



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**

**5070/22**

Paper 2 Theory

**May/June 2010**

**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	
<b>Section A</b>	
<b>B7</b>	
<b>B8</b>	
<b>B9</b>	
<b>B10</b>	
<b>Total</b>	

This document consists of **17** printed pages and **3** blank pages.



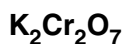
## Section A

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

The total mark for this section is 45.

For  
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**A1** Choose from the following compounds to answer the questions below.



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

Which compound

(a) is responsible for ozone depletion,

..... [1]

(b) is formed by the bacterial decay of vegetable matter,

..... [1]

(c) is used to remove sulfur dioxide in flue gas desulfurisation,

..... [1]

(d) is an insoluble salt,

..... [1]

(e) is orange in colour,

..... [1]

(f) decolourises aqueous bromine?

..... [1]

[Total: 6]

**A2** Lithium, sodium and potassium are elements in Group I of the Periodic Table. Francium, Fr, is another element in Group I.

*For  
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Use*

(a) How many electrons are in there in the outer shell of a francium atom?

..... [1]

(b) Complete the following table about an atom of francium.

mass number	223
proton (atomic) number	
number of protons	
number of electrons	
number of neutrons	

[2]

(c) Predict two **physical** properties of francium.

1 .....

2 .....

[2]

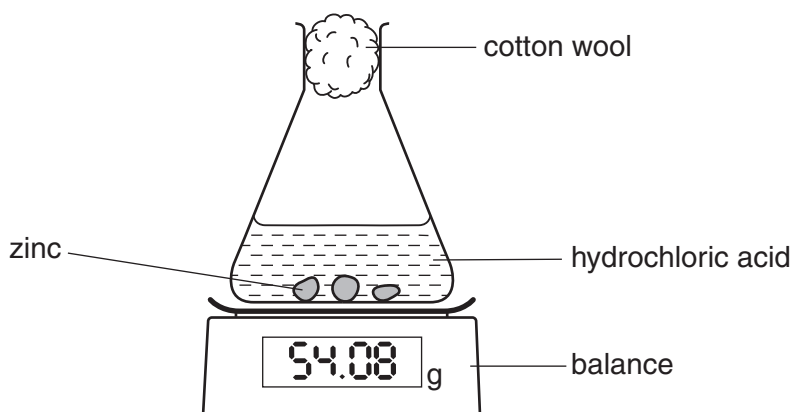
(d) A scientist predicts that francium reacts violently with water.  
Write the equation for this reaction.

[1]

[Total: 6]

**A3** The diagram below shows apparatus that can be used to investigate the rate of reaction between zinc and hydrochloric acid.

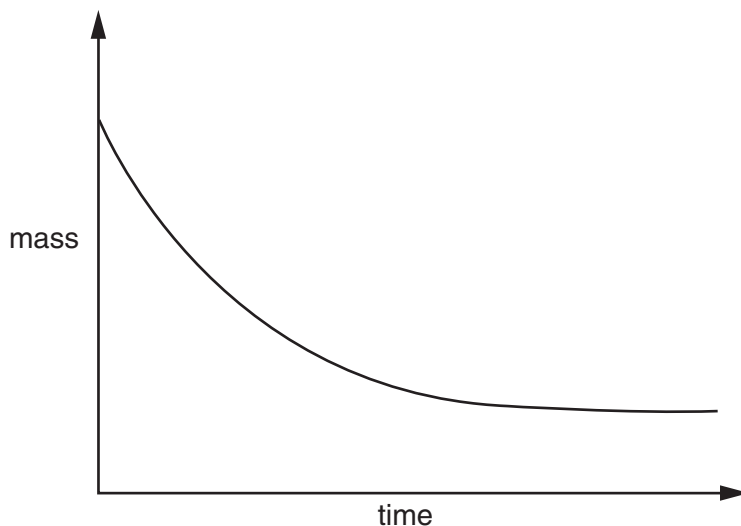
*For  
Examiner's  
Use*



**(a)** Write the equation, including state symbols, for the reaction between zinc and hydrochloric acid.

[2]

**(b)** The graph shows the change in mass that occurs during the reaction between zinc and hydrochloric acid.



**(i)** Explain why the mass decreases during the course of the reaction.

.....  
 ..... [1]

**(ii)** Exactly the same experiment was repeated but with a catalyst added. Sketch on the graph the results that would be obtained in the presence of the catalyst. [2]

(c) Explain why zinc reacts more slowly with dilute hydrochloric acid than with concentrated hydrochloric acid.

.....  
.....  
..... [2]

(d) Explain why hydrochloric acid reacts much faster with zinc powder than with lumps of zinc.

.....  
.....  
..... [2]

(e) Zinc is added to excess hydrochloric acid. Aqueous sodium hydroxide is added drop by drop to this reaction mixture until it is in excess. Describe what you would observe.

.....  
.....  
..... [2]

[Total: 11]

**A4** The electrical conductivity of a substance is related to its structure and bonding.

**(a)** Graphite and diamond are both forms of solid carbon. Explain why graphite conducts electricity but diamond does not.

.....  
 .....  
 ..... [2]

**(b)** Explain why solid sodium chloride does not conduct electricity whereas aqueous sodium chloride does conduct electricity.

.....  
 .....  
 .....  
 ..... [2]

**(c)** Complete the following table about electrolysis using inert graphite electrodes.

electrolyte	product at cathode	product at anode
molten lead(II) bromide		
aqueous copper(II) sulfate	copper	
dilute sulfuric acid		oxygen

[3]

**(d)** Describe one commercial use of electrolysis.

use .....

electrolyte used .....

ionic equation for reaction at the cathode .....

[3]

[Total: 10]

**A5** Ethanol, C<sub>2</sub>H<sub>5</sub>OH, can be manufactured by two different processes.

- process **1** – the catalysed addition of steam to ethene
- process **2** – the fermentation of glucose

(a) Name the type of reaction used to manufacture **ethene**.

..... [1]

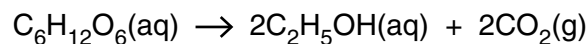
(b) (i) Write the equation for process **1**.

[1]

(ii) Suggest the name of the alcohol made when the alkene C<sub>3</sub>H<sub>6</sub> reacts with steam in the presence of a catalyst.

..... [1]

(c) The equation for process **2** is shown below.



(i) Describe **two** essential conditions required for efficient fermentation.

.....

.....

..... [2]

(ii) Suggest **one** advantage of manufacturing ethanol by process **2** rather than by process **1**.

.....

..... [1]

(d) Process **2** makes an aqueous solution of ethanol. Suggest a method of purification that can be used to remove water from the aqueous ethanol.

..... [1]

(e) Describe a chemical test which could be used to positively identify the carbon dioxide formed during fermentation.

test .....

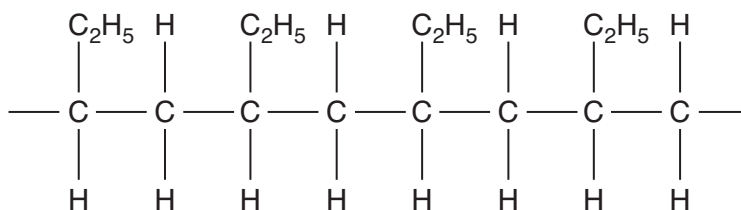
observation ..... [1]

[Total: 8]

**A6** Plastics are made of macromolecules called polymers. In the middle of the Pacific Ocean there is a huge area of water that is contaminated with small bits of plastics. The waste plastics have been washed away from coastlines.

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(a) Part of the structure of one of the polymers found in the ocean is shown below.



(i) Name this type of polymer.

..... [1]

(ii) Draw the structure of the monomer used in the manufacture of this polymer.

[1]

(iii) Explain why this polymer is described as a saturated hydrocarbon.

.....  
 ..... [1]

(b) Suggest why this polymer is not destroyed in water.

.....  
 ..... [1]

[Total: 4]



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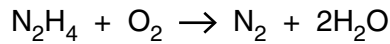
Section B

For  
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Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

**B7** Hydrazine, N<sub>2</sub>H<sub>4</sub>, is a liquid that has been used as a rocket fuel. It reacts with oxygen as shown in the equation.



This reaction is highly exothermic.

**(a)** Suggest why the combustion of hydrazine has very little environmental impact.

.....  
..... [1]

**(b)** Explain, in terms of the energy changes which occur during bond breaking and bond forming, why the combustion of hydrazine is exothermic.

.....  
.....  
..... [2]

**(c) (i)** Calculate the volume of oxygen, measured at room temperature and pressure, needed to completely combust 1.00 tonne of hydrazine.  
[One tonne is 10<sup>6</sup> grams. One mole of any gas at room temperature and pressure occupies a volume of 24 dm<sup>3</sup>.]

volume of oxygen = ..... dm<sup>3</sup> [3]

**(ii)** A rocket burns hydrazine in an atmosphere of oxygen. Both hydrazine and oxygen are stored in the rocket as liquids. Suggest why oxygen is stored as a liquid rather than as a gas.

.....  
..... [1]

(d) Hydrazine,  $N_2H_4$ , has similar chemical properties to ammonia.

(i) Hydrazine reacts with hydrochloric acid. Suggest the formula of the product of this reaction.

..... [1]

(ii) Hydrazine is a covalent compound. Draw a 'dot-and-cross' diagram for hydrazine.

[2]

[Total: 10]

For  
Examiner's  
Use

**B8** An ester is made from a carboxylic acid and an alcohol.

The carboxylic acid has the molecular formula  $C_4H_8O_2$ . Analysis of the alcohol shows it has the following percentage composition by mass:  
52.2% carbon; 13.0% hydrogen; 34.8% oxygen.

For  
Examiner's  
Use

**(a) (i)** Suggest a possible name for the carboxylic acid.

..... [1]

**(ii)** Draw a possible structure for the carboxylic acid.

[1]

**(iii)** What is the empirical formula for the carboxylic acid?

..... [1]

**(b)** Calculate the empirical formula for the alcohol.

.....  
.....  
.....  
.....  
..... [2]

**(c) (i)** Name the ester formed when ethanol reacts with ethanoic acid.

..... [1]

**(ii)** Suggest **one** commercial use of this ester.

..... [1]

(d) *Terylene* is a polyester used to make clothing materials.

For  
Examiner's  
Use

(i) Draw the partial structure of *Terylene*. Include all the atoms and all the bonds in the ester linkage.

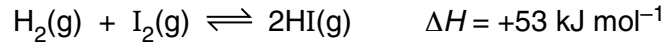
[2]

(ii) Which type of natural macromolecule contains the ester linkage?

..... [1]

[Total: 10]

- B9** Hydrogen and iodine react together to form hydrogen iodide in a reversible redox reaction. The forward reaction is endothermic.



Hydrogen and hydrogen iodide are colourless gases whereas iodine gas is purple.

- (a)** What is meant by the term *redox reaction*?

.....  
 ..... [1]

- (b)** A mixture of  $\text{H}_2(\text{g})$ ,  $\text{I}_2(\text{g})$  and  $\text{HI}(\text{g})$  are in dynamic equilibrium at a pressure of 2 atmospheres and  $200^\circ\text{C}$ .

The temperature of the mixture is **increased** to  $500^\circ\text{C}$  but the pressure remains unchanged.

Explain why the mixture becomes less purple in colour.

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

- (c)** Calculate the maximum mass of hydrogen iodide that can be made from 45.3g of hydrogen.

maximum mass of hydrogen iodide = ..... g [3]

(d) Hydrogen iodide is dissolved in water to make solution **X**.

- (i) **X** is acidified with dilute nitric acid and then aqueous lead(II) nitrate is added. A yellow precipitate is formed.

Write an ionic equation, including state symbols, for this reaction.

[2]

- (ii) A small volume of acidified potassium manganate(VII) is added to **X**. The solution changes colour to orange-brown.

From this description what can you deduce about the chemical properties of **X**?

..... [1]

[Total: 10]

For  
Examiner's  
Use

**B10** Fertilisers are used to promote plant growth and increase crop yield.  
Three fertilisers are potassium chloride, potassium nitrate and ammonium phosphate.

**(a)** Potassium nitrate is a soluble salt that can be prepared by reaction between an acid and an alkali.

**(i)** Write an equation for the reaction of an acid with an alkali to prepare potassium chloride.

[1]

**(ii)** Describe the essential experimental details of this preparation of solid potassium chloride.

.....  
.....  
.....  
.....  
.....  
.....  
..... [2]

**(b)** Ammonium phosphate is an ionic compound containing the phosphate ion,  $\text{PO}_4^{3-}$ .

**(i)** Write the formula for ammonium phosphate.

..... [1]

**(ii)** Calculate the percentage by mass of nitrogen in ammonium phosphate.

% by mass = ..... [2]



(c) A farmer adds excess calcium hydroxide to react with hydrogen ions in acidic soils. He then adds fertiliser to increase the nitrogen content of the soil.

(i) Write an ionic equation to show the neutralisation of hydrogen ions by solid calcium hydroxide.

[1]

(ii) Suggest why the farmer should use potassium nitrate rather than ammonium phosphate to increase the nitrogen content of the soil.

.....  
..... [1]

(d) A scientist believes a water sample is contaminated by potassium nitrate. Describe a chemical test to confirm the presence of aqueous nitrate ions.

.....  
.....  
.....  
.....  
..... [2]

[Total: 10]

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

		Group																																																																																																														
I	II	III	IV	V	VI	VII	0																																																																																																									
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	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	18 <b>Ar</b> Argon 18	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10	23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	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	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36	37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54	55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	58 <b>Ce</b> Cerium 58	59 <b>Pr</b> Praseodymium 59	60 <b>Nd</b> Neodymium 60	61 <b>Pm</b> Promethium 61	62 <b>Sm</b> Samarium 62	63 <b>Eu</b> Europium 63	64 <b>Gd</b> Gadolinium 64	65 <b>Tb</b> Terbium 65	66 <b>Dy</b> Dysprosium 66	67 <b>Ho</b> Holmium 67	68 <b>Er</b> Erbium 68	69 <b>Tm</b> Thulium 69	70 <b>Yb</b> Ytterbium 70	71 <b>Lu</b> Lutetium 71	72 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89	90 <b>Th</b> Thorium 90	91 <b>Pa</b> Protactinium 91	92 <b>U</b> Uranium 92	93 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103	104 <b>Fr</b> Francium 87	105 <b>Ra</b> Radium 88	106 <b>Ac</b> Actinium 89	107 <b>Th</b> Thorium 90	108 <b>Pa</b> Protactinium 91	109 <b>U</b> Uranium 92	110 <b>Np</b> Neptunium 93	111 <b>Pu</b> Plutonium 94	112 <b>Am</b> Americium 95	113 <b>Cm</b> Curium 96	114 <b>Bk</b> Berkelium 97	115 <b>Cf</b> Californium 98	116 <b>Es</b> Einsteinium 99	117 <b>Fm</b> Fermium 100	118 <b>Md</b> Mendelevium 101	119 <b>No</b> Nobelium 102	120 <b>Lr</b> Lawrencium 103	121 <b>Lu</b> Lutetium 71	122 <b>Rn</b> Radon 86	123 <b>Fr</b> Francium 87	124 <b>Ra</b> Radium 88	125 <b>Ac</b> Actinium 89	126 <b>Th</b> Thorium 90	127 <b>Pa</b> Protactinium 91	128 <b>U</b> Uranium 92	129 <b>Np</b> Neptunium 93	130 <b>Pu</b> Plutonium 94	131 <b>Am</b> Americium 95	132 <b>Cm</b> Curium 96	133 <b>Bk</b> Berkelium 97	134 <b>Cf</b> Californium 98	135 <b>Es</b> Einsteinium 99	136 <b>Fm</b> Fermium 100	137 <b>Md</b> Mendelevium 101	138 <b>No</b> Nobelium 102	139 <b>Lr</b> Lawrencium 103

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

a **X**  
b

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

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