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.

UNIVERSITY *of* CAMBRIDGE
International Examinations

[Turn over

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]

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]

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]

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.

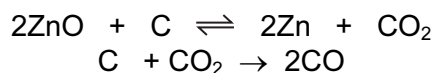   (i)   Give another use of sulphur dioxide.

       .... [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]

(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. ....

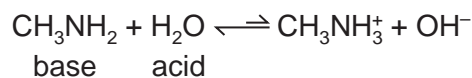 2. .... [2]

[Total: 15]

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.

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

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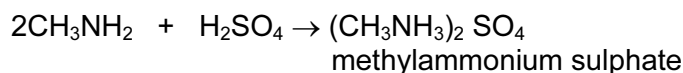
(b) An aqueous solution of the strong base, sodium hydroxide, is pH 12. Predict the pH of an aqueous solution of methylamine which has the same concentration. Give a reason for your choice of pH.

....

.... [2]

(c) Methylamine is a weak base like ammonia.

(i) Methylamine can neutralise acids.

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

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]

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	$CH_3\text{-}CH_2\text{-}OH$	-1370
propan-1-ol	$CH_3\text{-}CH_2\text{-}CH_2\text{-}OH$	-2020
butan-1-ol	$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}OH$	

(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.

number of carbon atoms per molecule
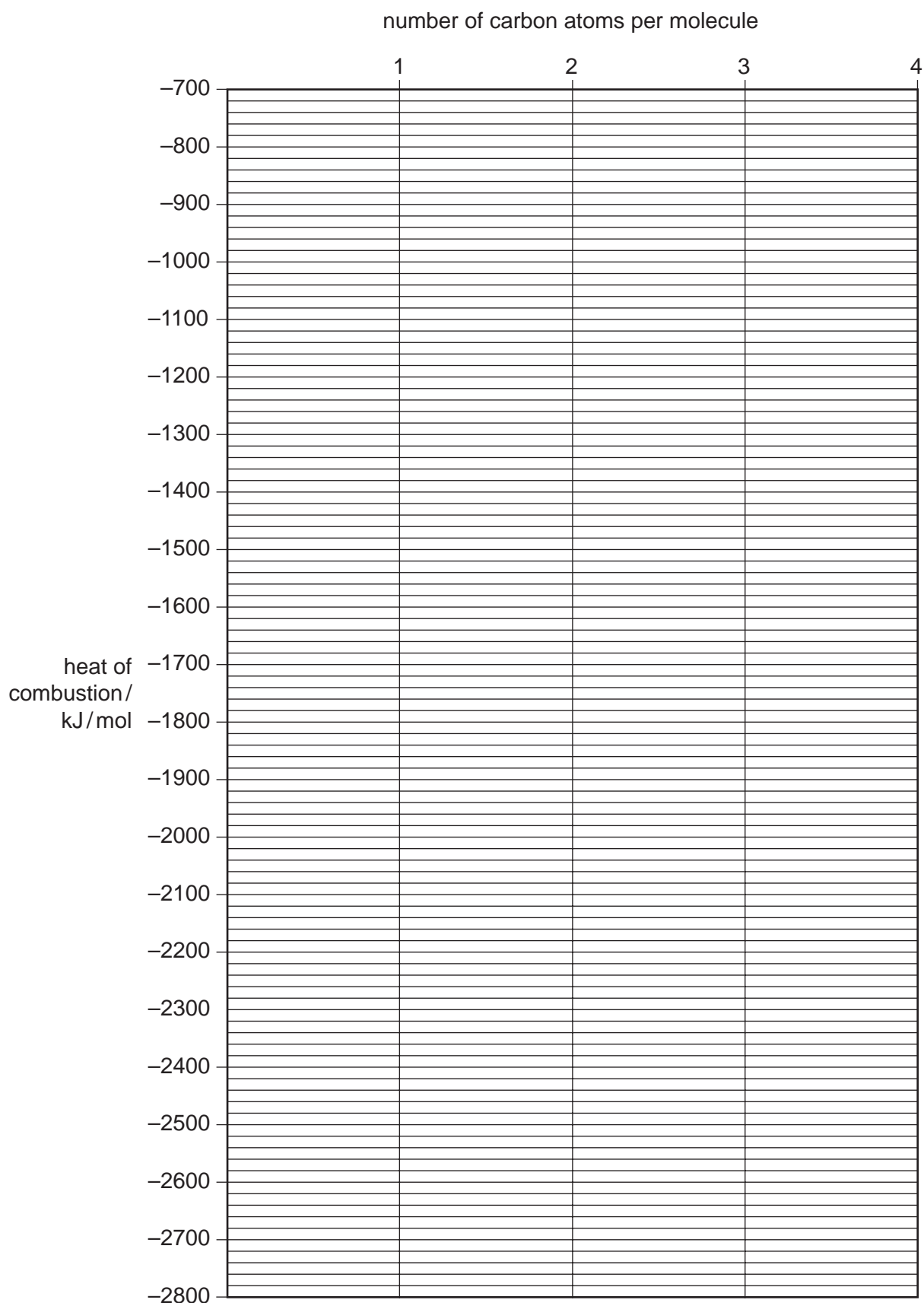
The heat of combustion of butan-1-ol = ... kJ/mol   [3]

(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]

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/dm³	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]

(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
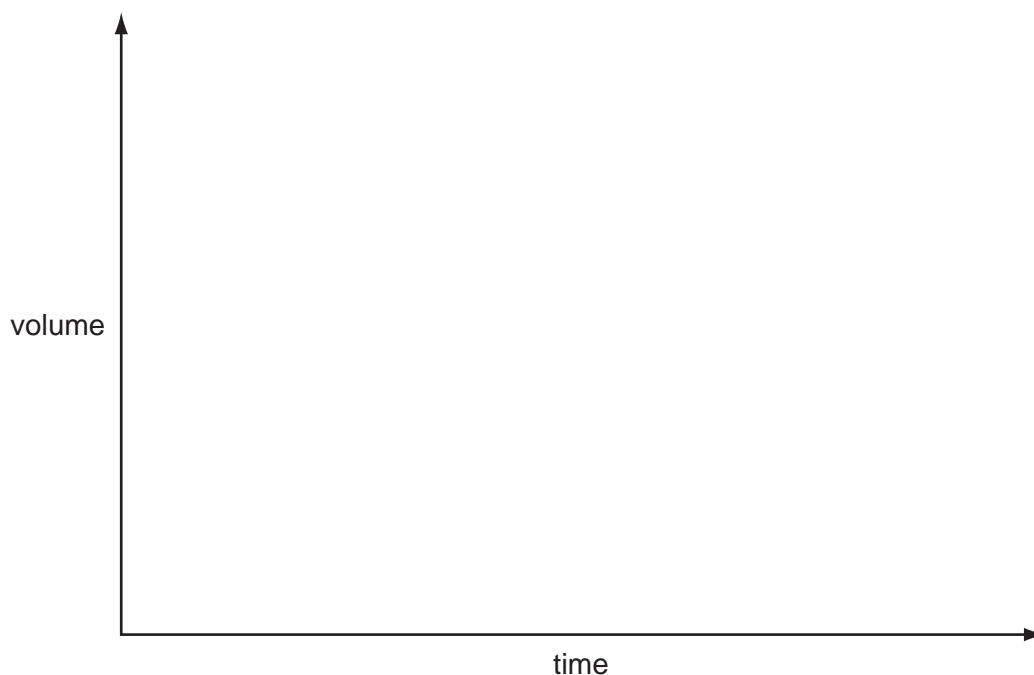
[2]

    (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 HCl = ...

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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14

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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 **A***l* Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **C***l* 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 **T***l* 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 †																

*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 dm³ at room temperature and pressure (r.t.p.).