UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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	
Section A	
B7	
B8	
B9	
B10	
Total	

This document consists of **17** printed pages and **3** 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 Choose from the following compounds to answer the questions below.

$BaSO_4$

CH_4

C_2H_4

C_3H_8

CO_2

$CaCO_3$

CF_3Cl

$K_2Cr_2O_7$

$MgSO_4$

$NaCl$

$ZnSO_4$

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.

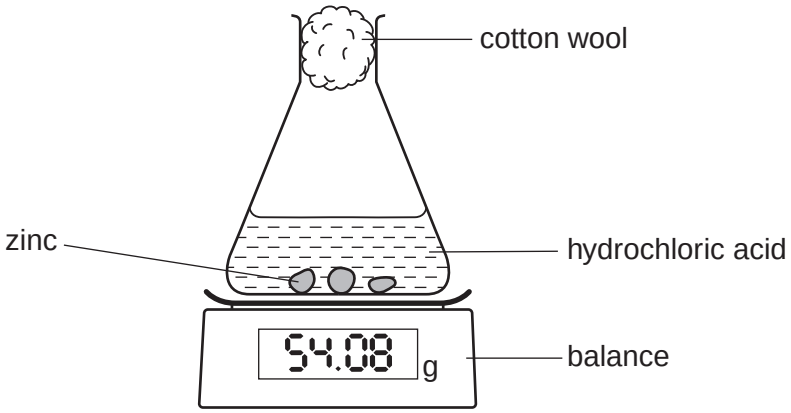
[1]

[Total: 6]

[Turn over

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

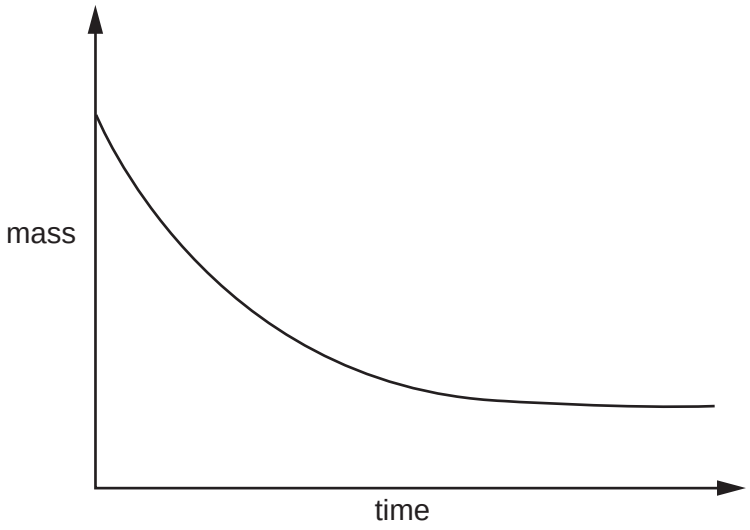
For Examiner's Use



(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.

For Examiner's Use

.....

.....

..... [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]

[Turn over

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_2H_5OH, 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_3H_6 reacts with steam in the presence of a catalyst.

..... [1]

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

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

(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 .....

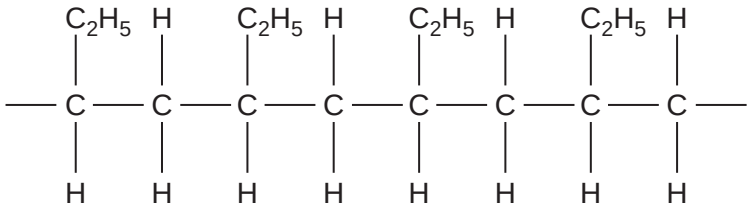
observation ..... [1]

[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

For Examiner's Use

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

The total mark for this section is 30.

B7 Hydrazine, N_2H_4, is a liquid that has been used as a rocket fuel. It reacts with oxygen as shown in the equation.

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

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 dm^3.]

volume of oxygen = ... 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, N_2H_4, has similar chemical properties to ammonia.

For Examiner's Use

(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]

[Turn over

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

For Examiner's Use

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

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +53 \text{ kJ mol}^{-1}$$

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 $H_2(g)$, $I_2(g)$ and HI(g) are in dynamic equilibrium at a pressure of 2 atmospheres and 200 °C.

The temperature of the mixture is **increased** to 500 °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 45.3 g 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.

For Examiner's Use

(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, 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.

For Examiner's Use

(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	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 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	55 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.).