



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



**CHEMISTRY**  
Paper 2 Theory

**5070/22**  
**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.

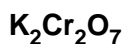
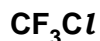
## Section A

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

The total mark for this section is 45.

For  
Examiner's  
Use

**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  
Examiner's  
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]

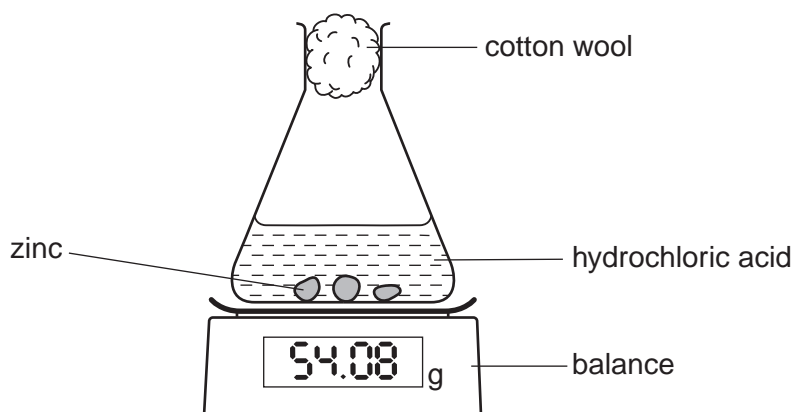
**(d)** A scientist predicts that francium reacts violently with water.  
Write the equation for this reaction.

[1]

[Total: 6]

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

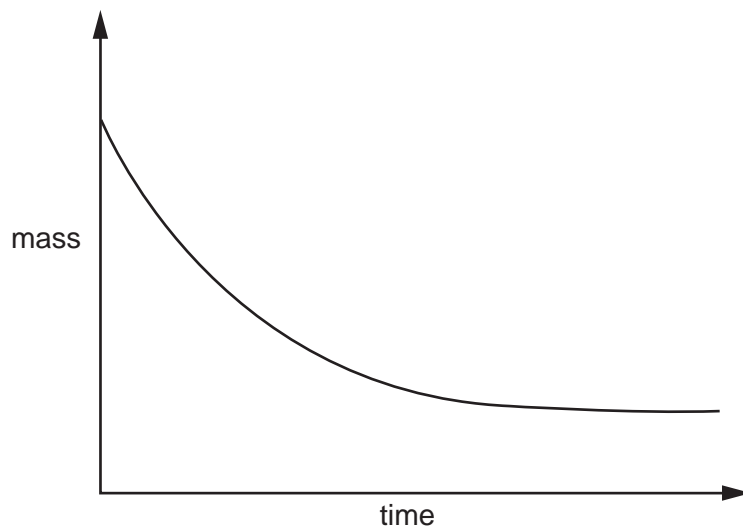
For  
Examiner's  
Use



**(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.

For  
Examiner's  
Use

- (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.

For  
Examiner's  
Use

- 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]

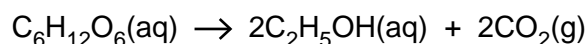
**(b) (i)** Write the equation for process **1**.

[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 .....

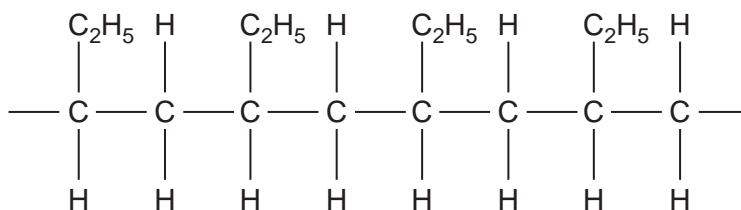
observation ..... [1]

[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.

For  
Examiner's  
Use

**(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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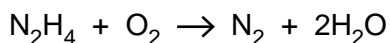
## Section B

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

The total mark for this section is 30.

For  
Examiner's  
Use

- B7** Hydrazine,  $\text{N}_2\text{H}_4$ , 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  $10^6$  grams. One mole of any gas at room temperature and pressure occupies a volume of  $24 \text{ dm}^3$ .]

volume of oxygen = .....  $\text{dm}^3$  [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,  $\text{N}_2\text{H}_4$ , 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.

**(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]

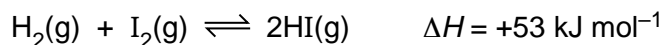
- (ii) Which type of natural macromolecule contains the ester linkage?

..... [1]

[Total: 10]

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

For  
Examiner's  
Use



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**.

For  
Examiner's  
Use

- (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]

**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			
	1 <b>H</b> Hydrogen										
3	7 <b>Li</b> Lithium	4		5 <b>B</b> Boron	6 <b>C</b> Carbon	7 <b>N</b> Nitrogen	8 <b>O</b> Oxygen	9 <b>F</b> Fluorine	10 <b>Ne</b> Neon	2	
11	23 <b>Na</b> Sodium	12	13 <b>Al</b> Aluminium	14 <b>Si</b> Silicon	15 <b>P</b> Phosphorus	16 <b>S</b> Sulfur	17 <b>Cl</b> Chlorine	18 <b>Ar</b> Argon			
19	39 <b>K</b> Potassium	20	21 <b>Ca</b> Calcium	22 <b>Ti</b> Titanium	23 <b>V</b> Vanadium	24 <b>Cr</b> Chromium	25 <b>Mn</b> Manganese	26 <b>Fe</b> Iron	27 <b>Co</b> Cobalt	28 <b>Ni</b> Nickel	
37	85 <b>Rb</b> Rubidium	38	88 <b>Sr</b> Strontium	40 <b>Zr</b> Zirconium	41 <b>Nb</b> Niobium	42 <b>Mo</b> Molybdenum	43 <b>Tc</b> Technetium	44 <b>Ru</b> Ruthenium	45 <b>Rh</b> Rhodium	46 <b>Pd</b> Palladium	
55	133 <b>Cs</b> Caesium	56	137 <b>Ba</b> Barium	72 <b>Hf</b> Hafnium	73 <b>Ta</b> Tantalum	74 <b>W</b> Tungsten	75 <b>Re</b> Rhenium	76 <b>Os</b> Osmium	77 <b>Ir</b> Iridium	78 <b>Pt</b> Platinum	
87	223 <b>Fr</b> Francium	88	226 <b>Ra</b> Radium	89 <b>Ac</b> Actinium							
				30 <b>Zn</b> Zinc	31 <b>Ga</b> Gallium	32 <b>Ge</b> Germanium	33 <b>As</b> Arsenic	34 <b>Se</b> Selenium	35 <b>Br</b> Bromine	36 <b>Kr</b> Krypton	
				48 <b>Cd</b> Cadmium	49 <b>In</b> Indium	50 <b>Sn</b> Tin	51 <b>Sb</b> Antimony	52 <b>Te</b> Tellurium	53 <b>I</b> Iodine	54 <b>Xe</b> Xenon	
				80 <b>Hg</b> Mercury	81 <b>Tl</b> Thallium	82 <b>Pb</b> Lead	83 <b>Bi</b> Bismuth	84 <b>Po</b> Polonium	85 <b>At</b> Astatine	86 <b>Rn</b> Radon	
				108 <b>Ag</b> Silver	109 <b>Cu</b> Copper	110 <b>Ni</b> Nickel	111 <b>Pd</b> Palladium	112 <b>Cd</b> Cadmium	113 <b>In</b> Indium	114 <b>Sn</b> Tin	
				146 <b>Pu</b> Plutonium	147 <b>Pm</b> Promethium	148 <b>Sm</b> Samarium	149 <b>Eu</b> Europium	150 <b>Gd</b> Gadolinium	151 <b>Tb</b> Terbium	152 <b>Dy</b> Dysprosium	
				184 <b>Os</b> Osmium	185 <b>Ir</b> Iridium	186 <b>Pt</b> Platinum	187 <b>Au</b> Gold	188 <b>Hg</b> Mercury	189 <b>Tl</b> Thallium	190 <b>Pb</b> Lead	
				208 <b>Po</b> Polonium	209 <b>Bi</b> Bismuth	210 <b>Po</b> Polonium	211 <b>At</b> Astatine	212 <b>Rn</b> Radon	213 <b>Fr</b> Francium	214 <b>Ra</b> Radium	
				268 <b>U</b> Uranium	269 <b>Np</b> Neptunium	270 <b>Pu</b> Plutonium	271 <b>Am</b> Americium	272 <b>Cm</b> Curium	273 <b>Bk</b> Berkelium	274 <b>Cf</b> Californium	
				32 <b>Be</b> Beryllium	33 <b>B</b> Boron	34 <b>C</b> Carbon	35 <b>N</b> Nitrogen	36 <b>O</b> Oxygen	37 <b>F</b> Fluorine	38 <b>Ne</b> Neon	
				68 <b>Er</b> Erbium	69 <b>Tm</b> Thulium	70 <b>Yb</b> Ytterbium	71 <b>Lu</b> Lutetium	72 <b>Hf</b> Hafnium	73 <b>Ta</b> Tantalum	74 <b>W</b> Tungsten	
				92 <b>U</b> Uranium	93 <b>Np</b> Neptunium	94 <b>Pu</b> Plutonium	95 <b>Am</b> Americium	96 <b>Cm</b> Curium	97 <b>Bk</b> Berkelium	98 <b>Cf</b> Californium	
				102 <b>No</b> Nobelium	103 <b>Lr</b> Lawrencium	104 <b>Rf</b> Rutherfordium	105 <b>Db</b> Dubnium	106 <b>Sg</b> Seaborgium	107 <b>Bh</b> Bohrium	108 <b>Hs</b> Hassium	
				122 <b>Xe</b> Xenon	123 <b>Fr</b> Francium	124 <b>Ra</b> Radium	125 <b>Ac</b> Actinium	126 <b>Po</b> Polonium	127 <b>At</b> Astatine	128 <b>Rn</b> Radon	
				162 <b>Dy</b> Dysprosium	163 <b>Ho</b> Holmium	164 <b>Er</b> Erbium	165 <b>Tm</b> Thulium	166 <b>Yb</b> Ytterbium	167 <b>Lu</b> Lutetium	168 <b>Hf</b> Hafnium	
				202 <b>Rn</b> Radon	203 <b>Fr</b> Francium	204 <b>Ra</b> Radium	205 <b>Ac</b> Actinium	206 <b>Po</b> Polonium	207 <b>At</b> Astatine	208 <b>Rn</b> Radon	
				252 <b>Es</b> Einsteinium	253 <b>Fm</b> Fermium	254 <b>Md</b> Mendelevium	255 <b>No</b> Nobelium	256 <b>Lr</b> Lawrencium	257 <b>Uu</b> Ununseptium	258 <b>Uub</b> Ununbium	
				288 <b>Og</b> Oganesson	289 <b>Ts</b> Tennessine	290 <b>Uu</b> Ununseptium	291 <b>Uub</b> Ununbium	292 <b>Uuq</b> Ununquadium	293 <b>Uub</b> Ununbium	294 <b>Uuq</b> Ununquadium	

\* 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.).