| Centre Number | Candidate Number | Name |
|---------------|------------------|------|
| | | |

CAMBRIDGE INTERNATIONAL EXAMINATIONS General Certificate of Education Ordinary Level

CHEMISTRY 5070/02

Paper 2 Theory

May/June 2003

1 hour 30 minutes

Candidates answer on the Question Paper. Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces at the top of this page and on any separate answer paper used.

Sections A

Answer all questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer any three questions.

Write your answers on the separate answer paper.

At the end of the examination, fasten any separate answer paper used securely to the question paper.

The number of marks is given in brackets [] at the end of each question or part question. A copy of the Periodic Table is printed on page 16.

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 at the top of this page.

Stick your personal label here, if provided.

| For Examiner's Use | | |
|--------------------|--|--|
| Section A | | |
| В8 | | |
| В9 | | |
| B10 | | |
| B11 | | |
| TOTAL | | |

This document consists of 14 printed pages and 2 blank pages.

Section A

Answer all the questions in this section in the spaces provided.

| Cho | noose from the following elements to answer the questions below. | | | | | | |
|-----|--|--|--|--|--|--|--|
| | argon | bromine | carbon | hydrogen | | | |
| | iodine | iron | neon | sulphur | | | |
| Eac | h element can l | be use used once | , more than onc | ee, or not at all. | | | |
| Nan | me an element which | | | | | | |
| (a) | forms a basic | oxide, | | | | | |
| | | | | [1] | | | |
| (b) | is a liquid at ro | om temperature a | and pressure, | | | | |
| | | | | [1] | | | |
| (c) | reacts with aqueous copper(II) sulphate to give a pink solid, | | | | | | |
| | | | | [1] | | | |
| (d) | is formed durin | ng the electrolysis | of concentrated | d aqueous sodium chloride, | | | |
| | | | | [1] | | | |
| (e) | has a giant mo | olecular structure. | | | | | |
| | | | | [1] | | | |
| | Eac Nam (a) (b) (c) | argon iodine Each element can lead to the lead of the | argon bromine iodine iron Each element can be use used once Name an element which (a) forms a basic oxide, (b) is a liquid at room temperature a (c) reacts with aqueous copper(II) s (d) is formed during the electrolysis (e) has a giant molecular structure. | argon bromine carbon iodine iron neon Each element can be use used once, more than once Name an element which (a) forms a basic oxide, (b) is a liquid at room temperature and pressure, (c) reacts with aqueous copper(II) sulphate to give | | | |

| A 2 | Ethanol, CH_3CH_2OH , is a liquid fuel. Ethanol can be manufactured either from gluce $C_6H_{12}O_6$, or from ethene. | | | | | |
|------------|--|-------|--|--|--|--|
| | (a) | | fly describe the manufacture of ethanol from glucose. ude the balanced equation in your answer. | | | |
| | | | | | | |
| | | | | | | |
| | | | [4] | | | |
| | (b) | (i) | Draw the displayed formula for ethene. | | | |
| | | | | | | |
| | | | | | | |
| | | (ii) | Name the substance that reacts with ethene to make ethanol. | | | |
| | 1 | (iii) | Give the conditions needed for this reaction. | | | |
| | | | | | | |
| | | | [4] | | | |

| A 3 | Petroleum is a complex mixture of hydrocarbons. Petroleum is a source of many useful fuels | | | | eful fuels. | | |
|------------|--|--|----------------------------------|--|-------------|--|--|
| | (a) | What is meant by the term hydrocarbon? | | | | | |
| | | | | | | | |
| | 71.3 | | [1] | | | | |
| | (b) | Petroleum is separated by fractional distillation. | | | | | |
| | | (i) | Complete the following ta | ble about the fractions obtained from petroleum. | | | |
| | | | fraction | use | | | |
| | | | petrol (gasoline) | fuel for cars | | | |
| | | | paraffin (kerosene) | | | | |
| | | | diesel | fuel for diesel engines | | | |
| | | | bitumen | | | | |
| | (c) | ma Cra | ch demand. | eleum does not produce sufficient of some fra arge hydrocarbon molecules into smaller molec | | | |
| | | A h | ydrocarbon of molecular fo | rmula C ₁₂ H ₂₆ is cracked. | | | |
| | | (i) | | ne alkane that may be produced. | | | |
| | | | | | | | |
| | | (ii) | Suggest the formula of or | ne alkene that may be produced. | | | |
| | | | | | | | |
| | | (iii) | Describe a chemical test alkane. | that can be used to distinguish between an alken | e and an | | |
| | | | chemical test | | | | |
| | | | result with alkane | | | | |
| | | | result with alkene | | [4] | | |

A4 Carbon dioxide is a greenhouse gas. Carbon dioxide is given a greenhouse factor of 1. Other gases are given a greenhouse factor that compares their effect with carbon dioxide. The greenhouse effect increases as the factor value increases. The table gives some information about four different gases.

| gas | greenhouse factor | percentage of gas in the atmosphere |
|---------------------|----------------------|-------------------------------------|
| CO ₂ | 1 | 0.036 |
| CH ₄ | 30 | 0.0017 |
| N ₂ O | 160 | 3.0×10^{-4} |
| CC l ₃ F | 21000 | 2.8 × 10 ⁻⁸ |

(a) State **one** possible consequence of an increased greenhouse effect.

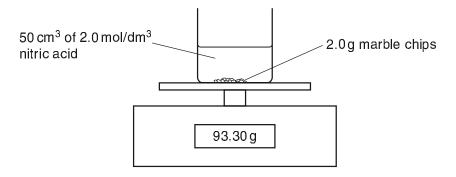
| (b) | Give one source of methane. |
|-----|---|
| | [1] |
| (c) | Why is an increase in the percentage of methane more worrying than the same percentage increase of carbon dioxide? |
| | |
| | [1] |
| (d) | What other environmental problem, beside its action as a greenhouse gas, is caused by ${\rm CC}\it l_3{\rm F}\it ?$ |
| | [1] |

A5 Marble statues are being damaged by acid rain. The chemical name for marble is calcium carbonate.

A student investigated the reaction between marble chips and nitric acid.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(I) + CO_2(g)$$

The diagram shows the apparatus the student used.



The student recorded the balance reading every minute.

The table shows the results.

| time/minutes | balance reading/g |
|--------------|-------------------|
| 0 | 93.30 |
| 1 | 93.28 |
| 2 | 93.26 |
| 3 | 93.24 |
| 4 | 93.22 |
| 5 | 93.21 |
| 6 | 93.20 |
| 7 | 93.19 |
| 8 | 93.18 |
| 9 | 93.17 |
| 10 | 93.16 |
| 11 | 93.15 |
| 12 | 93.15 |
| 13 | 93.14 |
| 14 | 93.14 |
| | |

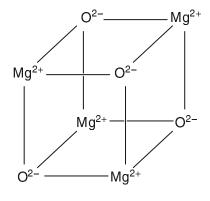
| (a) | Explain why the balance reading decreases during the experiment. |
|-----|--|
| | [1] |
| (b) | How can the student tell when the reaction has finished? |
| | [1] |

| (c) | (i) | Calculate the number of moles of nitric acid in $50\mathrm{cm^3}$ of $2.0\mathrm{mol/dm^3}$ solution. |
|-----|--------------|--|
| | | |
| | | |
| | | |
| | (ii) | Calculate the number of moles of calcium carbonate in 2.0 g. |
| | | |
| | | |
| | | |
| | (iii) | Which reagent, calcium carbonate or nitric acid, is in excess? |
| | ` , | Explain your answer. |
| | | |
| | | |
| | | |
| | | [5] |
| (d) | nitr of o | e student repeats the experiment using the same quantities of calcium carbonate and ic acid. This time the acid is at a higher temperature. Describe and explain, in terms collisions between reacting particles, the effect of increasing the temperature on the e of reaction. |
| | | |
| | | |
| | | [2] |
| | | |

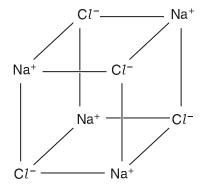
A6 A student adds aqueous sodium hydroxide from a burette into 25.0 cm³ of dilute sulphuric acid. The student measures the pH value of the mixture during the addition of the sodium

| hyd | ydroxide. | | | | | |
|-----|-----------|---|---|--|--|--|
| (a) | Des | Describe how the pH value changes. | | | | |
| | | [1] | | | | |
| (b) | | e an ionic equation to represent the neutralisation reaction between sodium oxide and sulphuric acid. | 1 | | | |
| | | [1] | ĺ | | | |
| (c) | Sul | phuric acid is a strong acid. | | | | |
| | (i) | What is meant by the term acid? | | | | |
| | | | | | | |
| | | | | | | |
| | (ii) | What is the difference between a strong acid and a weak acid? | | | | |
| | | | | | | |
| | | | | | | |
| | | [3] | I | | | |
| (d) | | te sulphuric acid reacts with magnesium to give hydrogen. e the ionic equation for this reaction. | | | | |
| | | [1] | l | | | |

A7 The structures of two ionic lattices are shown below.



magnesium oxide



sodium chloride

| | |
|------|------|
| | [1] |

(b) (i) Explain why magnesium oxide has a very high melting point.

| |
|------|
| |
| |

(ii) Suggest why the melting point of magnesium oxide is much higher than that of sodium chloride.

| | |
|------|---------|
| | |
| | [2] |

(c) Draw the electronic structure of a magnesium ion and of an oxide ion.

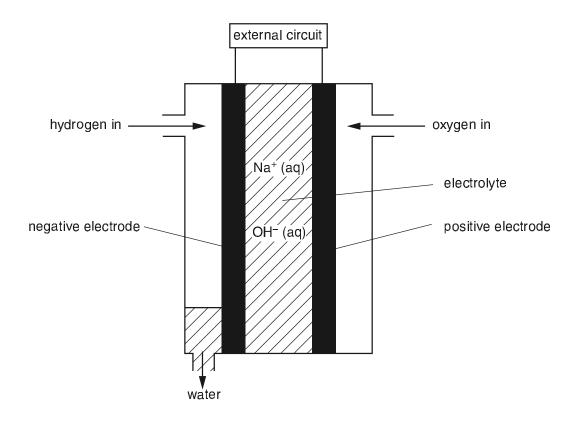
magnesium ion

oxide ion

Section B

Answer three questions from this section.

B8 The NASA space shuttle uses fuel cells to generate electricity. The diagram below shows a hydrogen-oxygen fuel cell.



At the positive electrode, oxygen reacts with water as shown.

$$O_2(g) + 2H_2O(I) + 4e^- \rightarrow 4OH^-(aq)$$

At the negative electrode, hydrogen reacts with hydroxide ions as shown.

$$H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(I) + 2e^-$$

The overall reaction in the fuel cell is the reaction between hydrogen and oxygen to make water.

- (a) Give one source for hydrogen and one source for oxygen for use in a fuel cell. [2]
- (b) What is the name of the electrolyte used in the fuel cell? [1]
- (c) What type of reaction takes place, reduction or oxidation, at the positive electrode? Explain your answer. [1]
- (d) A fuel cell uses 240 dm³ of hydrogen. Calculate the volume of oxygen needed, and the mass of water formed. All gas volumes measured at room temperature and pressure. [3]
- (e) Describe some advantages and disadvantages of using a fuel cell to generate electricity. [3]

B9 The table gives information about the first five members of the homologous series of carboxylic acids.

| name of acid | formula | relative molecular mass | melting point/°C | boiling point/°C |
|----------------|---|----------------------------|------------------|------------------|
| methanoic acid | HCO ₂ H | 46 | 8.4 | 101 |
| ethanoic acid | CH ₃ CO ₂ H | 60 | 17 | 118 |
| propanoic acid | C ₂ H ₅ CO ₂ H | 74 | -22 | 141 |
| butanoic acid | C ₃ H ₇ CO ₂ H | 88 | -8 | 164 |
| pentanoic acid | | | | |

- (a) (i) Predict the formula and the relative molecular mass for pentanoic acid.
 - (ii) Explain why it is easier to predict the boiling point of pentanoic acid than the melting point.

(b) Draw the displayed formula for propanoic acid. [1]

- (c) Analysis of an organic acid isolated from red ants shows that it contains 0.060 g of carbon, 0.010 g of hydrogen and 0.16 g of oxygen.Calculate the empirical formula for this acid.[2]
- (d) Ethanoic acid reacts with magnesium oxide.

 Name the products formed and write a balanced equation for the reaction. [2]
- (e) Describe how ethanoic acid can be converted into ethyl ethanoate. [2]

5070/02/M/J/03 [Turn over

[3]

B10 Methane, CH₄, is used as a fuel. The complete combustion of methane can be represented by the equation below.

H
$$C-H + 20=0 \rightarrow 0=C=0 + 2 O$$
 H
 $\Delta H = -890 \text{ kJ/mol}$

- (a) Explain why this reaction is exothermic in terms of the energy changes that take place during bond breaking and bond making. [3]
- (b) Calculate the energy released when 4.0 g of methane is completely combusted. [2]
- (c) Draw the energy profile diagram for the complete combustion of methane.

 Label on the diagram the activation energy and the enthalpy change.

 [3]
- (d) Draw a 'dot and cross' diagram to show the bonding in methane.
 You only need to draw the outer (valence) electrons of carbon. [2]

- **B11** Coal-burning power stations produce sulphur dioxide and oxides of nitrogen. These two gases cause acid rain.
 - (a) Nitric oxide, NO, is made in a power station when nitrogen and oxygen react together.

 Write the equation for this reaction.

 [1]
 - (b) Many coal burning power stations are now fitted with a flue gas desulphurisation plant which removes sulphur dioxide and nitrogen dioxide from the gaseous emissions.

In a flue gas desulphurisation plant, powdered calcium carbonate reacts with sulphur dioxide as shown.

$$SO_2(g) + CaCO_3(s) \rightarrow CaSO_3(s) + CO_2(g)$$

- (i) Suggest why the calcium carbonate is powdered.
- (ii) Calculate the mass of calcium carbonate needed to react with 8000 kg of sulphur dioxide. [3]

[1]

- (iii) Nitrogen dioxide also reacts with calcium carbonate. Suggest the name of the solid product of this reaction. [1]
- (c) In the air sulphur dioxide reacts with nitrogen dioxide forming sulphur trioxide. The reactions that take place are shown in the equations.

$$SO_2 + NO_2 \rightarrow SO_3 + NO$$

 $2NO + O_2 \rightarrow 2NO_2$

Suggest the role of nitrogen dioxide in these reactions. Explain your answer. [2]

(d) Sulphur dioxide is used in the Contact process to make sulphuric acid.

Describe the conditions and name the catalyst in the Contact process. [2]

BLANK PAGE

BLANK PAGE

The Periodic Table of the Flements DATA SHEET

| | | | | | | - | ne Perio | Gic I abi | The Periodic Lable of the Elements | Elemen | 21 | | | | | | | |
|-------------------------|-----------------|---------------------------|-----------------|----------------|--------------------|------------------|------------------|----------------|------------------------------------|------------------|---------------|-------------------------|-----------------|------------------|-----------------|-----------------|----------------|----|
| _ | = | | | | | | | | <u> </u> | | | | ≥ | > | > | > | 0 | |
| | | _ | | | | | - | | | | | | | | | | 4 | |
| | | | | | | | I | | | | | | | | | | He | |
| | | | | | | | nydrogen 1 | | | | | | | | | | Helium 2 | |
| 7 | 6 | | | | | | | | | | | 11 | 12 | 14 | 16 | 19 | 20 | |
| _ | Be | | | | | | | | | | | Ω | ပ | z | 0 | ш | Ne | |
| Lithium 3 | Beryllium 4 | E | | | | | | | | | | Boron 5 | Carbon 6 | Nitrogen 7 | Oxygen 8 | Fluorine 9 | Neon 10 | |
| 23 | 24 | | | | | | | | | | | 27 | 28 | 31 | 32 | 35.5 | 40 | |
| Na | Ma | | | | | | | | | | | Αl | S | Д | S | CI | Ā | |
| Sodium 11 | Magnesium 12 | E. | | | | | | | | | | Auminium 13 | _ | Phosphorus 15 | Sulphur 16 | Chlorine 17 | Argon 18 | |
| 39 | 40 | 45 | 48 | 15 | 83 | 55 | 56 | 59 | 59 | 64 | 65 | 70 | 73 | 75 | 79 | 80 | 84 | |
| ¥ | ပီ | လွ | F | > | ပ် | Mn | Ъ | ပိ | Z | చె | Zu | Ga | g | As | Se | ā | 호 | |
| 0/0209 19 | Calcium 20 | . 2 | Titanium 22 | Vanadium 23 | Chromium 24 | Manganese 25 | Iron 26 | Cobalt 27 | Nickel 28 | Copper 29 | Znc 30 | Gallium 31 | Germanium 32 | Arsenic 33 | Selenium 34 | Bromine 35 | Krypton 36 | |
| 58 2/M/ | 88 | 88 | 91 | 93 | 96 | | 101 | 103 | 106 | 108 | 112 | 115 | 119 | 122 | 128 | 127 | 131 | ıv |
| J/03 | ഗ് | > | Ž | g | Mo | ဍ | Bu | R | Pd | Ag | ဦ | In | Sn | gs | Те | _ | Xe | |
| Rubidium 37 | Strontium 38 | n Yttrium 39 | Zirconium 40 | Niobium 41 | Molybdenum 42 | Technetium 43 | Ruthenium 44 | Rhodium 45 | Palladium 46 | Silver 47 | Cadmium 48 | Indium 49 | Tin 50 | Antimony 51 | Tellurium 52 | lodine 53 | Xenon 54 | |
| 133 | 137 | 139 | 178 | 181 | 184 | 186 | 190 | 192 | 195 | 197 | 201 | 204 | 207 | 209 | | | | |
| S | Ba | | Ξ | Б | ≥ | Re | SO | <u></u> | ₹ | ΡN | ξĤ | 11 | Pp | ö | Po | Αt | R | |
| Caesium 55 | Barium 56 | Lanthanum 57 * | Hafnium 72 | Tantalum 73 | Tungsten 74 | Rhenium 75 | Osmium 76 | iridium 77 | Platinum 78 | Gold 79 | Mercury 80 | Tha ll ium 81 | Lead 82 | Bismuth 83 | Polonium 84 | Astatine 85 | Radon 86 | |
| | 226 | 227 | | | | | | | | | | | | | | | | |
| Ţ | Ra | Ac | | | | | | | | | | | | | | | | |
| Francium 87 | Radium 88 | Actinium 89 † | | | | | | | | | | | | | | | | |
| *58.71 | yachtac | *58_71 sothonoid corios | | 140 | 141 | 144 | | 150 | 33 | 157 | 159 | 162 | 165 | 167 | 169 | 173 | 17.5 | |
| +90-103 Actinoid series | Actionic | old selles | | පී | Ā | PN | | Sm | П | gg | Д | Dy | 운 | щ | Ħ | ΛÞ | Γn | |
| <u> </u> | | 63 De D | | Cerium 58 | Praseodymium 59 | Neodymium 60 | Promethium 61 | Samarium 62 | Europium 63 | Gedolinium 64 | Terbium 65 | Dysprosium 66 | Holmium 67 | Erbium 68 | Thulium 69 | Ytterbium 70 | Luteflum 71 | |
| | m | a = relative atomic mass | nic mass | 0 | | 000 | | | | | | | | | | | | |

Mendelevium 101 Thulium 69 _____Erbium | 68 |-Fm Fermium 100 Einsteinium Holmium Californium Terbium , **BK**Berkelium
97 Gadolinium 64 Curlium Promethium Samarium Europium 61 63 Am
Americium
95 **Pu**Plutonium
94 Neptunium Neodymium F 60 238 **C** Uranium Praseodymium 59 Pa Protactinium 91 Cerlum . 232 **Th** Thorium 90 b = proton (atomic) number

a = relative atomic mass X = atomic symbol

в 🗶

Key

Lr Lawrencium 103

Nobelium 102

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).