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.

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]

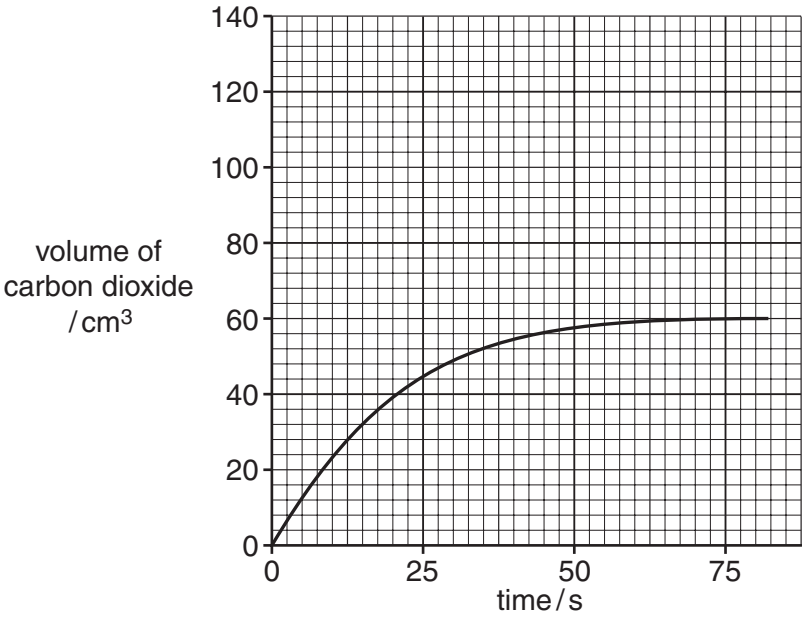

Fig. 1

[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.

$$CH_3OH + NH_3 \rightarrow CH_3NH_2 + H_2O$$

(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.

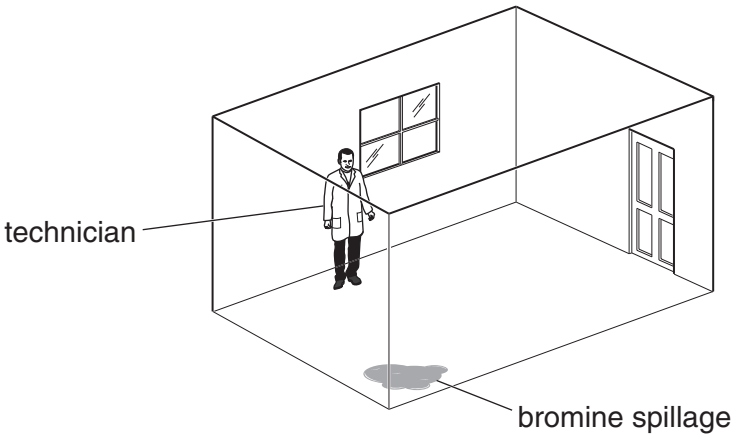

Fig. 2

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

.....

.....

.....

.....[3]

[Total: 8]

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.

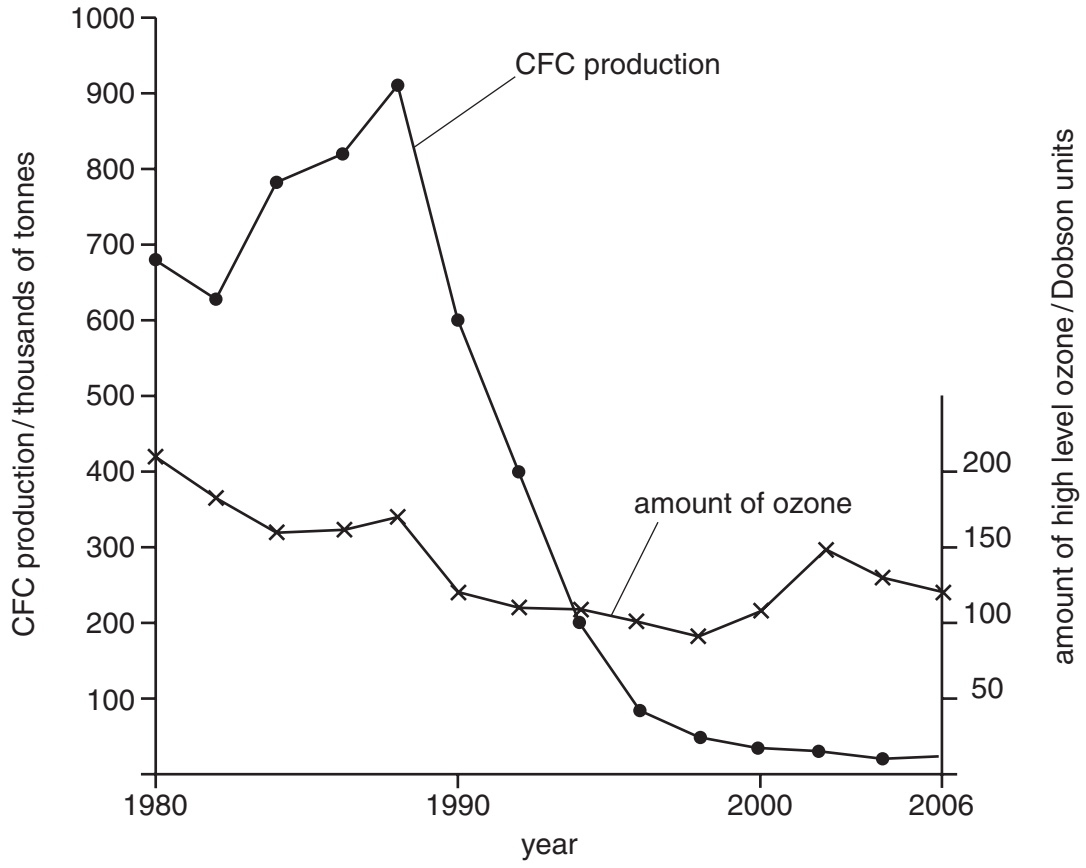

Fig. 3

(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.

.....

.....

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.....

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.....

.....

.....[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

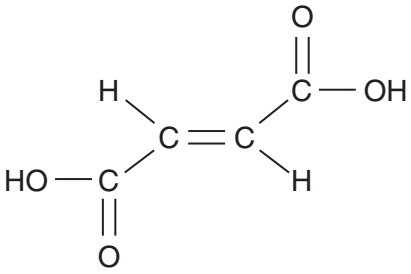

Fig. 4

(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.

.....

.....

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.....

.....[3]

(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

For Examiner's Use

.....[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]

B9 The diagram shows the carbon cycle.

For Examiner's Use

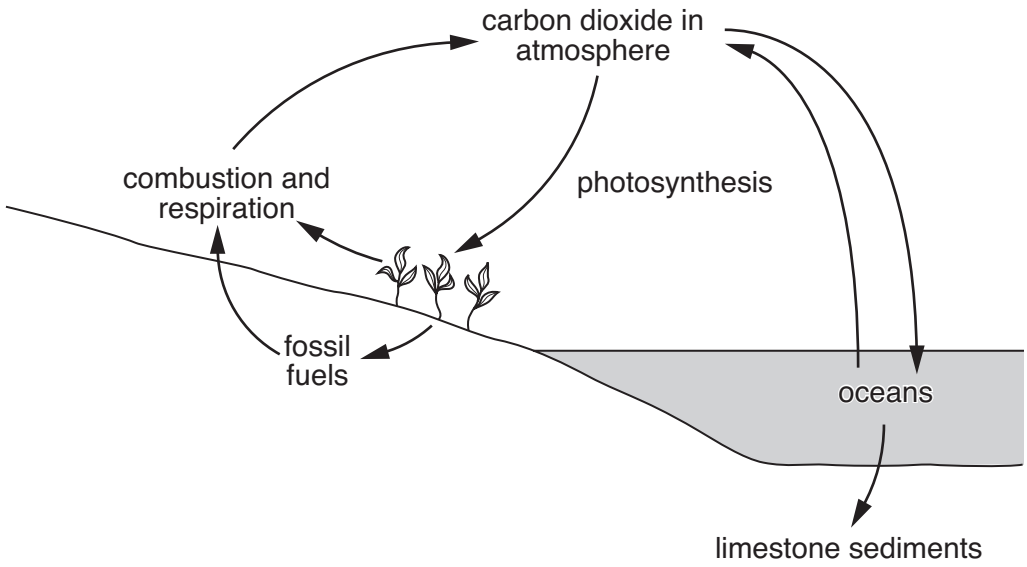

Fig. 5

(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]

(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.

.....

.....

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.....[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.

.....

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.....[3]

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

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.....[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	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 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.).