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	
B8	
B9	
B10	
B11	
TOTAL	

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

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Local Examinations Syndicate
[Turn over

Section A

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

A1 Choose from the following elements to answer the questions below.

argon	bromine	carbon	hydrogen
iodine	iron	neon	sulphur

Each element can be use used once, more than once, or not at all.

Name an element which

(a) forms a basic oxide,

.....[1]

(b) is a liquid at room temperature and pressure,

.....[1]

(c) reacts with aqueous copper(II) sulphate to give a pink solid,

.....[1]

(d) is formed during the electrolysis of concentrated aqueous sodium chloride,

.....[1]

(e) has a giant molecular structure.

.....[1]

A2 Ethanol, CH_3CH_2OH, is a liquid fuel. Ethanol can be manufactured either from glucose, $C_6H_{12}O_6$, or from ethene.

(a) Briefly describe the manufacture of ethanol from glucose.
Include 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.

.....

(iii) Give the conditions needed for this reaction.

.....

.....
[4]

[Turn over

A3 Petroleum is a complex mixture of hydrocarbons. Petroleum is a source of many useful fuels.

(a) What is meant by the term *hydrocarbon*?

.....

.....[1]

(b) Petroleum is separated by fractional distillation.

(i) Complete the following table about the fractions obtained from petroleum.

fraction	use
petrol (gasoline)	fuel for cars
paraffin (kerosene)	
diesel	fuel for diesel engines
bitumen	

(ii) Name one **other** fraction obtained from petroleum.

.....
[3]

(c) Fractional distillation of petroleum does not produce sufficient of some fractions to match demand.
Cracking is used to convert large hydrocarbon molecules into smaller molecules that are more in demand.

A hydrocarbon of molecular formula $C_{12}H_{26}$ is cracked.

(i) Suggest the formula of one **alkane** that may be produced.

.....

(ii) Suggest the formula of one **alkene** that may be produced.

.....

(iii) Describe a chemical test that can be used to distinguish between an alkene and an alkane.

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_2O	160	3.0×10^{-4}
CCl_3F	21000	2.8×10^{-8}

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

.....[1]

(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 CCl_3F?

.....[1]

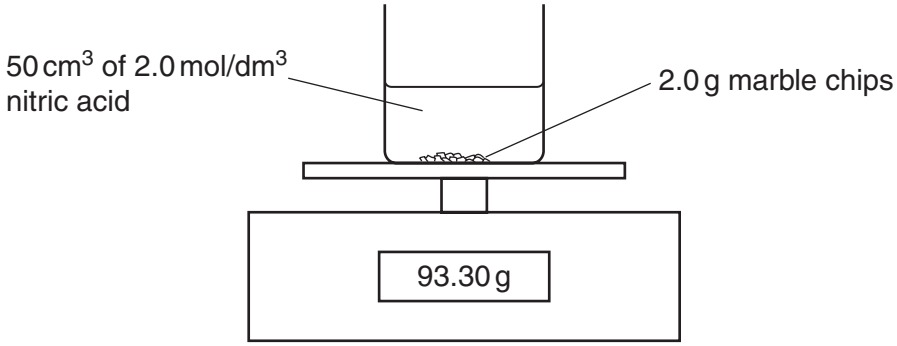
[Turn over

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.

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

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 cm^3 of 2.0 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) The student repeats the experiment using the same quantities of calcium carbonate and nitric acid. This time the acid is at a higher temperature. Describe and explain, in terms of collisions between reacting particles, the effect of increasing the temperature on the rate of reaction.

.....

.....

.....[2]

A6 A student adds aqueous sodium hydroxide from a burette into 25.0 cm^3 of dilute sulphuric acid. The student measures the pH value of the mixture during the addition of the sodium hydroxide.

(a) Describe how the pH value changes.

.....[1]

(b) Give an ionic equation to represent the neutralisation reaction between sodium hydroxide and sulphuric acid.

.....[1]

(c) Sulphuric 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?

.....

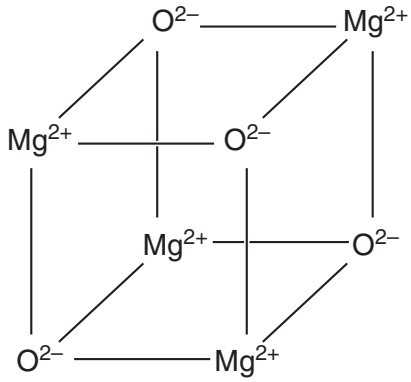
.....

.....
[3]

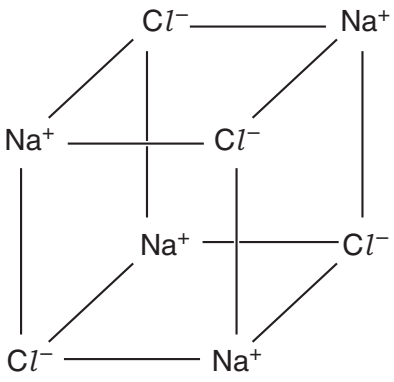
(d) Dilute sulphuric acid reacts with magnesium to give hydrogen.
Give the ionic equation for this reaction.

.....[1]

A7 The structures of two ionic lattices are shown below.



magnesium oxide



sodium chloride

(a) Explain why these two solids do not conduct electricity.

.....

.....[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

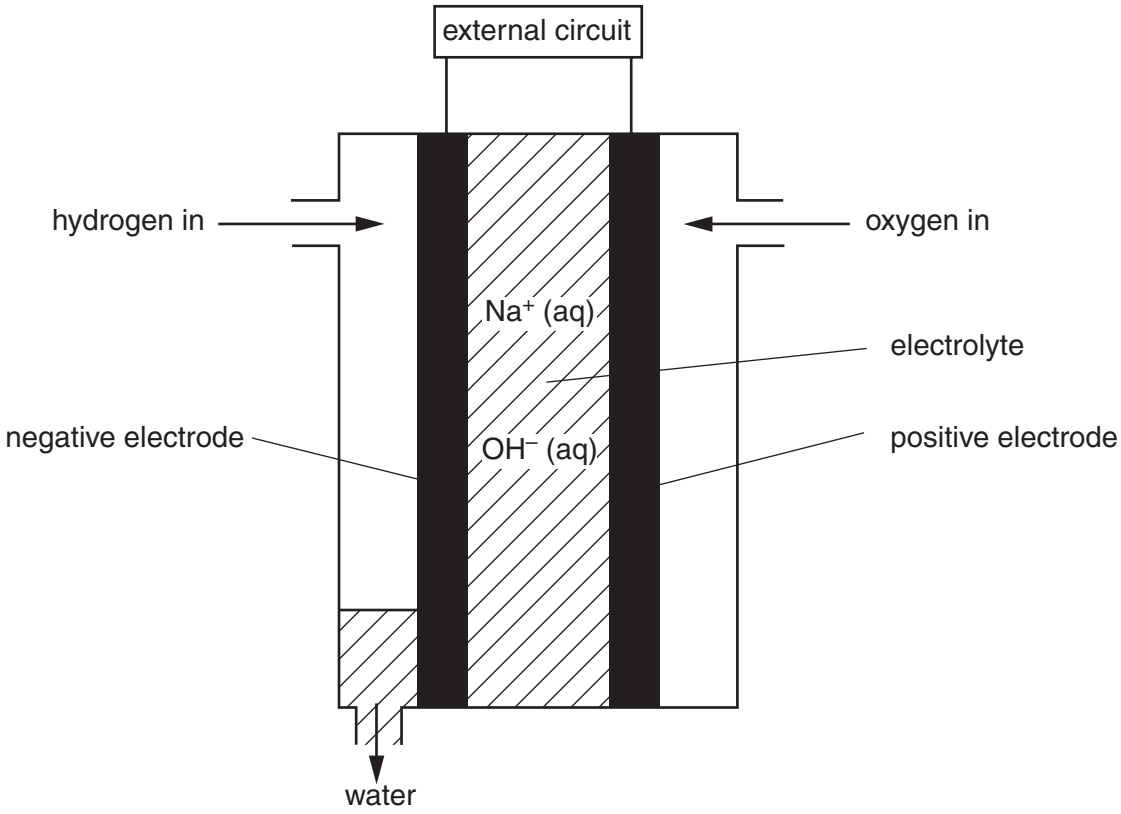
[2]

[Turn over

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.

$$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$$

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

$$H_2(g) + 2OH^-(aq) \longrightarrow 2H_2O(l) + 2e^-$$

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 dm^3 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_2H	46	8.4	101
ethanoic acid	CH_3CO_2H	60	17	118
propanoic acid	$C_2H_5CO_2H$	74	–22	141
butanoic acid	$C_3H_7CO_2H$	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.

[3]

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

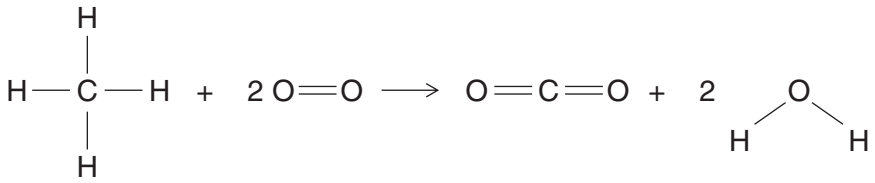
(c) Analysis of an organic acid isolated from red ants shows that it contains 0.060 g of carbon, 0.010 g of hydrogen and 0.16 g of oxygen.
Calculate the empirical formula for this acid. [2]

(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]

[Turn over

B10 Methane, CH_4, is used as a fuel. The complete combustion of methane can be represented by the equation below.



$\Delta H = -890\,kJ/mol$

(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.

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

(i) Suggest why the calcium carbonate is powdered. [1]

(ii) Calculate the mass of calcium carbonate needed to react with 8000 kg of sulphur dioxide. [3]

(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.

$$SO_2 + NO_2 \longrightarrow SO_3 + NO$$

$$2NO + O_2 \longrightarrow 2NO_2$$

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]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radius 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).