Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CHEMISTRY **5070/02**

Paper 2 Theory

May/June 2005

1 hour 30 minutes

Candidates answer on the Question Paper.
Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.
You may use a calculator.

Sections A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer any **three** questions.
Write your answers on any lined pages and/or separate answer paper.
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.
A copy of the Periodic Table is printed on page 16.

For Examiner's Use	
Section A	
B7	
B8	
B9	
B10	
Total	

This document consists of **13** printed pages and **3** lined pages.

For Examiner's Use

Section A

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.

aluminium oxide
ammonia
barium sulphate
calcium carbonate
carbon monoxide
lead(II) iodide
nitrogen dioxide
silicon dioxide

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

Name a substance which

(a) is a gas that causes acid rain,

....[1]

(b) has a giant molecular structure,

....[1]

(c) is amphoteric,

....[1]

(d) is an insoluble yellow solid.

....[1]

A2 Iron is one of the most important metals. It is a transition element.
Most iron is used in the alloy steel.

(a) Explain, in terms of metallic bonding, why iron is a good electrical conductor.

....

....

....[2]

(b) Describe how different proportions of carbon can modify the physical properties of steel.

....

....

....[2]

(c) When underwater, iron pipes will rust relatively rapidly.

(i) State the essential conditions needed for the rusting of iron.

....

(ii) Pieces of magnesium are often attached to underwater iron pipes. Explain how the magnesium protects the iron pipes against rusting.

....

....

....
[3]

(d) Write **two** typical properties that are generally common **only** to transition elements.

1. ....

2. ....[2]

(e) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen.
Calculate the empirical formula of this compound.

Answer [3]

For Examiner's Use

A3 This question is about the Periodic Table.

The diagram below shows part of the original Periodic Table first published by Mendeleev in 1869.

	Period 1	Period 2	Period 3	Period 4		Period 5	
Group 1	H	Li	Na	K	Cu	Rb	Ag
Group 2		Be	Mg	Ca	Zn	Sr	Cd
Group 3		B	Al	*	*	Y	In
Group 4		C	Si	Ti	*	Zr	Sn
Group 5		N	P	V	As	Nb	Sb
Group 6		O	S	Cr	Se	Mo	Te
Group 7		F	Cl	Mn	Br	*	I

The asterisks (*) show gaps in the table that Mendeleev deliberately left.

(a) Which group of elements in a modern Periodic Table is missing from Mendeleev's Periodic Table?

....[1]

(b) Write two **other** differences between Mendeleev's original table and a modern Periodic Table.

....

....

....

....[2]

(c) Find rubidium, Rb, in the Periodic Table provided on page 16.
Predict the reaction between rubidium and cold water.
Include observations and the chemical equation.

....

....

....

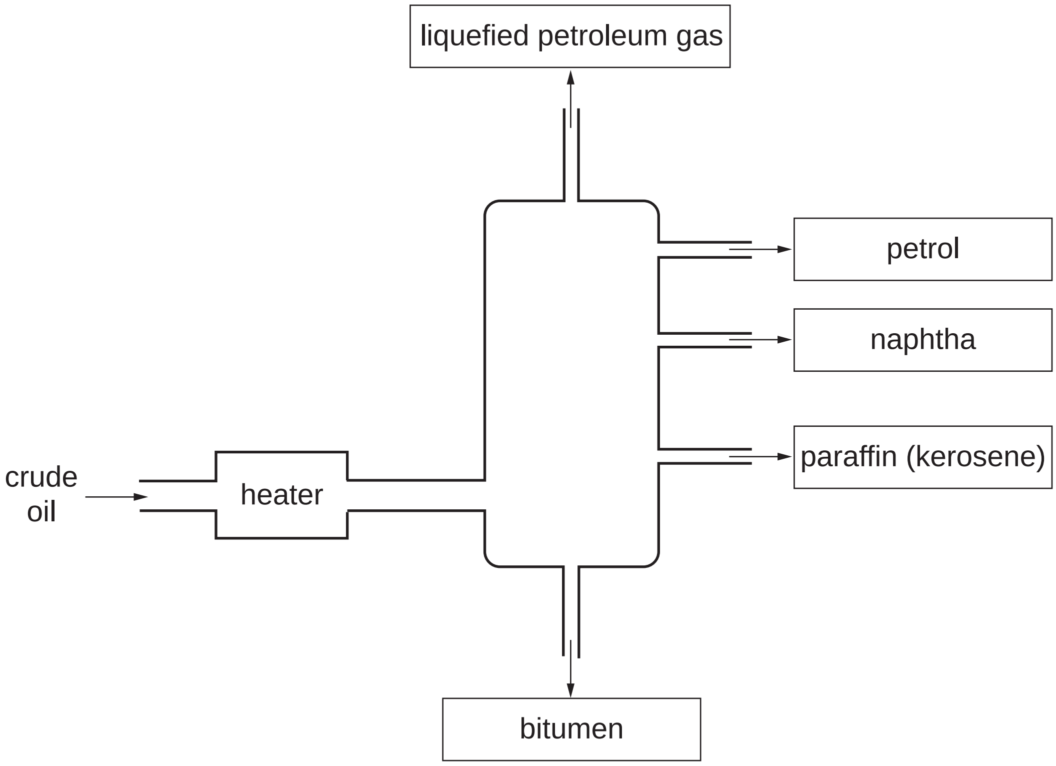
....

....[3]

For Examiner's Use

A4 Petroleum is a mixture of hydrocarbons. In an oil refinery it is separated into fract[ions by] fractional distillation.

The diagram shows a fractionating column and some of the fractions obtained from petroleum.



(a) State the physical property on which the separation depends.

....[1]

(b) **(i)** State **one** use for the naphtha fraction.

....

(ii) State **one** use for the bitumen fraction.

....
[2]

(c) The liquefied petroleum gas fraction contains the saturated hydrocarbons methane, CH_4, and ethane, C_2H_6.

(i) What is the meaning of the term *saturated hydrocarbon*?

....

....

(ii) Draw a 'dot and cross' diagram to show the bonding in methane. You only need to draw the outer electrons of carbon.

[4]

(d) Describe the importance of cracking in the oil refining process.

....

....

....[2]

A5 Chlorine, hydrogen and sodium hydroxide are made by the electrolysis of concentrated aqueous sodium chloride.

(a) Aqueous sodium chloride contains the following ions, Na^+, H^+, OH^- and Cl^-.

Concentrated aqueous sodium chloride can be electrolysed using inert electrodes.

The electrode reactions are represented below.

cathode $2H^+ + 2e^- \rightarrow H_2$
anode $2Cl^- \rightarrow Cl_2 + 2e^-$

(i) Explain why hydrogen, **not** sodium, is formed at the cathode.

....

....

(ii) Suggest why, as the electrolysis proceeds, the concentration of sodium hydroxide in the electrolyte increases.

....

....
[2]

(b) Describe a chemical test for each of the gases produced during the electrolysis of concentrated aqueous sodium chloride.

(i) chlorine

....

....

(ii) hydrogen

....

....

[2]

(c) Describe the use of chlorine in the purification of water.

....

....[1]

(d) Describe an advantage of using hydrogen as a possible fuel in the future.

....

....[1]

(e) Name the products, if any, of the reaction of chlorine with

(i) aqueous potassium fluoride,

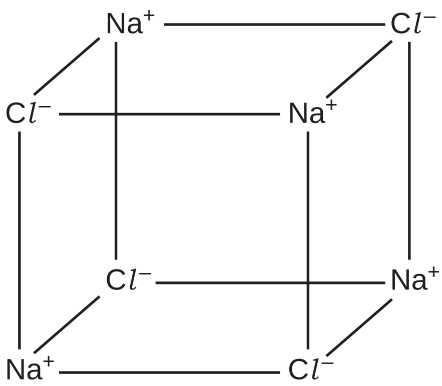
....

(ii) aqueous sodium bromide.

....

[2]

A6 The structure of sodium chloride is drawn below.



(a) Sodium chloride is an ionic solid.
Draw the electronic structure of both a sodium ion and a chloride ion.

sodium ion   chloride ion

[2]

(b) Sodium chloride has a melting point of about 800 °C.

(i) Explain why sodium chloride has a high melting point.

....

....

....

(ii) Magnesium oxide, MgO, has a similar structure to sodium chloride. Suggest why the melting point of magnesium oxide is higher than that of sodium chloride.

....

....
[3]

(c) Explain why solid sodium chloride will not conduct electricity but molten sodium chloride will.

....

....[1]

Section B

Answer **three** questions from this section.

The total mark for this section is 30.

B7 Ozone, O_3, is an atmospheric pollutant in the lower atmosphere but is beneficial higher up in the atmosphere.

(a) How is ozone formed in the lower atmosphere? [1]

(b) Ozone in the upper atmosphere is being depleted. Describe briefly how this is happening and some of the health problems caused by ozone depletion. [3]

(c) At room temperature ozone decomposes slowly to form oxygen, O_2.

The decomposition can be represented by the equation below. The reaction is exothermic. One mole of ozone will release 143 kJ when it is fully decomposed.

$$2O_3 \rightarrow 3O_2$$

(i) In terms of the energy changes that take place during bond breaking and bond making, explain why this reaction is exothermic.

(ii) Explain why the **rate** of this decomposition increases as the **temperature** increases.

(iii) Calculate the energy released when 16 g of ozone is decomposed.

[6]

For Examiner's Use

B8 Sunglasses can be made from photochromic glass. When bright light strikes photoc[hromic] glass it darkens.

Photochromic glass contains small amounts of silver chloride, Ag*Cl*, and copper(I) chloride, Cu*Cl*.

In the presence of bright light, silver chloride decomposes into silver atoms which make the glass go dark, and into chlorine atoms.

$$AgCl \rightarrow Ag + Cl$$

Chlorine atoms immediately react with copper(I) chloride to make copper(II) chloride.

$$CuCl + Cl \rightarrow CuCl_2$$

When the exposure to bright light ends, silver atoms reduce copper(II) chloride back into copper(I) chloride and silver chloride.

(a) Calculate the maximum mass of silver that can be formed when 0.287 g of silver chloride decomposes. [2]

(b) Explain why the reaction between copper(I) chloride and chlorine involves both oxidation and reduction. [3]

(c) Construct the equation for the reaction between silver and copper(II) chloride. [1]

(d) Aqueous copper(II) chloride reacts with aqueous sodium hydroxide to form a precipitate.

(i) Write the ionic equation, including state symbols, for the precipitation reaction.

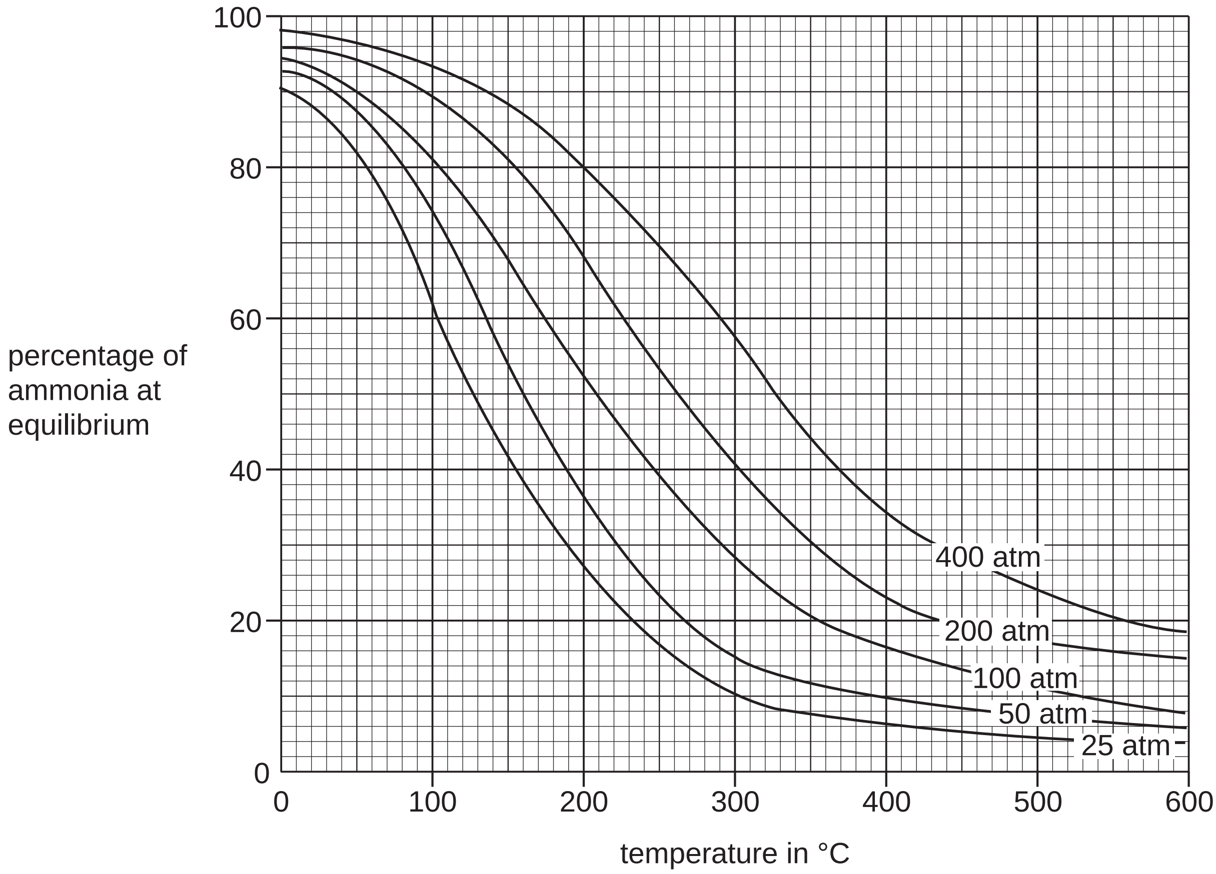
(ii) What is the name and colour of the precipitate?

[4]

For Examiner's Use

B9 Ammonia is manufactured by the Haber process. Ammonia is used to manu nitrogenous fertilisers such as ammonium nitrate.

(a) The graphs below give information about the percentage of ammonia present in the equilibrium mixture at different temperatures and pressures.



The reaction requires the use of a catalyst, which operates most efficiently within the temperature range 280 – 450 °C.

(i) Name the catalyst used in the Haber process.

(ii) Write a balanced equation for the formation of ammonia in the Haber process.

(iii) Which conditions of temperature and pressure give the highest percentage of ammonia at equilibrium within the catalyst operating temperature range?

(iv) Suggest why the normal working temperature used in the Haber process is often over 400 °C.

[5]

(b) Describe and explain the effect of a catalyst on the rate of a reaction.
Explain how the use of a catalyst can reduce the overall energy requirement for the Haber process. [3]

(c) A farmer spreads a fertiliser containing ammonium nitrate onto his land. The farmer then spreads calcium hydroxide on his land to reduce its acidity.

Write an equation for the reaction between ammonium nitrate and calcium hydroxide. Use this equation to explain why the nitrogen content of the fertiliser will be lowered. [2]

B10 All members of the carboxylic acid homologous series contain the $–CO_2H$ group.
The table shows the formula of the first three members of this homologous series.

carboxylic acid	formula
methanoic acid	HCO_2H
ethanoic acid	CH_3CO_2H
propanoic acid	$C_2H_5CO_2H$

(a) Name the unbranched carboxylic acid that has four carbon atoms per molecule. [1]

(b) Give the formula of the sixth member of the carboxylic acid homologous series. [1]

(c) Ethanol, C_2H_5OH, reacts with ethanoic acid to make ethyl ethanoate.
Draw the structure of ethyl ethanoate. [1]

(d) Name a reagent that can be used to convert ethanol into ethanoic acid. [1]

(e) Magnesium reacts with ethanoic acid to make magnesium ethanoate and hydrogen.

Write the equation for this reaction. Use the equation to calculate the mass of magnesium needed to react completely with 50 cm^3 of 1.0 mol/dm^3 of ethanoic acid. [3]

(f) Suggest why the reaction between magnesium and 1.0 mol/dm^3 ethanoic acid is much slower than the reaction between magnesium and 1.0 mol/dm^3 hydrochloric acid. [2]

(g) Aqueous sodium hydroxide neutralises dilute ethanoic acid.
Write the ionic equation for this reaction. [1]

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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	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 1	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 9	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 7	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 5	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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 7	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

8-71 Lanthanoid series
0-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

ey

a **X** b

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

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