a diagram, the electrolytic extraction of aluminium from purified aluminium oxide. State what the electrodes are made of.

(ii) Give an ion-electron equation for the electrode process

at the cathode, ...

at the anode. .....

(iii) What further reaction takes place at the anode?

.....

.....

[8]

(c) Much of the bodywork of trains, aircraft and ships is made from aluminium rather than from steel. State **two** advantages of using aluminium in the making of vehicles.

1. .....

.....

2. .....

.....[2]

[Total : 11]

4 Sulphuric acid is used in many industrial processes of major importance.

The first stage in the manufacture of sulphuric acid is to pass air over burning sulphur. The emerging gas has the following composition by volume.

sulphur dioxide	10%
sulphur trioxide	0.2%
oxygen	10%
nitrogen etc.	79–80%

(a) (i) Write an equation for sulphur burning in air.

.....

(ii) Suggest why the air is passed so fast that only half the oxygen is used.

.....

.....

[2]

The emerging gas is passed over a catalyst maintained at 450–550 °C in the reaction chamber.

(b) Name the catalyst used in the Contact process.

.....[1]

Sulphur trioxide is formed in 98% yield; 2% of sulphur dioxide remains unconverted.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197\ \text{kJ mol}^{-1}$$

(c) The high yield is only achieved under certain conditions.

After each condition explain why this leads to an increased yield of sulphur trioxide.

(i) There needs to be an excess of air in the reacting gas mixture.

explanation .....

.....

(ii) The catalyst needs to be cooled.

explanation .....

.....

(iii) The air used to burn the sulphur must be as clean as possible.

explanation .....

.....

[3]

[Turn over

(d) In modern plants, nearly all the SO_2/SO_3 mixture is absorbed but up to 0.05% by volume of SO_2 may be allowed to pass into the atmosphere through a chimney stack.

Give **two** reasons why SO_2 should not be discharged into the atmosphere.

.....

.....

.....[2]

(e) **(i)** When concentrated sulphuric acid is warmed with solid sodium chloride, misty fumes are produced.

Identify the fumes. .....

Write an equation for the reaction.

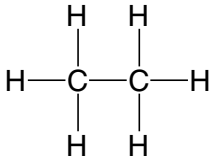
.....

(ii) When concentrated sulphuric acid is warmed with solid sodium iodide, purple fumes are produced.

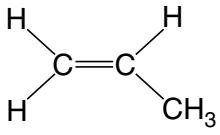
Identify the fumes. .....
[3]

[Total : 11]

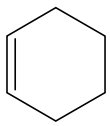
5 Crude oil is the principal source of hydrocarbons. The following are examples of such hydrocarbons.



ethane



propene



cyclohexene

(a) Give the structural formulae of the organic products in the following reactions.

(i) The reaction of ethane with bromine in the presence of u.v. light.

(ii) The polymerisation of propene.

(iii) The oxidation of propene with cold, acidified potassium manganate(VII).

(iv) The reaction of cyclohexene with hydrogen bromide.

(v) The reaction of cyclohexene with hot acidified potassium manganate(VII).

[5]

(b) Write equations for the following reactions.

(i) The complete combustion of ethane.

(ii) The action of steam on propene in the presence of a catalyst.

(iii) The reaction of cyclohexene with hydrogen in the presence of a catalyst.

[3]

(c) The process of cracking produces useful substances from oil.

(i) Explain why cracking is useful.

.....

.....

.....

.....

(ii) Suggest an equation for the cracking of $C_{16}H_{34}$ into at least three fragments.

[3]

[Total : 11]

6 Chlorofluorocarbons, CFCs, are small alkane molecules in which some of the hydrogen atoms have been replaced by atoms of chlorine and fluorine.

(a) **(i)** State **two** uses of CFCs.

.....

.....

(ii) What property of CFCs causes them to be useful?

.....

[2]

(b) A typical CFC is CHF_2CHClF.

(i) Which covalent bond in this CFC is the weakest?

.....

(ii) Why does this CFC present an environmental concern?

.....

.....

.....

.....

[3]

(c) Another CFC contains the following elements by mass. The value of its M_r is 135.

C, 17.8%; H, 1.5%; C*l*, 52.6%; F, 28.1%

Use these data to determine the molecular formula of the CFC.

[3]

[Total : 8]

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