



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

Paper 2 Theory

**5070/02**

**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	
<b>Section A</b>	
<b>B8</b>	
<b>B9</b>	
<b>B10</b>	
<b>B11</b>	
<b>Total</b>	

This document consists of **16** printed pages.



## Section A

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

The total mark for this section is 45.

For  
Examiner's  
Use

**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]

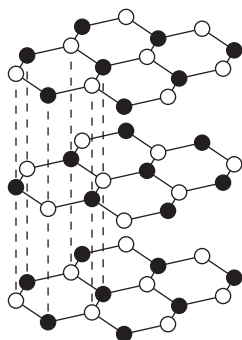
**(e)** reacts with aqueous potassium iodide to give a brown colour.

..... [1]

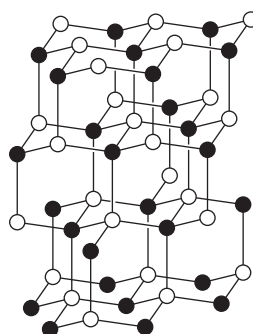
[Total: 5]

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 .....

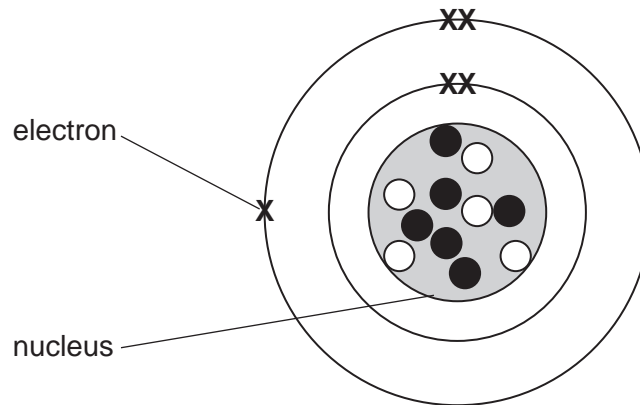
.....

time .....

.....[3]

[Total: 9]

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



○ = a proton  
● = a neutron

(a) Complete the table.

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

[2]

(b) Carbon-12 has the symbol  ${}^{12}_6\text{C}$ .  
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,  $\text{CCl}_4$ .  
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 <sup>3</sup>
Ca <sup>2+</sup>	0.125
H <sup>+</sup>	2.30
K <sup>+</sup>	0.234
NO <sub>3</sub> <sup>-</sup>	3.68
Fe <sup>2+</sup>	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<sup>2+</sup>, in 25 dm<sup>3</sup> 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.

.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

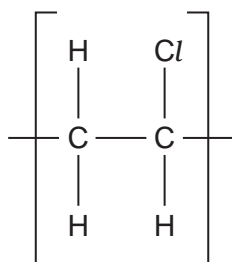
*For  
Examiner's  
Use*

[Total: 11]

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

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

For  
Examiner's  
Use

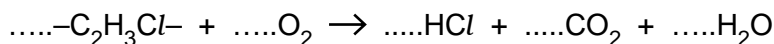


**(a)** Draw the structure of the monomer used to make poly(chloroethene).

[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).



[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

Answer **three** questions from this section.

The total mark for this section is 30.

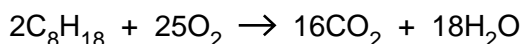
For  
Examiner's  
Use

**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.



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.

The table shows some information about different alcohols.

For  
Examiner's  
Use

alcohol	formula	boiling point / °C
methanol	CH <sub>3</sub> OH	65
ethanol	C <sub>2</sub> H <sub>5</sub> OH	78
propanol	C <sub>3</sub> H <sub>7</sub> OH	97
pentanol	C <sub>5</sub> H <sub>11</sub> 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<sub>6</sub>H<sub>12</sub>O<sub>6</sub>.



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 500g of ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , and 500g of potassium nitrate,  $\text{KNO}_3$ .

(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.

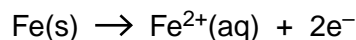
.....  
.....  
.....  
.....  
..... [3]

[Total: 10]

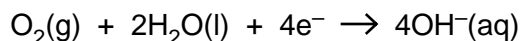
**B11** Aluminium and iron are both metals.

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.



At the same time oxygen,  $\text{O}_2$ , and water molecules react to form hydroxide ions.



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]

- (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]

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**DATA SHEET**  
**The Periodic Table of the Elements**

Group		I	II	III	IV	V	VI	VII	0	
		1 <b>H</b> Hydrogen 1							4 <b>He</b> Helium 2	
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4							16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18	
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	70 <b>Ga</b> Gallium 31	
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	127 <b>Te</b> Tellurium 52	
223 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	186 <b>Re</b> Rhenium 75	188 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	201 <b>Hg</b> Mercury 80	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	
		140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	147 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	
		232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	244 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	251 <b>Cf</b> Californium 98	
		175 <b>Lu</b> Lutetium 71	173 <b>Yb</b> Ytterbium 70	169 <b>Tm</b> Thulium 69	167 <b>Er</b> Erbium 68	165 <b>Ho</b> Holmium 67	163 <b>Er</b> Erbium 68	161 <b>Ho</b> Holmium 67	159 <b>Tb</b> Terbium 65	
		260 <b>Lr</b> Lawrencium 103	259 <b>No</b> Nobelium 102	258 <b>Md</b> Mendelevium 101	257 <b>Fm</b> Fermium 100	252 <b>Es</b> Einsteinium 99	251 <b>Cf</b> Californium 98	247 <b>Bk</b> Berkelium 97	247 <b>Bk</b> Berkelium 97	

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

**Key**

a	<b>X</b>
b	

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

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).