UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



**CHEMISTRY** **5070/02**

Paper 2 Theory **October/November 2009**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

**Section A**
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

**Section B**
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

A copy of the Periodic Table is printed on page 20.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

| For Examiner's Use | |
|---|---|
| Section A | |
| B7 | |
| B8 | |
| B9 | |
| B10 | |
| Total | |

This document consists of **18** printed pages and **2** blank pages.




UNIVERSITY of CAMBRIDGE International Examinations

## Section A

*For Examiner's Use*

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

The total mark for this section is 45

**A1** **(a)** Choose from the following compounds to answer the questions below.

**ammonium sulfate**
**calcium oxide**
**copper(II) chloride**
**ethanoic acid**
**ethene**
**nitrogen dioxide**
**sodium iodide**
**sulfur dioxide**

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

Which compound

**(i)** may be formed when alkanes are cracked,

.....[1]

**(ii)** forms a yellow precipitate with aqueous silver nitrate,

.....[1]

**(iii)** is used as a fertiliser,

.....[1]

**(iv)** is a pollutant arising from lightning activity,

.....[1]

**(v)** is used by farmers to reduce soil acidity,

.....[1]

**(vi)** forms an alkaline solution when it reacts with water?

.....[1]

**(b)** Define the term *compound*.

.....

.....[1]

**(c)** Explain why sodium iodide will **not** conduct electricity when solid but will conduct when dissolved in water.

*For Examiner's Use*

.....

..... [2]

[Total: 9]

**A2** In the presence of yeast, aqueous glucose, $C_6H_{12}O_6$, is changed into carbon dioxide and ethanol.

*For Examiner's Use*

**(a)** Write the equation for this reaction.

.....[1]

**(b)** Name this reaction.

.....[1]

**(c)** Suggest how the speed of this reaction varies as the temperature changes from 20 to 60 °C.

.....

.....[2]

**(d)** Carbon dioxide is also formed when calcium carbonate reacts with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The graph shows how the volume of carbon dioxide changes when calcium carbonate powder reacts with excess 0.5 mol/dm$^3$ hydrochloric acid.
On the same axes, sketch the curve you would expect when the experiment is repeated using the same amount of calcium carbonate and excess 1.0 mol/dm$^3$ hydrochloric acid.
[2]

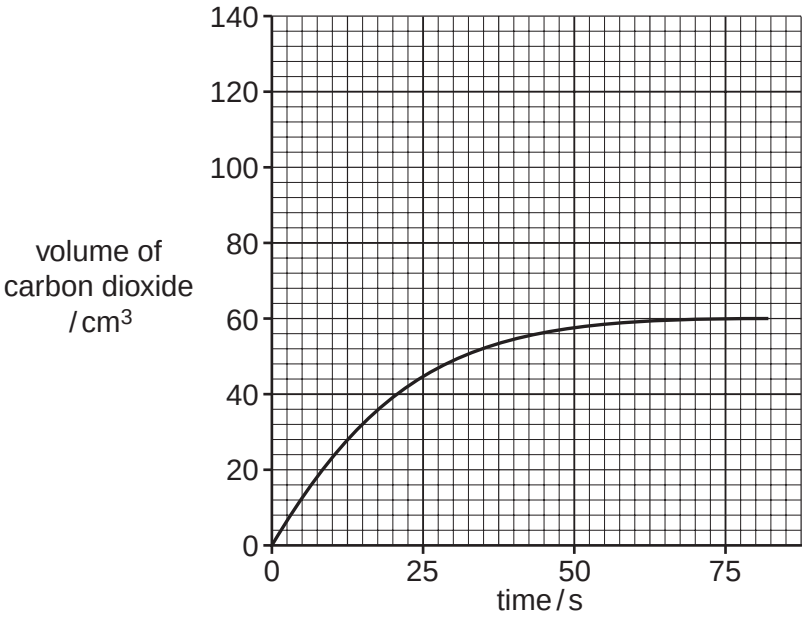


**Fig. 1**

[Total: 6]

**A3** Dry air contains mainly nitrogen and oxygen together with small amounts of argon and carbon dioxide.

*For Examiner's Use*

**(a)** State the approximate percentages of nitrogen and oxygen in dry air.

nitrogen .....% oxygen .....% [1]

**(b)** Dry air contains about 1% of the argon-40 isotope, $^{40}_{18}Ar$.

**(i)** What do you understand by the term *isotope*?

.....

.....[1]

**(ii)** State the number of electrons and neutrons in this isotope of argon.

number of electrons .....

number of neutrons ..... [1]

**(c)** Argon is used in the manufacture of titanium. In this process titanium(IV) chloride, $TiCl_4$, is reduced with hot sodium. The products are titanium and sodium chloride.

**(i)** Write an equation for the reaction between titanium(IV) chloride and sodium.

.....[1]

**(ii)** During this reaction argon is blown over the mixture of sodium and titanium(IV) chloride.
Suggest why the reaction is carried out in an atmosphere of argon.

.....[1]

**(d)** A small amount of xenon is present in the air. Several compounds of xenon have been made in recent years.
A compound of xenon contained 9.825 g of xenon, 1.200 g of oxygen and 5.700 g of fluorine.
Determine the empirical formula of this compound.

[3]

[Total: 8]





**[Turn over**

**A4** Methylamine, $CH_3NH_2$, is a base which has similar properties to ammonia.
When methylamine dissolves in water, the following equilibrium is set up.

For Examiner's Use

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$$

**(a)** Explain why methylamine behaves as a base in this reaction.

.....[1]

**(b)** When aqueous methylamine is added to aqueous iron(III) chloride, a red-brown precipitate is observed.
Suggest what you would observe when aqueous methylamine is added to aqueous iron(II) chloride.

.....

.....[1]

**(c)** Methylamine is a gas. Calculate the volume occupied by 6.2 g of methylamine at room temperature and pressure.

[2]

**(d)** Methylamine is made by reacting methanol with excess ammonia under pressure in the presence of a catalyst.

$$CH_3OH + NH_3 \longrightarrow CH_3NH_2 + H_2O$$

**(i)** Define the term *catalyst*.

.....[1]

**(ii)** Calculate the theoretical yield of methylamine that can be obtained from 240 kg of methanol.

[2]

[Total: 7]

**A5** Bromine is extracted by reacting the potassium bromide in seawater with chlorine.

*For Examiner's Use*

**(a)** Write an equation for this reaction.

.....[1]

**(b)** The bromine is purified by treatment with sulfur dioxide.
Describe a test for sulfur dioxide.

test .....

result ..... [2]

**(c)** Bromine is a halogen.
Complete the table to estimate both the density and boiling point of bromine.

| halogen | density of solid halogen in g/cm$^3$ | boiling point / °C |
|---|---|---|
| fluorine | 1.51 | –188 |
| chlorine | 1.56 | –35 |
| bromine | | |
| iodine | 4.93 | 184 |

[2]

**(d)** Bromine is a liquid with a low boiling point and a strong smell.
A technician spilt some bromine in the corner of a room which is free of draughts. After thirty seconds the bromine could be smelt on the other side of the room.

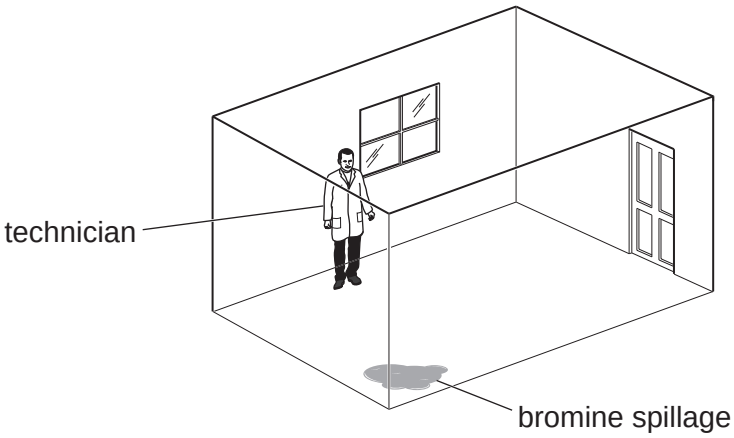


**Fig. 2**

Use the kinetic particle theory to explain why the bromine could be smelt on the other side of the room.

.....

.....

.....

.....[3]

[Total: 8]





**[Turn over**

**A6** A thin layer of ozone, $O_3$, is present high in the Earth's atmosphere.

*For Examiner's Use*

**(a)** Explain why the ozone layer is important in terms of human health.

.....

.....

.....[2]

**(b)** Chlorofluorocarbons, CFCs, catalyse the conversion of ozone to oxygen.
Write the equation for this reaction.

.....[1]

**(c)** The graphs show how both the world CFC production and the amount of high level ozone at the South Pole have changed over the last 26 years.

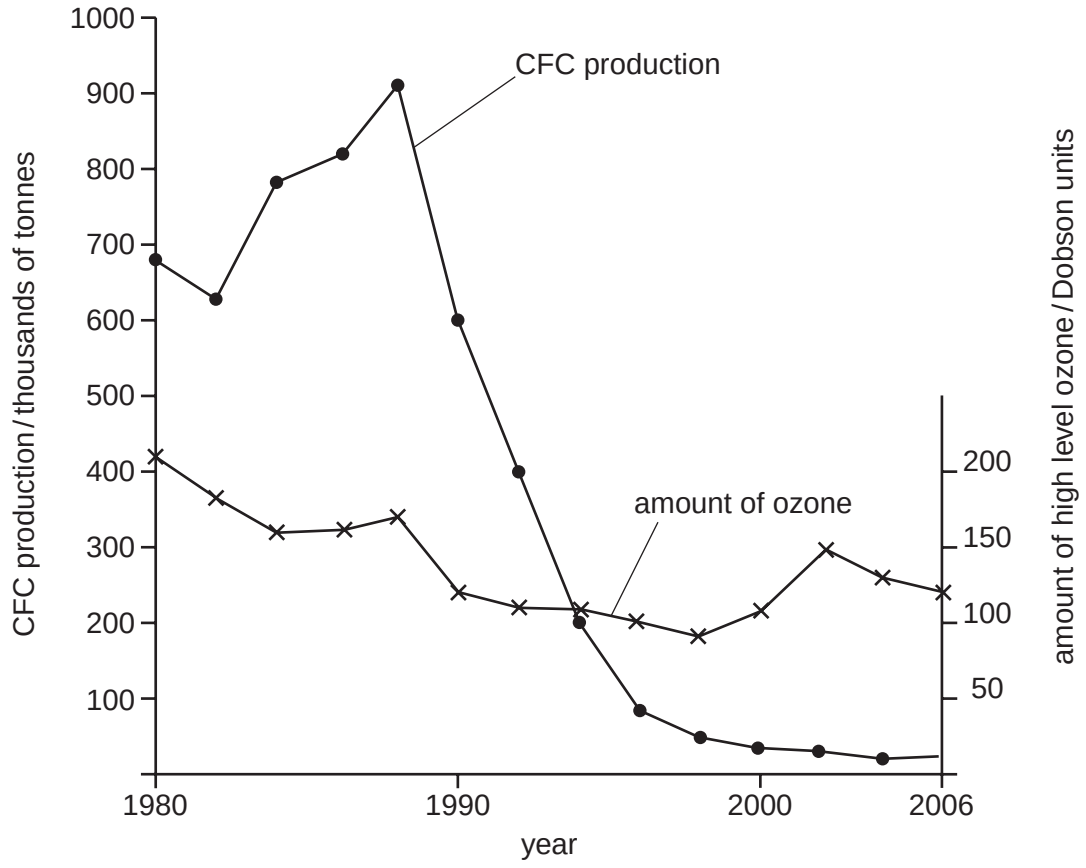


**Fig. 3**

**(i)** Describe how the world production of CFCs has changed over the last 26 years.

.....

.....[2]

**(ii)** What evidence, if any, is there to indicate a link between the world CFC production and the amount of high-level ozone in the atmosphere at the South Pole?

*For Examiner's Use*

Explain your answer.

.....

.....

.....

.....

.....[2]

[Total: 7]

## Section B

For Examiner's Use

Answer **three** questions from this section.

The total mark for this section is 30.

**B7** Copper is purified by the electrolysis of aqueous copper(II) sulfate using copper electrodes.

**(a)** Explain how this process is carried out in the laboratory and give relevant equations for the electrode reactions.

.....

.....

.....

.....

.....

.....

.....

.....[4]

**(b)** Aqueous copper(II) sulfate can also be electrolysed using carbon electrodes.

**(i)** Write an equation for the reaction which takes place at the anode in this electrolysis.

.....[1]

**(ii)** Explain why the colour of the copper(II) sulfate solution fades during this electrolysis.

.....

.....[1]

**(c)** Copper is a transition element.

**(i)** Name **two** transition elements, or compounds of transition elements, which are used as catalysts. For each catalyst name an industrial product made using the catalyst.

.....

.....

.....

.....[2]

**(ii)** Other than acting as catalysts state **two** properties which are specific to transition elements.

*For Examiner's Use*

.....

..... [2]

[Total: 10]

**B8** Fumaric acid is a colourless solid which can be extracted from plants.

*For Examiner's Use*

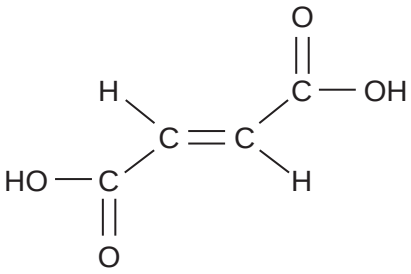


**Fig. 4**

**(a)** Describe the reaction of aqueous fumaric acid with aqueous bromine, giving the equation for the reaction and stating any observations.

.....

.....

.....

.....

.....

..... [3]

**(b)** A solution of fumaric acid was titrated against aqueous sodium hydroxide.

$$HO_2CCH{=}CHCO_2H + 2NaOH \rightarrow NaO_2CCH{=}CHCO_2Na + 2H_2O$$

18.0 $cm^3$ of 0.200 $mol/dm^3$ sodium hydroxide were required to neutralise 60.0 $cm^3$ of fumaric acid solution.
Calculate the concentration, in $mol/dm^3$, of the fumaric acid solution.

.....

.....

.....

.....

.....

..... [3]

*For Examiner's Use*

**(c)** Suggest the type of condensation polymer which is made when fumaric acid reacts with ethane-1,2-diol, HO—$CH_2$—$CH_2$—OH

.....[1]

**(d)** Nylon is a condensation polymer.
State **one** use of nylon.

.....[1]

**(e)** Describe **two** pollution problems caused by the disposal of non-biodegradable plastics.

.....

.....

.....

.....[2]

[Total: 10]





**[Turn over**

**B9** The diagram shows the carbon cycle.



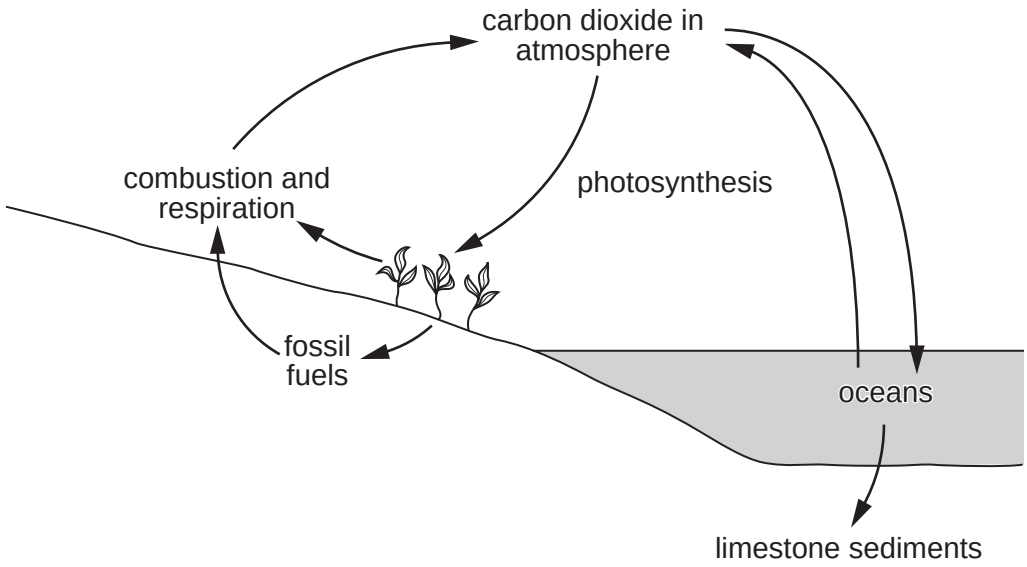


**Fig. 5**

**(a)** Describe the process of photosynthesis in simple terms.

.....

.....

..... [2]

**(b)** Draw a dot-and-cross diagram for carbon dioxide showing the outer electrons only.

[1]

*For Examiner's Use*

**(c)** Many scientists think that the burning of hydrocarbons such as octane, $C_8H_{18}$, contributes to climate change.

**(i)** Write an equation for the complete combustion of octane.

.....[1]

**(ii)** Why do some scientists think that the burning of hydrocarbons contributes to climate change?

.....

.....[1]

**(d)** In the oceans carbon dioxide reacts with carbonate ions in seawater to form hydrogencarbonate ions.

$$CO_2 + H_2O + CO_3^{2-} \rightleftharpoons 2HCO_3^-$$

**(i)** Microscopic plants remove carbon dioxide from the surface waters of the oceans. What effect does this have on the reaction above? Explain your answer.

.....

.....

.....

.....[2]

**(ii)** Name a carbonate compound which is soluble in water.

.....[1]

**(e)** Calcium carbonate is used in flue gas desulfurisation.
Describe this process and explain why it is important for the environment.

.....

.....

.....

.....

.....[2]

[Total: 10]

**B10** Iron is extracted by reducing iron ore in a blast furnace. The raw materials used are iron ore, coke, air and limestone.

*For Examiner's Use*

**(a)** Name an ore of iron.

.....[1]

**(b)** Explain, by reference to the chemical reactions involved, why limestone is used in the blast furnace.

.....

.....

.....

.....

.....

.....

.....[3]

**(c)** Coke burns in oxygen to form carbon dioxide.
Explain, in terms of bond breaking and bond making, why this reaction is exothermic.

.....

.....

.....

.....

.....

.....

.....[3]

**(d)** In the centre of the blast furnace iron(III) oxide, $Fe_2O_3$, is reduced by carbon monoxide to form iron and carbon dioxide. Near the bottom of the blast furnace the remaining iron(III) oxide is reduced by carbon to form iron and carbon monoxide.
Write equations for both of these reactions.

.....

.....[2]

**(e)** When cold, the iron obtained from the blast furnace is brittle.
How can this iron from the blast furnace be converted to mild steel?

*For Examiner's Use*

.....

..... [1]

[Total: 10]

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# DATA SHEET
## The Periodic Table of the Elements

| Group I | Group II | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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 Sulfur 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 | 209 Po Polonium 84 | 210 At Astatine 85 | 222 Rn Radon 86 |
| 223 Fr Francium 87 | 226 Ra Radium 88 | 227 Ac Actinium 89 † | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 147 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 | 231 Pa Protactinium 91 | 238 U Uranium 92 | 237 Np Neptunium 93 | 244 Pu Plutonium 94 | 243 Am Americium 95 | 247 Cm Curium 96 | 247 Bk Berkelium 97 | 251 Cf Californium 98 | 252 Es Einsteinium 99 | 257 Fm Fermium 100 | 258 Md Mendelevium 101 | 259 No Nobelium 102 | 260 Lr Lawrencium 103 |

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

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

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