Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Joint Examination for the School Certificate and General Certificate of Education Ordinary Level

CHEMISTRY 5070/2

PAPER 2 Theory **OCTOBER/NOVEMBER SESSION 2002**

1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Answer paper

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

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

Section 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 lined pages provided and/or on separate answer paper.

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

INFORMATION FOR CANDIDATES

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.

FOR EXAMINER'S USE	
Section A	
B7	
B8	
B9	
B10	
TOTAL	

This question paper consists of 13 printed pages and 3 lined pages.

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

[Turn over

Section A

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

The total mark for this section is 45.

A1 Use the substances named in the table to answer the following questions.

name of substance	melting point / °C	boiling point / °C	percentage by volume in clean air
argon	–189	–186	0.93
carbon dioxide	sublimes at –78		0.03
helium	–270	–269	0.0005
nitrogen	–210	–196	78.03
oxygen	–219	–183	20.99

(a) (i) Name a monatomic gas.

.....

(ii) Name the gas used in the Haber Process to make ammonia.

.....

(iii) Which substances are liquids at –187 °C?

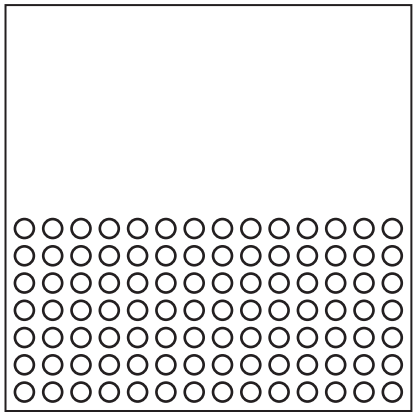
.....

(iv) Name the substance which is a liquid over the largest range of temperature.

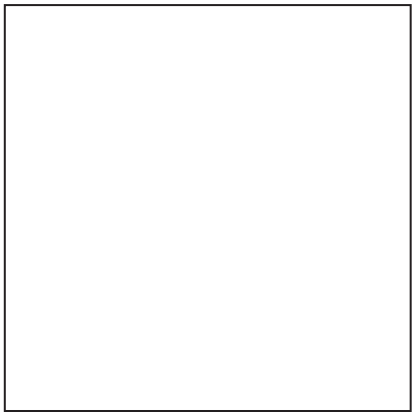
.....

Box A represents the arrangement of particles in carbon dioxide at –79 °C.

(v) Draw a diagram in box B to show the arrangement of particles in carbon dioxide at –77 °C.



Box A



Box B [6]

The percentage amounts of the same gases were measured in air from a crowded classroom.

(b) (i) Name one gas whose percentage is **higher** in air from a crowded classroom.

.....

(ii) Name one gas whose percentage is **lower** in air from a crowded classroom.

.....

[2]

[Turn over

A2 Chlorofluorocarbons (CFCs) are sometimes used as propellants in aerosols. 'Holes' in the ozone layer are caused by reactions involving chlorofluorocarbons.

(a) Explain why holes in the ozone layer can cause harm to humans.

.....[2]

Difluoromethane, CH_2F_2 is a hydrofluorocarbon.
It can be used instead of CFCs in aerosols.

(b) Draw a dot and cross diagram to show the bonding in CH_2F_2.
Your diagram only needs to show outer shell electrons.

[2]

(c) Difluoromethane can be made by reacting methane with fluorine.

$CH_4 + F_2 \rightarrow CH_3F +$ substance **X**
$CH_3F + F_2 \rightarrow CH_2F_2 +$ substance **X**

(i) Name substance **X**.

.....

(ii) What is the name for this type of reaction?

.....

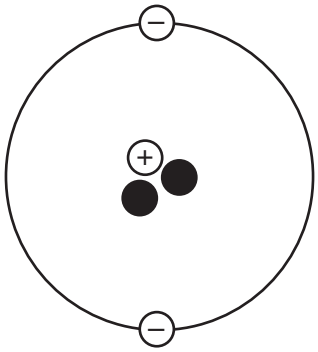
(iii) Gaseous bromine will also react with methane.
Suggest whether the reaction is faster or slower than with fluorine.
Explain your answer.

.....

.....

.....
[3]

A3 Tritium is an isotope of hydrogen.
An **ion** of tritium has the following structure.



(a) Complete the following table to show the names and charges of the particles in this tritium ion.

symbol	name	charge
●	neutron	
⊕		+1
⊖		–1

[2]

(b) Using the symbol T to represent tritium, give the formulae of

(i) the ion shown above .....

(ii) the compound formed between tritium and sodium. .....
[2]

(c) Would you expect the oxide of tritium to be a solid, a liquid or a gas?
Explain your reasoning.

.....

.....

.....[1]

[Turn over

A4 Propane and propene are organic compounds.

(a) State one similarity and one difference between the **structures** of propane and propene.

similarity .....

difference .....[2]

(b) Name a substance that can be used to distinguish between propane and propene. In each case, describe what you would see.

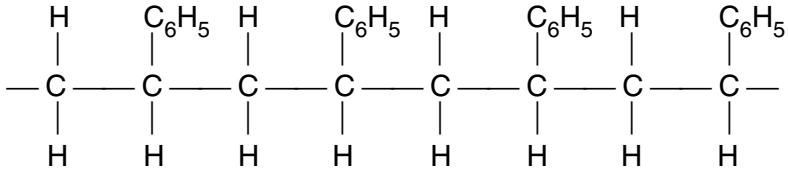
substance .....

observation with propane .....

observation with propene .....[2]

(c) Another compound, **Z**, can be polymerised to form polystyrene.

Part of the structure of polystyrene is shown below.



(i) Draw the structure of compound **Z**.

(ii) Name the two products which are formed by complete combustion of polystyrene.

.....

(iii) Give one advantage of disposing of waste polystyrene by burning.

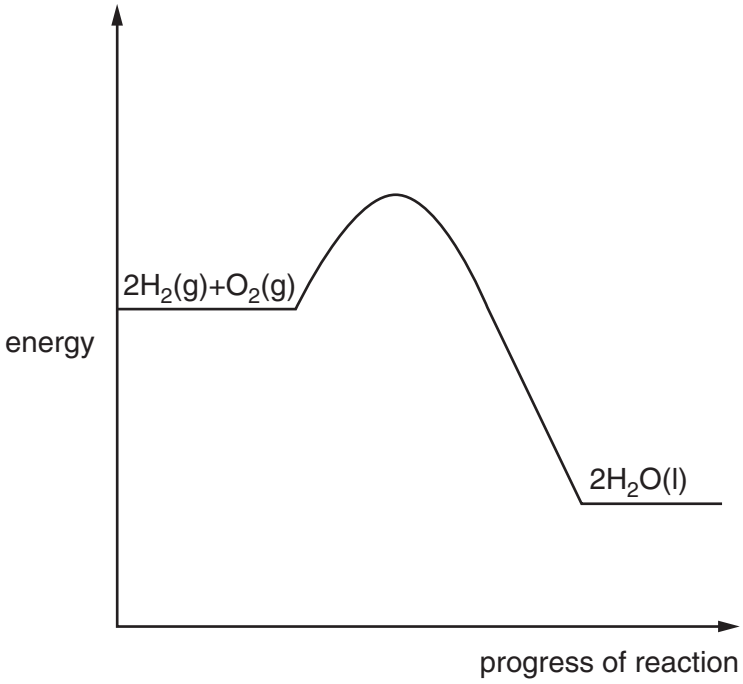
.....

[4]

A5 In the future, fuel cells may be used to power cars.
In a fuel cell, the overall reaction is represented by the equation

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

(a) This is the energy profile diagram for the reaction between hydrogen and oxygen.



(i) Label on the diagram the **activation energy** of the reaction.

(ii) The fuel cell contains a catalyst. Draw a second curve on the diagram to show the energy profile for the catalysed reaction.

(iii) Explain why this reaction is exothermic in terms of bond breaking and bond forming.

.....

.....

.....

[5]

(b) Choose from the following list the metal that is most likely to act as a catalyst. Give a reason for your choice.

beryllium **lead** **titanium** **aluminium**

metal .....

reason .....[1]

[Turn over

A6 Iron is manufactured in the blast furnace from haematite.

(a) In the furnace, a redox reaction takes place between iron and carbon monoxide.

$$Fe_2O_3 + \square\ CO \rightarrow \square\ Fe + \square\ CO_2$$

(i) Balance the equation by inserting numbers into the boxes.

(ii) Explain how carbon monoxide is acting as a reducing agent.

.....

.....

(iii) State the change in oxidation state of iron during the reaction.

from…….....…… to .....

(iv) Explain why this is an example of reduction, in terms of electron transfer.

.....

.....

[5]

(b) Scrap iron can be recycled by adding it to the molten iron, after it leaves the blast furnace.
Give **one** reason, other than cost, why scrap iron is recycled.

.....[1]

(c) Magnetite is another ore of iron.
A student found that a sample of magnetite contained 50.4 g of iron and 19.2 g of oxygen.
Calculate the empirical formula of magnetite.

.....[3]

(d) Iron from the blast furnace is used to make steel for building bridges.
Some bridges have blocks of magnesium attached to them.
Explain why.

.....

.....[2]

Section B

Answer **three** questions from this section.

Write your answers on the lined pages that follow.

B7 Zinc can be extracted from calamine, $ZnCO_3$, in a two-stage process.

Stage 1 $\quad ZnCO_3 \rightarrow ZnO + CO_2$

Stage 2 $\quad ZnO + C \rightarrow Zn + CO$

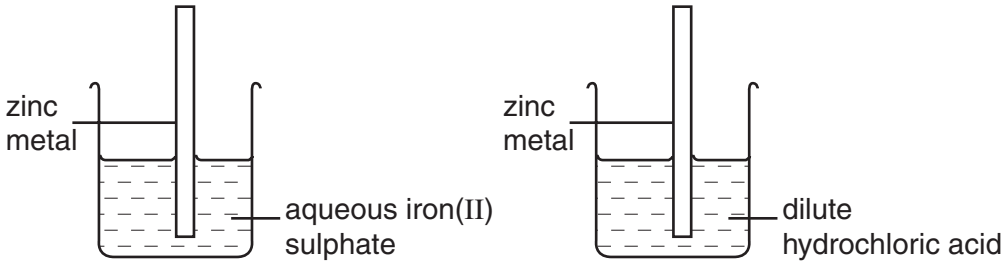
(a) Explain why the gases from stage 2 must be removed for the safety of the workers. [1]

(b) Explain why the same two-stage process cannot be used to extract sodium from sodium carbonate, Na_2CO_3. [2]

(c) Industrial processes release large amounts of carbon dioxide. This contributes to global warming.

Describe **two** environmental consequences of an increase in global warming. [2]

(d) In the laboratory, two experiments were set up using zinc metal.



For each experiment, describe what you would observe and how you would test any gases evolved. Write an equation for the reaction in each beaker. [5]

[Total : 10]

[Turn over

B8 Aqueous copper(II) sulphate is electrolysed using carbon electrodes.

(a) Give the formulae of all the ions present in the solution. [2]

(b) A copper coating forms on the cathode, and a gas is evolved at the anode.

(i) Write a half equation for the formation of copper at the cathode.

(ii) Name the gas formed at the anode and describe a test for this gas.

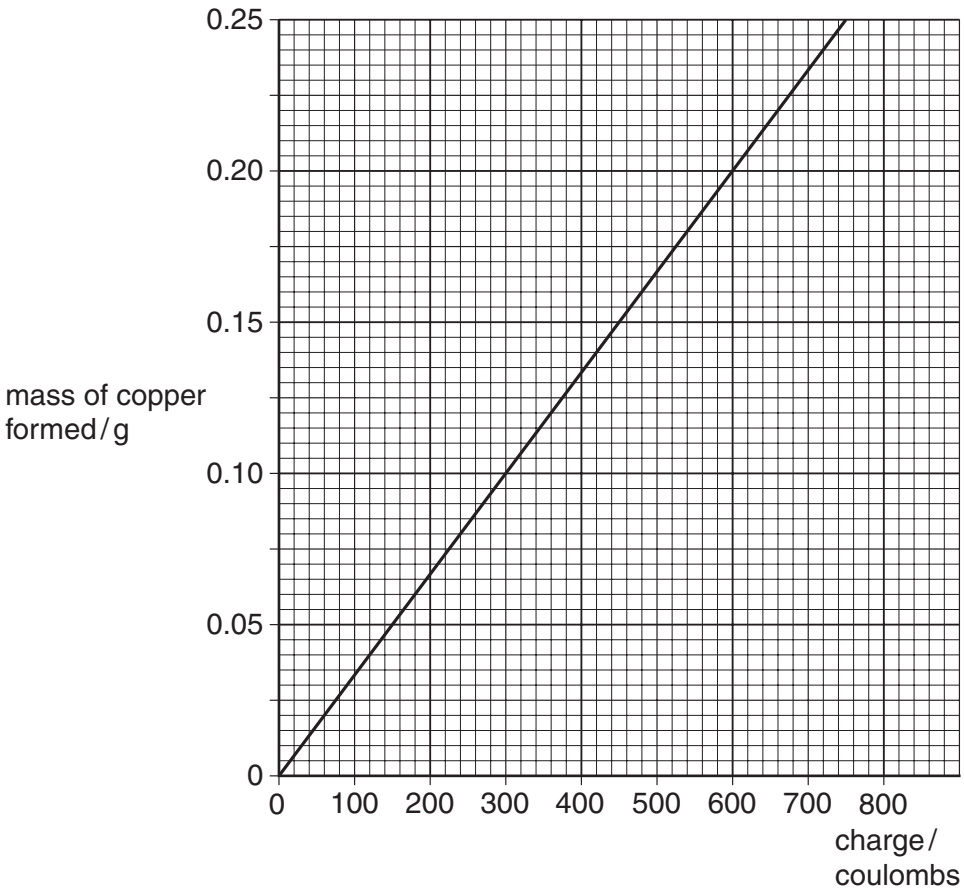
[3]

(c) After some time, the blue colour of the aqueous copper(II) sulphate fades and the pH of the solution decreases.

Explain why these changes take place. [2]

(d) A student investigated the relationship between the mass of copper formed and the total charge passed through the solution.

This is a graph of the results.



(i) What mass of copper is formed when a charge of 600 coulombs is passed through the solution?

(ii) Use your graph to predict the charge needed to form 1 g of copper, and hence predict the charge needed to deposit 1 mole of copper.

[3]

[Total : 10]

B9 Ammonia is used to manufacture nitric acid, by a two-stage process.

Stage 1: the ammonia is converted to nitrogen(II) oxide.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \quad \Delta H = -950\,kJ/mol$$

(a) **(i)** State and explain how the **rate** changes when the pressure is increased. Use ideas about colliding particles.

(ii) State and explain how the **yield** changes when the pressure is increased. Use ideas about reacting volumes of gases.

[4]

(b) During the reaction, the ammonia and oxygen are passed through a powdered catalyst.

(i) Explain why the catalyst becomes hot during the reaction.

(ii) Explain why the catalyst is used in the form of a powder.

[2]

Stage 2: the nitrogen dioxide is converted to nitric acid.

$$4NO\,(g) + 2H_2O(g) + 3O_2(g) \rightarrow 4HNO_3(aq)$$

(c) Calculate the maximum mass of nitric acid which can be made from 720 dm^3 of nitrogen(II) oxide, NO, at room temperature and pressure. [3]

(d) Use the two equations to construct an overall equation for the conversion of ammonia to nitric acid. [1]

[Total : 10]

B10 Emissions from coal fired power stations contain sulphur dioxide, which causes acid rain.

Sulphur dioxide can be removed from the emissions by reaction with calcium carbonate.

(a) Name the raw material used as a source of calcium carbonate. [1]

(b) The sulphur dioxide reacts with the calcium carbonate to produce calcium sulphite, $CaSO_3$, and carbon dioxide.

(i) Write an equation for the reaction between calcium carbonate and sulphur dioxide.

(ii) A large coal-fired power station produces 960 tonnes of sulphur dioxide each year.

Calculate the mass of calcium carbonate needed to react with 960 tonnes of sulphur dioxide (1 tonne = 1 x 10^6 g).

[3]

(c) Sulphur dioxide can be recovered by heating the calcium sulphite.

Describe, with the aid of equations, the manufacture of sulphuric acid from sulphur dioxide.

[6]

[Total : 10]

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 Radium 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 = 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.).