

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.



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]

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]

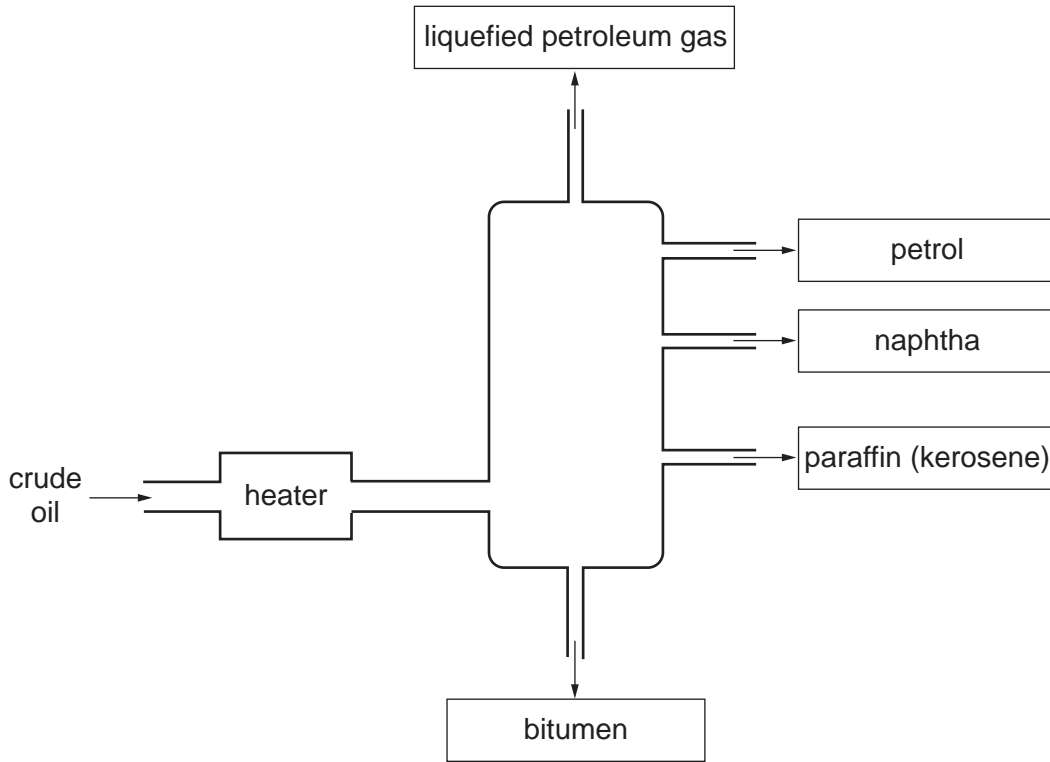
(c) Find rubidium, Rb, in the Periodic Table provided on page 16.
 Predict the reaction between rubidium and cold water.
 Include observations and the chemical equation.

.....

[3]

A4 Petroleum is a mixture of hydrocarbons. In an oil refinery it is separated into fractions 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.

.....

.....

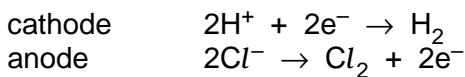
.....[2]

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.



- (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,

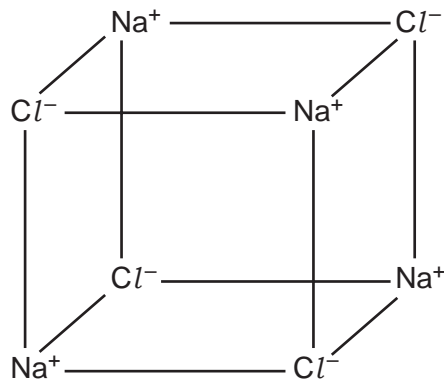
.....

(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

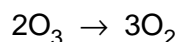
Answer **three** questions from this section.

The total mark for this section is 30.

B7 Ozone, O₃, 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, O₂.

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.

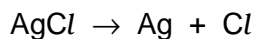


- (i) In terms of the energy changes that take place during bond breaking and bond making, explain why this reaction is exothermic.
- (ii) Explain why the **rate** of this decomposition increases as the **temperature** increases.
- (iii) Calculate the energy released when 16 g of ozone is decomposed. [6]

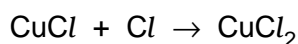
- B8** Sunglasses can be made from photochromic glass. When bright light strikes photochromic glass it darkens.

Photochromic glass contains small amounts of silver chloride, AgCl , and copper(I) chloride, CuCl .

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



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

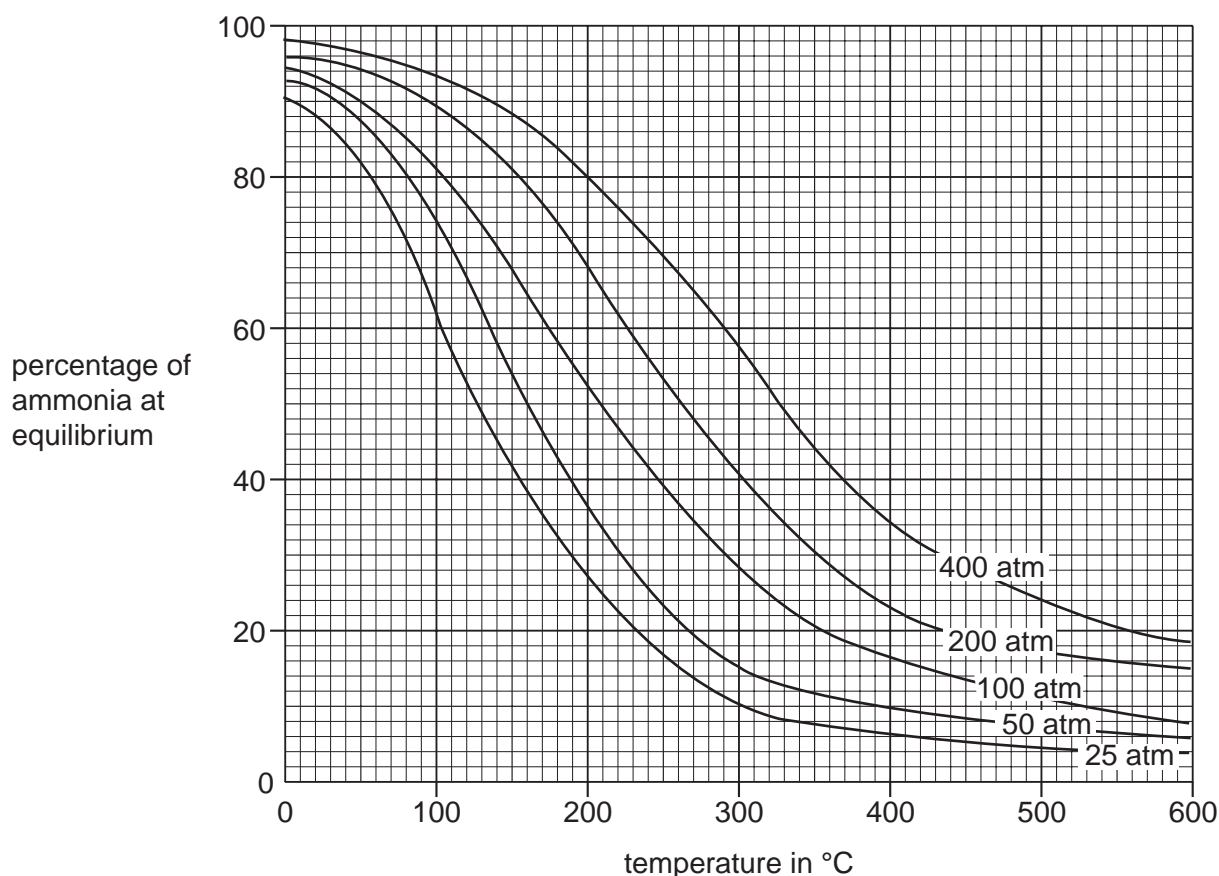


When the exposure to bright light ends, silver atoms reduce copper(II) chloride back into copper(I) chloride and silver chloride.

- (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]

B9 Ammonia is manufactured by the Haber process. Ammonia is used to manufacture 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 $-\text{CO}_2\text{H}$ group.
The table shows the formula of the first three members of this homologous series.

carboxylic acid	formula
methanoic acid	HCO_2H
ethanoic acid	$\text{CH}_3\text{CO}_2\text{H}$
propanoic acid	$\text{C}_2\text{H}_5\text{CO}_2\text{H}$

- (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, $\text{C}_2\text{H}_5\text{OH}$, 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]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Lined writing area with horizontal dotted lines.

A series of 25 horizontal dotted lines spanning the width of the page, intended for writing.

DATA SHEET
The Periodic Table of the Elements

		Group																																											
		I	II	III	IV	V	VI	VII	0																																				
7 Li Lithium 3	9 Be Beryllium 4	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="text-align: center;">1 H Hydrogen 1</td> <td colspan="10"></td> </tr> </table>										1 H Hydrogen 1											4 He Helium 2																						
1 H Hydrogen 1																																													
23 Na Sodium 11	24 Mg Magnesium 12	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 P Phosphorus 15	16 O Oxygen 8	17 F Fluorine 9	18 Ne Neon 10	35.5 Cl Chlorine 17	40 Ar Argon 18																																		
39 K Potassium 19	40 Ca Calcium 20	27 Ga Gallium 31	28 Ge Germanium 32	29 Zn Zinc 30	30 Ni Nickel 28	31 Co Cobalt 27	32 Fe Iron 26	33 Cu Copper 29	34 Ni Nickel 28	35 As Arsenic 33	36 Se Selenium 34	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54																
133 Cs Caesium 55	137 Ba Barium 56	59 Co Cobalt 27	60 Ni Nickel 28	61 Cu Copper 29	62 Zn Zinc 30	63 Ga Gallium 31	64 Ge Germanium 32	65 As Arsenic 33	66 Se Selenium 34	67 Br Bromine 35	68 Kr Krypton 36	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86																
226 Ra Radium 88	227 Ac Actinium 89	140 Ce Cerium 58	141 Pr Praseodymium 59	142 Nd Neodymium 60	143 Pm Promethium 61	144 Sm Samarium 62	145 Eu Europium 63	146 Gd Gadolinium 64	147 Tb Terbium 65	148 Dy Dysprosium 66	149 Ho Holmium 67	150 Er Erbium 68	151 Tm Thulium 69	152 Yb Ytterbium 70	153 Lu Lutetium 71	154 La Lanthanum 57	155 Ce Cerium 58	156 Pr Praseodymium 59	157 Nd Neodymium 60	158 Pm Promethium 61	159 Sm Samarium 62	160 Eu Europium 63	161 Gd Gadolinium 64	162 Tb Terbium 65	163 Dy Dysprosium 66	164 Ho Holmium 67	165 Er Erbium 68	166 Tm Thulium 69	167 Yb Ytterbium 70	168 Lu Lutetium 71	169 La Lanthanum 57	170 Ce Cerium 58	171 Pr Praseodymium 59	172 Nd Neodymium 60	173 Pm Promethium 61	174 Sm Samarium 62	175 Eu Europium 63	176 Gd Gadolinium 64	177 Tb Terbium 65	178 Dy Dysprosium 66	179 Ho Holmium 67	180 Er Erbium 68	181 Tm Thulium 69	182 Yb Ytterbium 70	183 Lu Lutetium 71

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a	X
b	

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).