UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/02**

Paper 2 Theory **May/June 2007**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Answer Booklet/Paper

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.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON ANY BARCODES.

Section 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.

A copy of the Periodic Table is printed on page 16.
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	
B9	
B10	
B11	
B12	
Total	

This document consists of **16** printed pages.

UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

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 oxides to answer the questions below.

aluminium oxide
calcium oxide
carbon monoxide
copper(II) oxide
sulphur dioxide
sulphur trioxide
vanadium(V) oxide

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

Name an oxide which

(a) is used as a catalyst in the Contact process,

.....[1]

(b) is formed during the incomplete combustion of propane,

.....[1]

(c) reacts with dilute sulphuric acid to give a blue solution,

.....[1]

(d) reacts with water to give sulphurous acid,

.....[1]

(e) when heated in a Blast Furnace with sand makes slag.

.....[1]

[Total: 5]

A2 A fertiliser contains three compounds:

ammonium sulphate, $(NH_4)_2SO_4$,
iron(II) sulphate, $FeSO_4$,
sand, SiO_2.

(a) Calculate the percentage by mass of nitrogen in ammonium sulphate.

..... % [2]

(b) Aqueous iron(II) ions and aqueous iron(III) ions can be distinguished by reaction with aqueous sodium hydroxide. Describe what you would observe as a result of each reaction.

observation with aqueous iron(II) ions .....

.....

observation with aqueous iron(III) ions .....

.....[2]

(c) Aqueous iron(II) ions can be oxidised by reaction with acidified potassium manganate(VII), $KMnO_4$. The colour change during the reaction shows that iron(II) ions act as a reducing agent.

(i) Describe the colour change during the reaction.

.....[1]

(ii) In terms of oxidation numbers, explain the meaning of the term *reducing agent*.

.....

.....[1]

(d) The mass of iron(II) ions in a sample of fertiliser can be determined by the reaction between iron(II) ions and acidified potassium manganate(VII), $KMnO_4$.

A student analysed a sample of the fertiliser. He dissolved the sample in 25.0 cm^3 of dilute sulphuric acid and titrated the solution formed with 0.0200 mol/dm^3 potassium manganate(VII).

The student used 22.5 cm^3 of potassium manganate(VII) to reach the end-point.

(i) Calculate the number of moles of potassium manganate(VII) used in the titration.

..... moles [1]

(ii) One mole of potassium manganate(VII) reacts with five moles of iron(II) ions. Calculate the mass, in grams, of iron(II) ions in the sample analysed.

..... g [2]

[Total: 9]

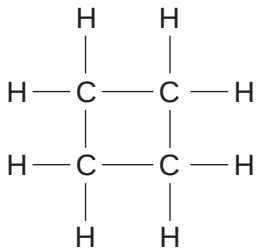
A3 Complete the table below to show the number of subatomic particles in each of the two ions.

ion	number of protons	number of neutrons	number of electrons
$^{40}Ca^{2+}$			
$^{37}Cl^{-}$			

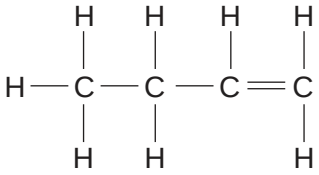
[2]

[Total: 2]

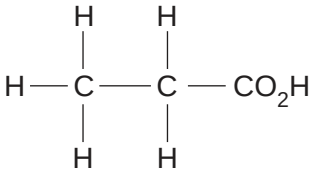
A4 Structures of six organic compounds are shown.



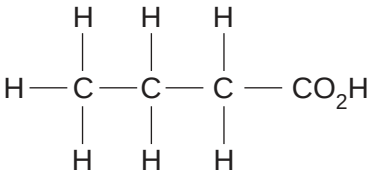
compound **A**



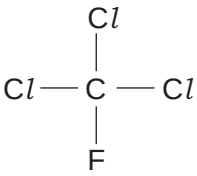
compound **B**



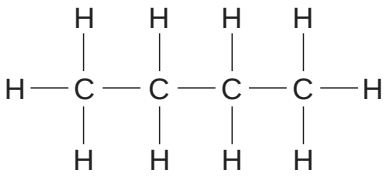
compound **C**



compound **D**



compound **E**



compound **F**

(a) Which **two** compounds have the same molecular formula?

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

(b) Which compound is butanoic acid?

.....[1]

(c) Which compound contributes to ozone depletion in the upper atmosphere?

.....[1]

(d) Name compound **B**.

.....[1]

[Total: 4]

A5 **(a)** Concentrated aqueous sodium chloride contains H^+ and OH^- ions.

(i) Give the formulae of **two** other ions present in concentrated aqueous sodium chloride.

.....[1]

(ii) Concentrated aqueous sodium chloride is electrolysed using inert graphite electrodes.
Name the product formed at each electrode.

product at anode .....

product at cathode .....[2]

(b) Impure copper can be purified by electrolysis.

Draw a labelled diagram of the electrolytic cell that can be used to purify copper.

[3]

(c) Aluminium is extracted commercially from an aluminium ore by electrolysis.

(i) Name an ore containing aluminium.

.....[1]

(ii) Name the element used as the anode in this process.

.....[1]

[Total: 8]

A6 Chlorine is in Group VII of the Periodic Table.

Chlorine reacts with aqueous potassium iodide to form potassium chloride and iodine.

(a) Describe what you would see when chlorine is added to aqueous potassium iodide.

.....

.....[1]

(b) Write the equation for the reaction between chlorine and potassium iodide.

.....[1]

(c) When chlorine reacts with potassium iodide, iodine molecules are formed.

$$2I^- \rightarrow I_2 + 2e^-$$

Explain why the formation of an iodine molecule from iodide ions is an example of oxidation.

.....

.....[1]

(d) Astatine is another element in Group VII. It is highly radioactive and so is very difficult to study.

(i) Predict, with reasons, whether astatine will react with aqueous potassium iodide.

.....

.....[1]

(ii) Write the equation for the reaction between astatine and sodium.

.....

.....[1]

[Total: 5]

A7 The carbonates of many metallic elements decompose when heated.

(a) Name the gas produced during the decomposition of a metal carbonate and describe a chemical test for this gas.

gas produced .....

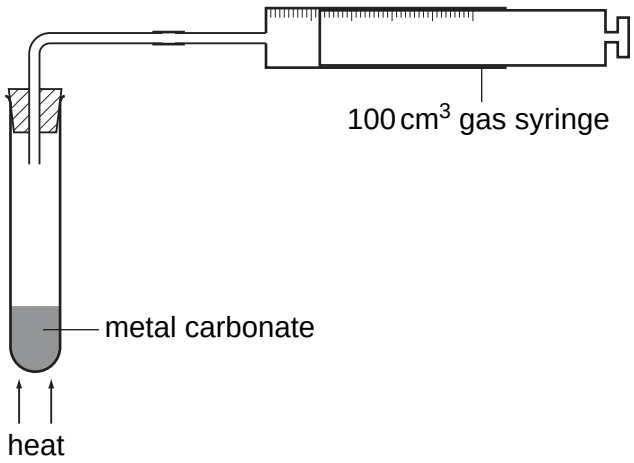
chemical test .....

.....[2]

(b) Calcium oxide is manufactured by the decomposition of calcium carbonate.
Write the equation for this decomposition.

.....[1]

(c) A student investigates the decomposition of five different metal carbonates.
The diagram shows the apparatus the student uses.



The student heats a 0.010 mol sample of each carbonate using the blue flame of the same Bunsen burner. She measures the time it takes for 100 cm^3 of gas to be collected in the gas syringe.
The table shows her results.

carbonate	time taken to collect 100 cm^3 of gas / s
metal **U** carbonate	25
metal **V** carbonate	100
metal **X** carbonate	300
metal **Y** carbonate	no gas produced after 1000 seconds
metal **Z** carbonate	50

The student used calcium carbonate, copper(II) carbonate, magnesium carbonate, sodium carbonate and zinc carbonate.

Complete the table to show the identity of each metal **U**, **V**, **X**, **Y** and **Z**.

metal	name of metal
U	.....
V	.....
X	.....
Y	.....
Z	.....

Explain how you used the student's results to identify each metal.

.....

.....

.....

[3]

(d) The nitrates of metallic elements also decompose when heated.
Calcium nitrate decomposes to form calcium oxide, nitrogen dioxide and oxygen.

$$2Ca(NO_3)_2(s) \longrightarrow 2CaO(s) + 4NO_2(g) + O_2(g)$$

A 0.010 mol sample of calcium nitrate is heated. Calculate the number of moles of gas produced when this sample is completely decomposed.

..... moles [1]

[Total: 7]

A8 Between the 13th and the 19th Century artists used a green pigment called verdigris. They made the pigment by hanging copper foil over boiling vinegar.

(a) Vinegar is an aqueous solution of ethanoic acid.
Draw the structure of ethanoic acid.

[1]

(b) During the preparation of verdigris, copper atoms, oxygen molecules and hydrogen ions combine to form copper(II) ions and water.

Write the ionic equation for this reaction.

.....[2]

(c) Verdigris has the formula $[Cu(CH_3CO_2)_2]_2.Cu(OH)_2.\mathbf{x}H_2O$.
It has a relative formula mass of 552.
Calculate the value of **x** in the formula.

x is …… [2]

[Total: 5]

Section B

Answer **three** questions from this section.

The total mark for this section is 30.

B9 This question is about the chemistry of the elements in Period 3 of the Periodic Table.

(a) Compare the reactions of sodium and of magnesium with cold water. In each case identify the products formed. [3]

(b) Draw electronic structures, including the charges, of the ions present in sodium oxide. Hence deduce the formula for sodium oxide. [2]

(c) Write an equation for the formation of aluminium oxide from its elements. [1]

(d) Pure sand is silicon(IV) oxide. It has a giant molecular structure similar to that of diamond. Suggest **two** physical properties of silicon(IV) oxide. [2]

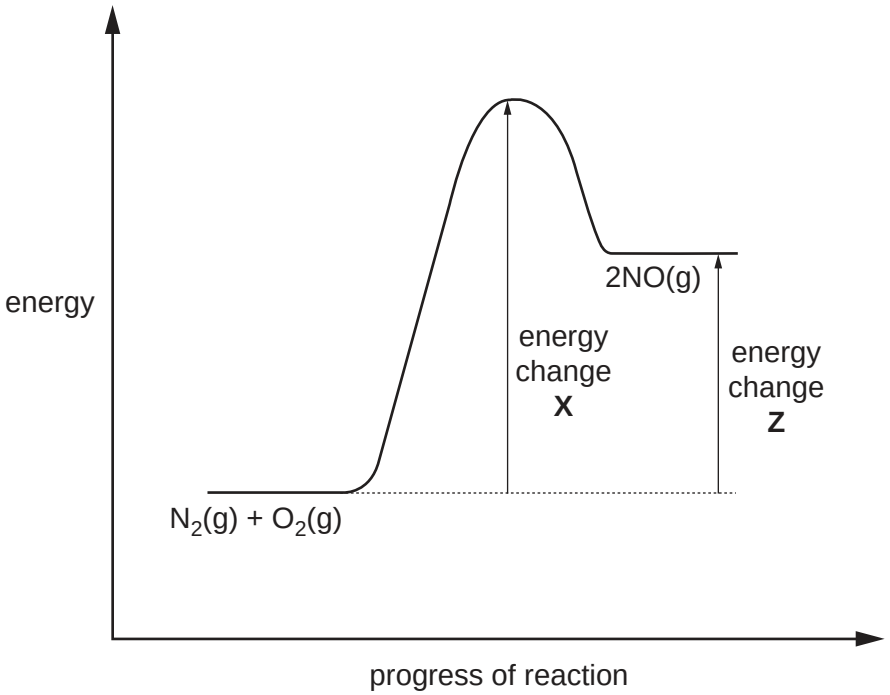
(e) Chlorine(VII) oxide, Cl_2O_7, has a simple molecular structure. Suggest one **physical** and one **chemical** property of Cl_2O_7. [2]

[Total: 10]

B10 Oxides of nitrogen are atmospheric pollutants. Nitrogen monoxide, NO, is formed in an internal combustion engine when nitrogen and oxygen react together.

$$N_2(g) + O_2(g) \longrightarrow 2NO(g)$$

The diagram shows the energy profile for this reaction.



(a) Identify the energy changes **X** and **Z**. [2]

(b) The reaction between nitrogen and oxygen is endothermic.

(i) Explain how you can tell from the diagram that the reaction is endothermic. [1]

(ii) Explain, using ideas about bond breaking and bond making, why the overall reaction is endothermic. [3]

(c) The exhaust system of a motor car is fitted with a catalytic converter. When nitrogen monoxide passes through the converter it reacts with carbon monoxide.

$$2NO(g) + 2CO(g) \longrightarrow N_2(g) + 2CO_2(g)$$

The catalyst increases the rate of this reaction.

(i) Explain how the catalyst in the converter increases the rate of this reaction. [1]

(ii) During the course of a journey 2.4 dm^3 of nitrogen monoxide was produced by the engine. Calculate the volume of nitrogen gas produced if all the nitrogen monoxide reacted in the converter. [1]

(iii) In reality, only 1.0 dm^3 of nitrogen was produced after the gases had passed over the catalytic converter. Calculate the percentage of nitrogen monoxide that had reacted. [2]

[Total: 10]

B11 The table shows the formula of the first three members of the alcohol homologous series.

alcohol	formula
methanol	CH_3OH
ethanol	C_2H_5OH
propanol	C_3H_7OH

(a) Deduce the general formula for the alcohol homologous series. [1]

(b) Name the products of the complete combustion of methanol. [1]

(c) Ethanol can be manufactured from either ethene or glucose.

(i) Write an equation for the production of ethanol from ethene and state the conditions under which the reaction takes place. [2]

(ii) The fermentation of glucose can be represented by the following equation.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

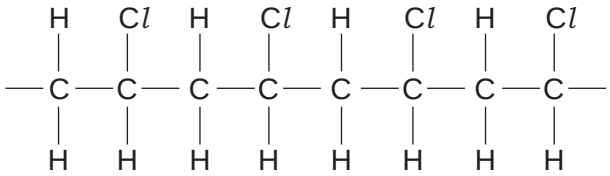
Calculate the maximum mass of ethanol that could be made from 36 tonnes of glucose. [3]

(iii) Explain why ethanol made from ethene is a non-renewable fuel but that made from glucose is a renewable fuel. [2]

(d) Propanol reacts in a similar way to ethanol.
Name the organic product of the reaction between propanol and warm acidified potassium dichromate(VI). [1]

[Total: 10]

B12 The macromolecule below is an addition polymer.



polymer **X**

(a) Draw the structure of the monomer from which polymer **X** is formed. [1]

(b) The atoms in polymer **X** are covalently bonded.

(i) Explain what is meant by a covalent bond. [1]

(ii) Polymer **X** is used as an insulating cover for electrical wires.
Explain why polymer **X** does not conduct electricity. [1]

(c) Polymer **X** is non-biodegradable.

(i) Describe one pollution problem that this causes. [1]

(ii) Polymer **X** can be disposed of by burning at high temperature. This produces waste gases, some of which are toxic such as hydrogen chloride.
The hydrogen chloride can be removed by reacting the waste gases with moist calcium carbonate powder.
Name the three products of this reaction. [3]

(d) Ethene can be used to make poly(ethene).

(i) Draw a 'dot-and-cross' diagram for an ethene molecule, C_2H_4. You must draw all of the electrons. [2]

(ii) What is the maximum mass of poly(ethene) that can be made from 28 tonnes of ethene? [1]

[Total: 10]

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 Sulphur 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	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	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radius 88	227 Ac Actinium 89 †															

*58-71 Lanthanoid series
†90-103 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	

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 dm^3 at room temperature and pressure (r.t.p.).