UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/02**

Paper 2 Theory **May/June 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 16.
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	
B8	
B9	
B10	
B11	
Total	

This document consists of **16** printed 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 Choose from the following substances to answer the questions below.

copper(II) chloride

chlorine

ethanoic acid

hydrochloric acid

manganese(IV) oxide

platinum

potassium dichromate(VI)

sodium chloride

sulfuric acid

vanadium(V) oxide

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

Name a substance which

(a) is a catalyst in the Contact process,

.....[1]

(b) has an aqueous solution that reacts with aqueous sodium hydroxide to give a blue precipitate,

.....[1]

(c) is a weak acid,

.....[1]

(d) can be used in the test for sulfur dioxide,

.....[1]

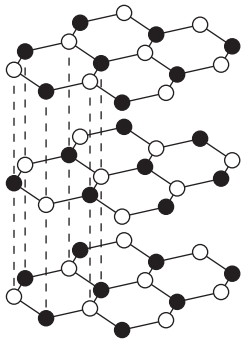
(e) reacts with aqueous potassium iodide to give a brown colour.

.....[1]

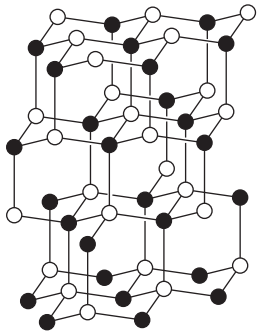
[Total: 5]

A2 Boron nitride, BN, exists in two physical forms. The structures of these forms are shown below.

For Examiner's Use



structure **A**



structure **B**

These two forms of boron nitride resemble two allotropes of carbon.

(a) Suggest why boron nitride with structure **A** can be used as a lubricant.

.....

.....

.....

.....[2]

(b) Suggest why boron nitride with structure **B** does **not** conduct electricity.

.....

.....[1]

(c) Suggest why boron nitride with structure **B** can be used in cutting tools and drill bits.

.....

.....

.....

.....[2]

[Total: 5]

A3 Electrolysis involves the decomposition of a compound by the passage of an electric current.

For Examiner's Use

(a) (i) Complete the table, which relates to the electrolysis of different solutions using inert electrodes.

electrolyte	ions in electrolyte	product at anode	product at cathode
dilute aqueous potassium nitrate	K^+, H^+, OH^- and NO_3^-	oxygen	hydrogen
concentrated aqueous sodium chloride	Na^+, H^+, OH^- and Cl^-	chlorine	hydrogen
dilute aqueous copper(II) sulfate	Cu^{2+}, SO_4^{2-}, H^+ and OH^-	.....	.....
dilute sulfuric acid	....	oxygen	hydrogen

[3]

(ii) Explain why the electrolysis of concentrated aqueous sodium chloride liberates hydrogen rather than sodium at the cathode.

.....

.....[1]

(iii) The electrolysis of **dilute** aqueous sodium chloride liberates oxygen at the anode. Suggest why the electrolysis of **concentrated** aqueous sodium chloride liberates chlorine rather than oxygen.

.....

.....[1]

(b) Aqueous copper(II) sulfate was electrolysed using copper electrodes. The copper anode lost mass as copper(II) ions were formed and the copper cathode gained mass as copper atoms were formed.

For Examiner's Use

(i) State one industrial application of this electrolysis.

.....[1]

(ii) The results of an experiment involving the electrolysis of aqueous copper(II) sulfate are shown below.

temperature of electrolyte / °C	current used / amps	time of electrolysis / s	mass of copper formed at the cathode / g
20	1.0	1000	0.329
20	2.0	1000	0.658
20	2.0	2000	1.320
25	2.0	2000	1.320
30	1.0	1000	0.329

Use the information in the table to describe how each of the variables affects the mass of copper formed at the cathode.

temperature .....

.....

current .....

.....

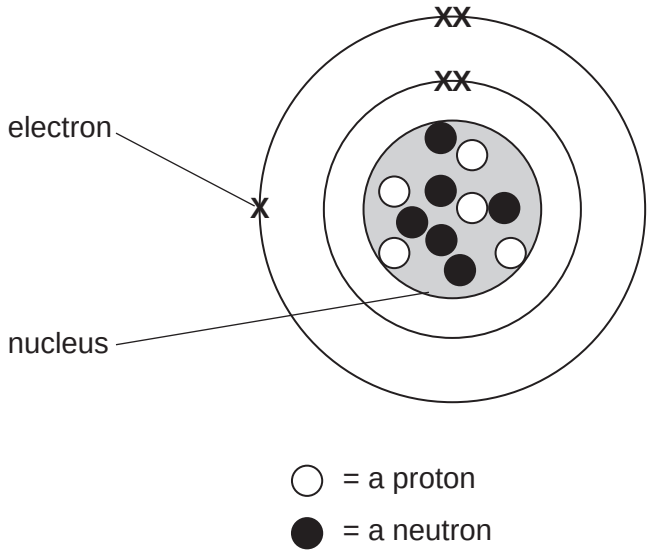
time .....

.....[3]

[Total: 9]

A4 The diagram shows the atomic structure of an atom of element **X**.

For Examiner's Use



(a) Complete the table.

sub-atomic particle	relative charge	relative mass
electron	–1	
neutron		
proton		1

[2]

(b) Carbon-12 has the symbol $^{12}_{6}C$.
Write the symbol for an atom of element **X**.

.....[2]

(c) Draw a diagram to show the atomic structure of **another** isotope of element **X**.

[2]

[Total: 6]

A5 Chlorine forms some compounds that are covalent and others that are ionic.

For Examiner's Use

(a) Draw a 'dot-and-cross' diagram for carbon tetrachloride, CCl_4.
You only need to draw the outer electrons of the carbon and chlorine atoms.

[2]

(b) Calcium reacts with chlorine to form calcium chloride.
Draw diagrams to show the electronic structures and charges of both ions present in calcium chloride.

[2]

[Total: 4]

A6 The table shows the concentration of different ions found in a sample of aqueous industrial waste.

For Examiner's Use

ion	concentration in mol/dm^3
Ca^{2+}	0.125
H^+	2.30
K^+	0.234
NO_3^-	3.68
Fe^{2+}	0.450

Use the information in the table to answer the following questions.

(a) Write the formula of one salt that could be obtained from the sample.

.....[1]

(b) Is the sample of aqueous waste acidic, neutral or alkaline? Explain your answer.

.....

.....[1]

(c) Calculate the mass of dissolved iron(II) ions, Fe^{2+}, in 25 dm^3 of the aqueous waste.

mass of iron(II) ions = ... g [2]

(d) Excess aqueous sodium hydroxide is added, a small volume at a time, to a sample of the aqueous industrial waste.
Describe and explain what you would observe.

.....

.....

.....

.....

.....[3]

(e) Describe how you would confirm the presence of dissolved nitrate ions in the sample.

For Examiner's Use

.....

.....

.....

.....

.....

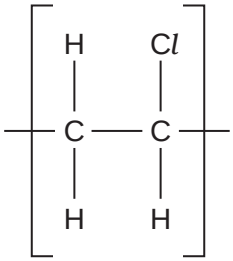
.....[4]

[Total: 11]

A7 Poly(chloroethene) is an addition polymer. It is often found in solid household waste.

For Examiner's Use

The diagram shows the repeat unit of poly(chloroethene).



(a) Draw the structure of the monomer used to make poly(chloroethene).

[1]

(b) One way to dispose of solid household waste is to burn it at a high temperature. The burning of poly(chloroethene) gives the waste gases hydrogen chloride, carbon dioxide and water.

(i) Balance the following equation to show the burning of poly(chloroethene).

$$\ldots\ldots\text{–}C_2H_3Cl\text{–} + \ldots\ldots O_2 \rightarrow \ldots\ldots HCl + \ldots\ldots CO_2 + \ldots\ldots H_2O$$

[1]

(ii) Hydrogen chloride gas is removed from the waste gases by reacting with moist powdered calcium carbonate. Name the solid product formed.

.....[1]

(c) Name and state the use of a man-made condensation polymer.

name of condensation polymer .....

use of condensation polymer .....[2]

[Total: 5]

Section B

For Examiner's Use

Answer **three** questions from this section.

The total mark for this section is 30.

B8 Petrol (gasoline) is a mixture of hydrocarbons, one of which is octane, C_8H_{18}.

(a) Describe briefly how petrol is obtained from crude oil.

.....

.....

.....

.....[2]

(b) Octane burns in air.

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

A petrol-powered motor car travels at a constant speed of 80 km/h. For every kilometre travelled 108 g of carbon dioxide are formed.

When the motor car travels 100 km calculate

(i) the mass of carbon dioxide emitted by the car,

[1]

(ii) the mass of petrol burned by the car assuming that petrol is 100% octane.

[4]

(c) In addition to carbon dioxide the exhaust emissions contain both nitric oxide, NO, and carbon monoxide, CO.
Describe how a catalytic converter can help to reduce the amounts of nitric oxide and carbon monoxide in the exhaust gases.

.....

.....

.....[2]

(d) State **one** environmental problem caused by nitrogen dioxide.

.....[1]

[Total: 10]

B9 Alcohols are an homologous series of organic chemical compounds.

For Examiner's Use

The table shows some information about different alcohols.

alcohol	formula	boiling point / °C
methanol	CH_3OH	65
ethanol	C_2H_5OH	78
propanol	C_3H_7OH	97
pentanol	$C_5H_{11}OH$	138

(a) What is meant by the term *homologous series*?

.....

.....

.....

.....[3]

(b) **(i)** Estimate the boiling point of butanol. .....[1]

(ii) A molecule of the alcohol hexanol contains six carbon atoms. Write the formula of hexanol.

..... [1]

(c) Ethanol can be manufactured from ethene.
Ethene reacts with steam in the presence of an acid catalyst to form ethanol.

(i) Write an equation for the reaction between ethene and steam.

.....[1]

(ii) Name the **type** of reaction that takes place.

.....[1]

(d) Ethanol can also be manufactured from glucose, $C_6H_{12}O_6$.

$$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH.$$

A solution containing 18 kg of glucose makes only 0.92 kg of ethanol.
Calculate the percentage yield of ethanol.

[3]

[Total: 10]

B10 Fertilisers supply the essential elements, nitrogen, phosphorus and potassium for plant growth.
A bag of fertiliser contains 500 g of ammonium sulfate, $(NH_4)_2SO_4$, and 500 g of potassium nitrate, KNO_3.

For Examiner's Use

(a) Calculate the percentage by mass of nitrogen in the bag of fertiliser.

[4]

(b) Eutrophication occurs in river water polluted by fertilisers.
Describe the principal processes involved in eutrophication.

.....

.....

.....

.....[3]

(c) Potassium sulfate is a soluble salt.
Outline the preparation of a pure, dry sample of potassium sulfate, starting from dilute sulfuric acid.

.....

.....

.....

.....

.....[3]

[Total: 10]

[Turn over

B11 Aluminium and iron are both metals.

For Examiner's Use

Iron rusts in the presence of oxygen and water. Rusting involves a series of reactions.

Initially iron atoms lose electrons to form iron(II) ions.

$$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$$

At the same time oxygen, O_2, and water molecules react to form hydroxide ions.

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

Aqueous iron(II) ions then react with aqueous hydroxide ions to form solid iron(II) hydroxide.

Finally the iron(II) hydroxide is oxidised to give hydrated iron(III) oxide (rust).

(a) (i) Explain why the formation of iron(II) ions from iron atoms is an example of oxidation.

.....

..... [1]

(ii) Write the ionic equation, including state symbols, for the reaction between iron(II) ions and hydroxide ions.

..... [2]

(b) The table shows part of the reactivity series of metals.

metal	relative reactivity
zinc	most reactive
iron	↓
tin	least reactive

An iron object plated with either zinc or tin will **not** rust.

(i) Suggest how tin stops iron from rusting.

..... [1]

For Examiner's Use

(ii) An iron object plated with tin will start to rust if the layer of tin is scratched.
An iron object plated with zinc will not rust if the layer of zinc is scratched.
Use the information in the table to explain these two observations.

.....

.....

.....

.....

.....[3]

(c) Explain why aluminium will **not** corrode in the presence of oxygen and water.

.....

.....[1]

(d) State a use of aluminium and explain why this metal is particularly suited for the stated use.

.....

.....

.....[2]

[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 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.).