UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

CHEMISTRY **0620/03**

Paper 3 (Extended) **October/November 2007**

1 hour 15 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 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.

Answer **all** questions.
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 questions.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

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

For Examiner's Use

1 A list of techniques used to separate mixtures is given below.

fractional distillation	**simple distillation**	**crystallization**	**filtration**	**diffusion**

From the list choose the most suitable technique to separate the following.

water from aqueous copper(II) sulphate .....

helium from a mixture of helium and argon .....

copper(II) sulphate from aqueous copper(II) sulphate .....

ethanol from aqueous ethanol .....

barium sulphate from a mixture of water and barium sulphate ..... [5]

[Total: 5]

For Examiner's Use

2 The table below gives the number of protons, neutrons and electrons in atoms or ions.

particle	number of protons	number of electrons	number of neutrons	symbol or formula
A	9	10	10	$^{19}_{9}F^-$
B	11	11	12	
C	18	18	22	
D	15	18	16	
E	13	10	14	

(a) Complete the table. The first line is given as an example. [6]

(b) Which atom in the table is an isotope of the atom which has the composition 11p, 11e and 14n? Give a reason for your choice.

.....

..... [2]

[Total: 8]

For Examiner's Use

3 Magnesium reacts with bromine to form magnesium bromide.

(a) Magnesium bromide is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of outer electrons around the negative ion.
The electron distribution of a bromine atom is 2, 8, 18, 7.

Use x to represent an electron from a magnesium atom.
Use o to represent an electron from a bromine atom. [3]

(b) In the lattice of magnesium bromide, the ratio of magnesium ions to bromide ions is 1:2.

(i) Explain the term *lattice*.

.....

..... [2]

(ii) Explain why the ratio of ions is 1:2.

..... [1]

(iii) The reaction between magnesium and bromine is redox. Complete the sentences.

Magnesium is the ..... agent because it has

..... electrons.

Bromine has been ..... because it has .....

electrons. [4]

[Total: 10]

For Examiner's Use

4 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide.

..... [1]

(ii) Describe how sulphur dioxide is converted into sulphur trioxide.

.....

.....

..... [3]

(iii) Name a fertiliser made from sulphuric acid.

..... [1]

(b) Some of the zinc oxide was mixed with an excess of carbon and heated to 1000 °C. Zinc distils out of the furnace.

$$2ZnO + C \rightleftharpoons 2Zn + CO_2$$
$$C + CO_2 \rightarrow 2CO$$

(i) Name the **two** changes of state involved in the process of distillation.

..... [2]

(ii) Why is it necessary to use an excess of carbon?

.....

..... [2]

For Examiner's Use

(c) The remaining zinc oxide reacts with sulphuric acid to give aqueous zinc sulphate. This is electrolysed with inert electrodes (the electrolysis is the same as that of copper(II) sulphate with inert electrodes).
ions present: $Zn^{2+}(aq)$ $SO_4^{2-}(aq)$ $H^+(aq)$ $OH^-(aq)$

(i) Zinc forms at the negative electrode (cathode). Write the equation for this reaction.

..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).

..... [2]

(iii) The electrolyte changes from aqueous zinc sulphate to

..... [1]

(d) Give two uses of zinc.

1. .....

2. ..... [2]

[Total: 15]

For Examiner's Use

5 Methylamine, CH_3NH_2, is a weak base. Its properties are similar to those of ammonia.

(a) When methylamine is dissolved in water, the following equilibrium is set up.

$$\underset{\text{base}}{CH_3NH_2} + \underset{\text{acid}}{H_2O} \rightleftharpoons CH_3NH_3^+ + OH^-$$

(i) Suggest why the arrows are not the same length.

.....

[1]

(ii) Explain why water is stated to behave as an acid and methylamine as a base.

.....

.....

[2]

(b) An aqueous solution of the strong base, sodium hydroxide, is pH 12. Predict the pH of an aqueous solution of methylamine which has the same concentration. Give a reason for your choice of pH.

.....

.....

[2]

(c) Methylamine is a weak base like ammonia.

(i) Methylamine can neutralise acids.

$$2CH_3NH_2 + H_2SO_4 \rightarrow \underset{\text{methylammonium sulphate}}{(CH_3NH_3)_2\,SO_4}$$

Write the equation for the reaction between methylamine and hydrochloric acid. Name the salt formed.

.....

.....

[2]

(ii) When aqueous methylamine is added to aqueous iron(II) sulphate, a green precipitate is formed. What would you see if iron(III) chloride solution had been used instead of iron(II) sulphate?

.....

[1]

(iii) Suggest the name of a reagent that will displace methylamine from one of its salts, for example methylammonium sulphate.

.....

[1]

[Total: 9]

For Examiner's Use

6 The alcohols form a homologous series. The first four members are methanol, ethanol, propan-1-ol and butan-1-ol.

(a) One characteristic of a homologous series is that the physical properties vary in a predictable way. The table below gives the heats of combustion of the first three alcohols.

alcohol	formula	heat of combustion in kJ / mol
methanol	CH_3OH	-730
ethanol	CH_3-CH_2-OH	-1370
propan-1-ol	CH_3-CH_2-CH_2-OH	-2020
butan-1-ol	CH_3-CH_2-CH_2-CH_2-OH	

(i) The minus sign indicates that there is less chemical energy in the products than in the reactants. What form of energy is given out by the reaction?

..... [1]

(ii) Is the reaction exothermic or endothermic?

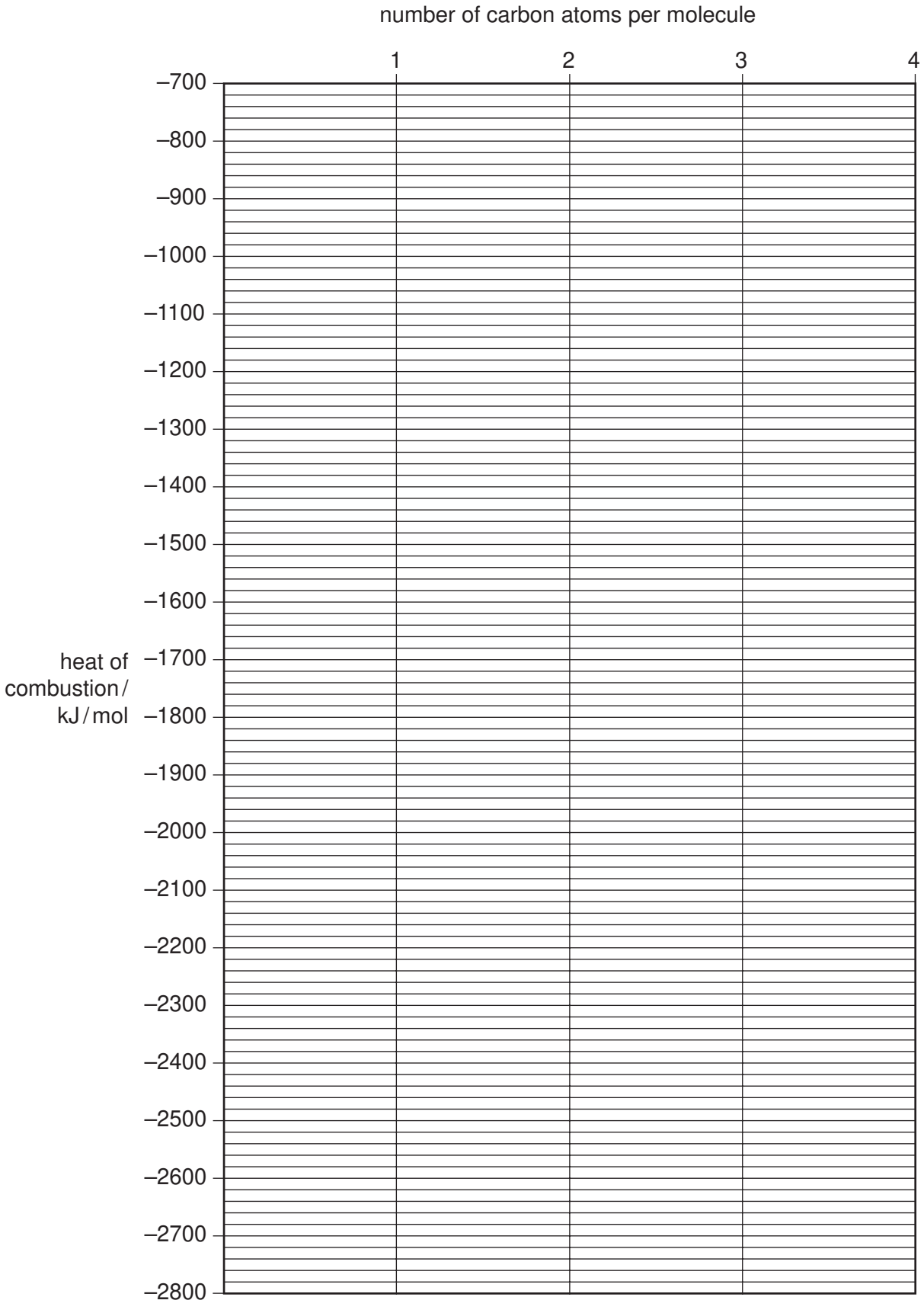
..... [1]

(iii) Complete the equation for the complete combustion of ethanol.

C_2H_5OH + ... $O_2 \rightarrow$ ..... + ... [2]

(iv) Determine the heat of combustion of butan-1-ol by plotting the heats of combustion of the first three alcohols against the number of carbon atoms per molecule.

For Examiner's Use



The heat of combustion of butan-1-ol = ... kJ / mol [3]

(v) Describe **two** other characteristics of homologous series.

.....

..... [2]

(b) Give the name and structural formula of an isomer of propan-1-ol.
structural formula

name ..... [2]

(c) Methanol is made from carbon monoxide.

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ the forward reaction is exothermic

(i) Describe how hydrogen is obtained from alkanes.

.....

..... [2]

(ii) Suggest a method of making carbon monoxide from methane.

..... [2]

(iii) Which condition, high or low pressure, would give the maximum yield of methanol? Give a reason for your choice.

pressure .....

reason ..... [2]

(d) For each of the following predict the name of the organic product.

(i) reaction between methanol and ethanoic acid

..... [1]

(ii) oxidation of propan-1-ol by potassium dichromate(VI)

..... [1]

(iii) removal of H_2O from ethanol (dehydration)

..... [1]

[Total: 20]

For Examiner's Use

7 **(a)** A small piece of marble, calcium carbonate, was added to 5 cm^3 of hydrochloric acid at 25 °C. The time taken for the reaction to stop was measured.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Similar experiments were performed always using 5 cm^3 of hydrochloric acid.

experiment	number of pieces of marble	concentration of acid in mol / dm^3	temperature / °C	time / min
1	1	1.00	25	3
2	1	0.50	25	7
3	1 piece crushed	1.00	25	1
4	1	1.00	35	2

Explain each of the following in terms of **collisions between reacting particles.**

(i) Why is the rate in experiment 2 slower than in experiment 1?

.....

..... [2]

(ii) Why is the rate in experiment 3 faster than in experiment 1?

.....

..... [2]

(iii) Why is the rate in experiment 4 faster than in experiment 1?

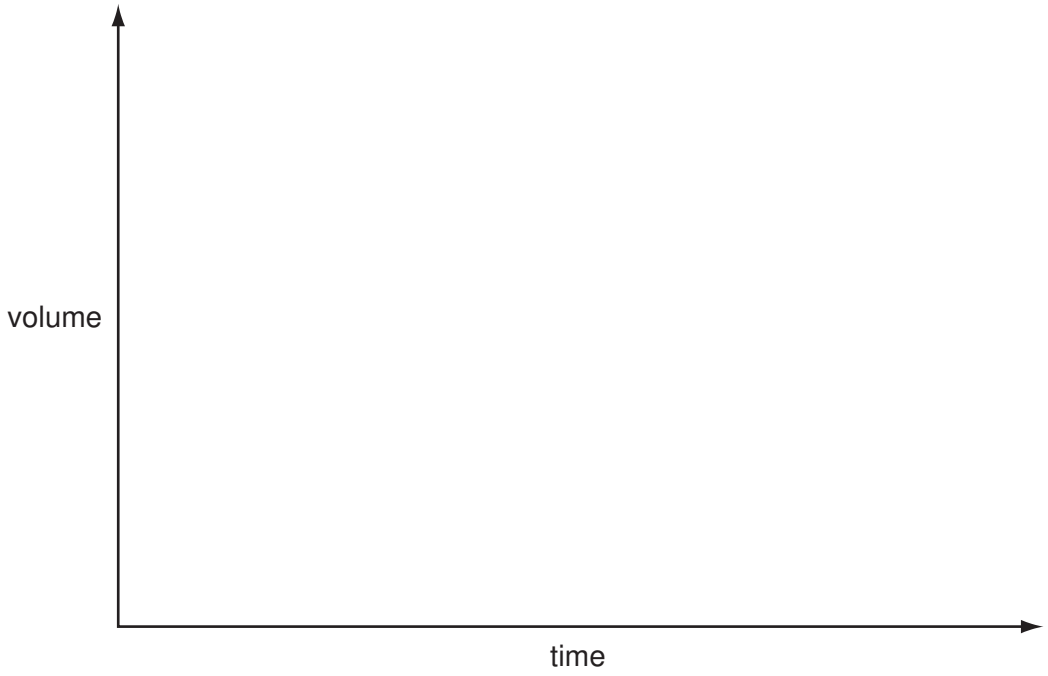
.....

..... [2]

For Examiner's Use

(b) An alternative method of measuring the rate of this reaction would be to measure the volume of carbon dioxide produced at regular intervals.

(i) Sketch this graph



[2]

(ii) One piece of marble, 0.3 g, was added to 5 cm^3 of hydrochloric acid, concentration 1.00 mol / dm^3. Which reagent is in excess? Give a reason for your choice.

mass of one mole of $CaCO_3$ = 100 g

number of moles of $CaCO_3$ = ...

number of moles of HC*l* = ...

reagent in excess is .....

reason ..... [4]

(iii) Use your answer to **(ii)** to calculate the maximum volume of carbon dioxide produced measured at r.t.p.

..... [1]

[Total: 13]

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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 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 Radium 88	227 Ac Actinium 89 †															

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

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

Key: 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.).