| 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?

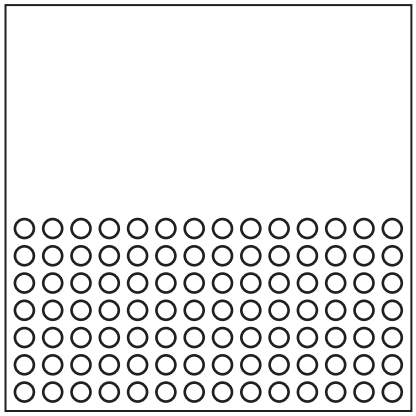
.....

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

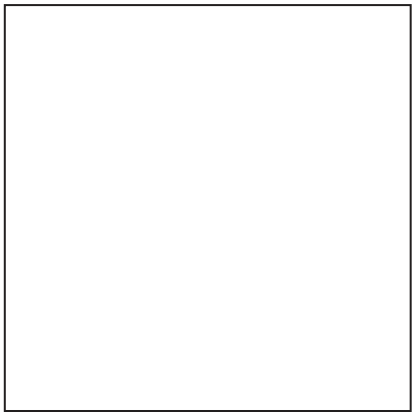
.....

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?

.....

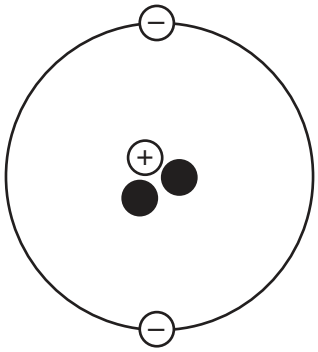
**(iii)** Gaseous bromine will also react with methane.
Suggest whether the reaction is faster or slower than with fluorine.
Explain your answer.

.....

.....

.....
[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.

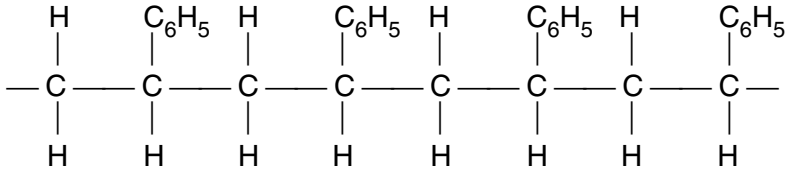
substance .....

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.

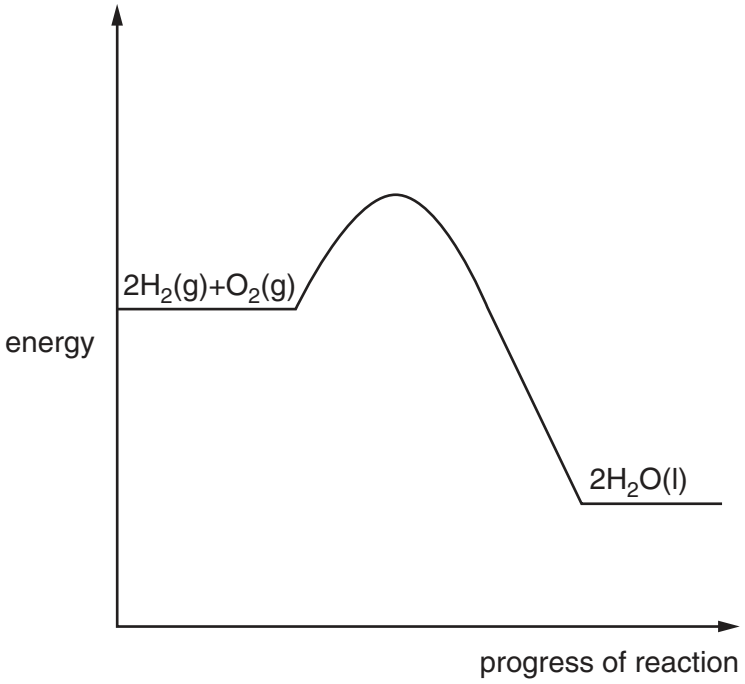
.....

[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 $ZnCO_3 \rightarrow ZnO + CO_2$

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

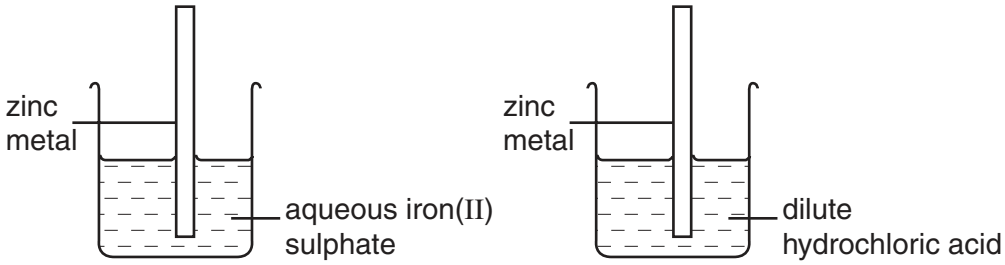
**(a)** Explain why the gases from stage 2 must be removed for the safety of the workers. [1]

**(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.

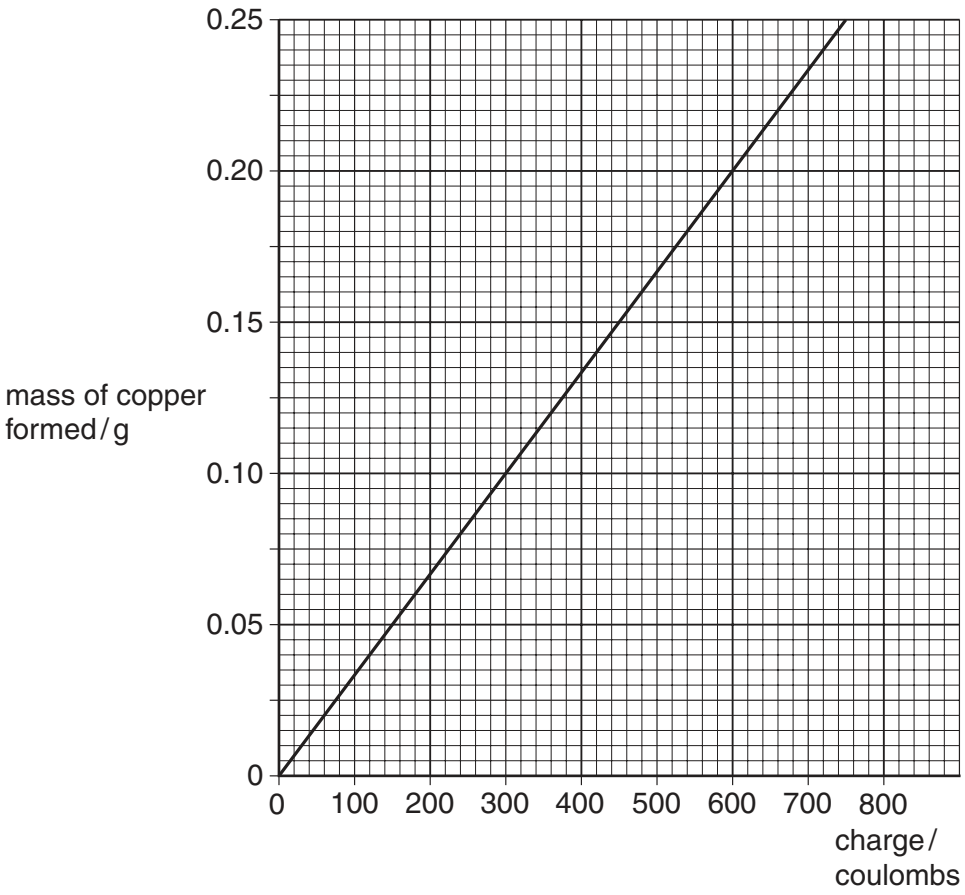
[3]

**(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]



**[Turn over**

**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 | 43 Tc Technetium | 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.).