UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CHEMISTRY

Paper 3 (Extended)

0620/03

May/June 2005

1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials required.

Candidate Name

Centre Number

Candidate Number

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.
WRITE IN THE BOXES PROVIDED ON THE QUESTION PAPER
DO **NOT** WRITE IN THE BARCODE.
DO **NOT** WRITE IN THE GREY AREAS BETWEEN THE PAGES.
Do not use staples, paper clips, highlighters, glue or correction fluid.
You may use a calculator.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part questions.
A copy of the Periodic Table is printed on page 16.

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1	
2	
3	
4	
5	
6	
Total	

This document consists of **14** printed pages and **2** blank pages.

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1 Three of the halogens in Group VII are:

chlorine
bromine
iodine

(a) (i) How does their colour change down the Group?

..... [1]

(ii) How does their physical state (solid, liquid or gas) change down the Group?

..... [1]

(iii) Predict the colour and physical state of fluorine.

colour .....

physical state ..... [2]

(b) Describe how you could distinguish between aqueous potassium bromide and aqueous potassium iodide.

test .....

result with bromide .....

result with iodide ..... [3]

(c) 0.015 moles of iodine react with 0.045 moles of chlorine to form 0.030 moles of a single product. Complete the equation.

I_2 + ... Cl_2 → ..... [2]

(d) Traces of chlorine can be separated from bromine vapour by diffusion.
Which gas would diffuse the faster and why?

.....

..... [2]

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2 The following apparatus was used to measure the rate of the reaction between zinc and iodine.

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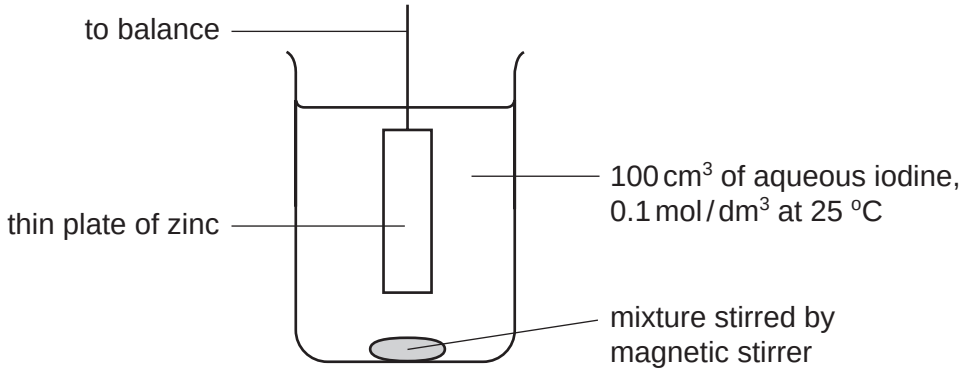

The mass of the zinc plate was measured every minute until the reaction was complete.

(a) Write an ionic equation for the redox reaction that occurred between zinc atoms and iodine molecules.

..... [2]

(b) Describe how you could show by adding aqueous sodium hydroxide and aqueous ammonia that a solution contained zinc ions.

result with sodium hydroxide .....

excess sodium hydroxide .....

result with aqueous ammonia .....

excess aqueous ammonia ..... [3]

(c) From the results of this experiment two graphs were plotted.

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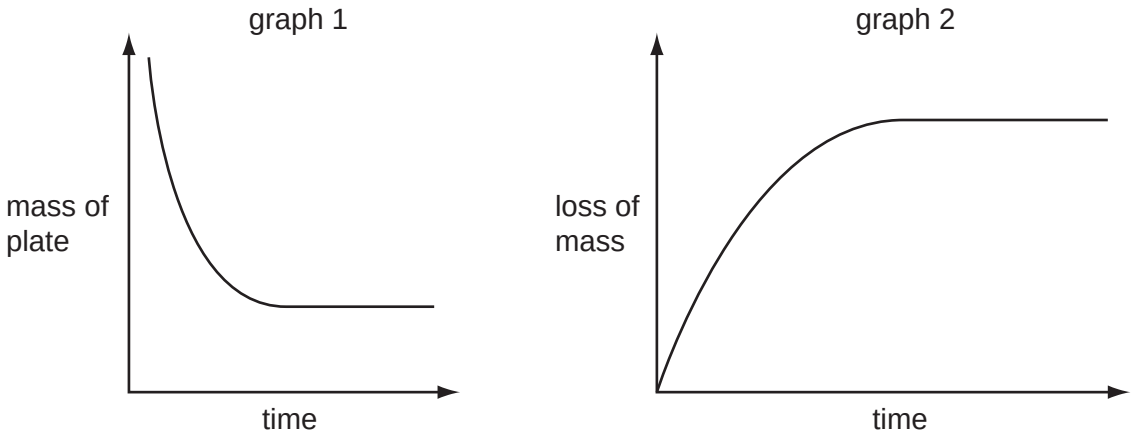

(i) Which reagent iodine or zinc was in excess? Give a reason for your choice.

.....

[1]

(ii) Describe how the shape of graph 1 would change if 100cm^3 of 0.05 mol/dm^3 iodine had been used.

.....

.....

[2]

(iii) On graph 2, sketch the shape if the reaction had been carried out using 100 cm^3 of 0.1 mol/dm^3 iodine at 35 °C instead of at 25 °C. [2]

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3 A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(a) (i) Give the structural formula of the monomer.

[1]

(ii) Draw the structural formula of the polymer.

[2]

(iii) Suggest which one, monomer or polymer, will react with aqueous bromine and why?

.....

..... [2]

(b) To show that the polymer contains silver the following test was carried out.

The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered. Aqueous sodium chloride was added to the filtrate and a white precipitate formed.

(i) Why was the mixture filtered?

..... [1]

(ii) Explain why the change of silver atoms to silver ions is oxidation.

..... [1]

(iii) Give the name of the white precipitate.

..... [1]

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(c) The unpleasant smell is caused by carboxylic acids. Bacteria cause the fats on the skin to be hydrolysed to these acids. Silver kills the bacteria and prevents the hydrolysis of the fats.

(i) Fats are esters. Give the name and structural formula of an ester.

name ..... [1]

structural formula

[1]

(ii) Complete the word equation.

Ester + water ⟶ carboxylic acid + ... [1]

(d) Propanoic acid is a weak acid.

(i) The following equation represents its reaction with ammonia.

$CH_3-CH_2-COOH + NH_3 \longrightarrow CH_3-CH_2-COO^- + NH_4^+$

Explain why propanoic acid behaves as an acid and ammonia as a base.

.....

..... [3]

(ii) Explain the expression *weak acid.*

..... [1]

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4 The Carlsbad caverns in New Mexico are very large underground caves. Although the walls of these caves are coated with gypsum (hydrated calcium sulphate), the caves have been formed in limestone.

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(a) It is believed that the caves were formed by sulphuric acid reacting with the limestone.

(i) Complete the word equation.

calcium carbonate + sulphuric acid ⟶ calcium sulphate + ... + ...

[1]

(ii) Describe how you could test the water entering the cave to show that it contained sulphate ions.

test .....

result ..... [2]

(iii) How could you show that the water entering the cave has a high concentration of hydrogen ions?

..... [1]

(b) Hydrogen sulphide gas which was escaping from nearby petroleum deposits was being oxidised to sulphuric acid.

(i) Complete the equation for this reaction forming sulphuric acid.

H_2S + ...O_2 ⟶ ..... [2]

(ii) Explain why all the hydrogen sulphide should be removed from the petroleum before it is used as a fuel.

.....

..... [1]

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(iii) Draw a diagram to show the arrangement of the valency electrons in one molecule of the covalent compound hydrogen sulphide.
Use o to represent an electron from a sulphur atom.
Use x to represent an electron from a hydrogen atom.

[2]

(c) Sulphuric acid is manufactured by the Contact Process. Sulphur dioxide is oxidised to sulphur trioxide by oxygen.

$$2SO_2 + O_2 \longrightarrow 2SO_3$$

(i) Name the catalyst used in this reaction.

..... [1]

(ii) What temperature is used for this reaction?

..... [1]

(iii) Describe how sulphur trioxide is changed into sulphuric acid.

.....

..... [2]

(d) Gypsum is hydrated calcium sulphate, $CaSO_4.xH_2O$. It contains 20.9% water by mass. Calculate x.

M_r: $CaSO_4$, 136; H_2O, 18.

79.1 g of $CaSO_4$ = ... moles

20.9 g of H_2O = ... moles

x = ... [3]

5 Enzymes are biological catalysts. They are used both in research laboratories and in industry.

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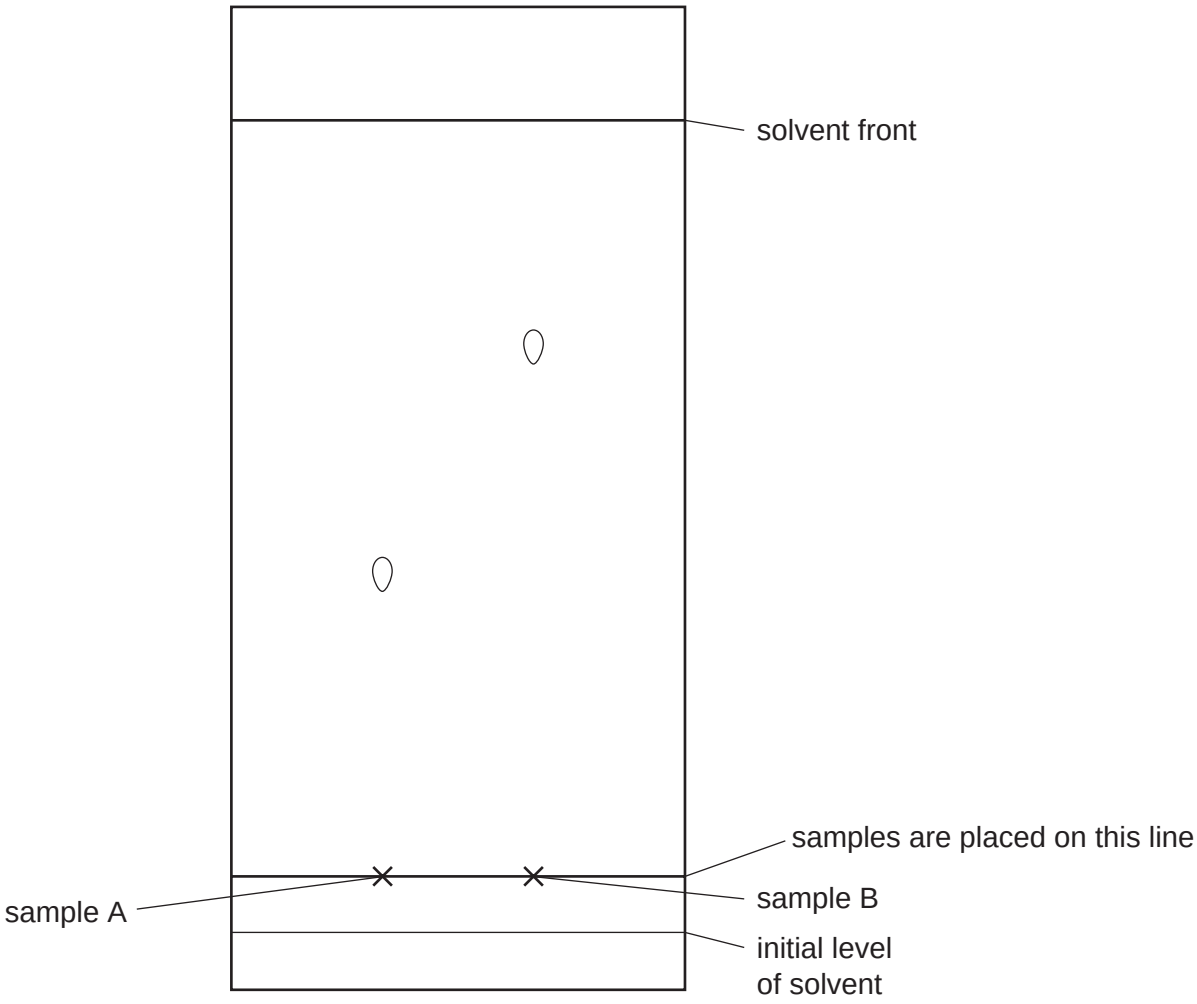
(a) Enzymes called proteases can hydrolyse proteins to amino acids. The amino acids can be separated and identified by chromatography. The diagram below shows a typical chromatogram.



(i) The R_f value of a sample = $\frac{\text{distance travelled by sample}}{\text{distance travelled by solvent front}}$

Some R_f values for amino acids are:

glutamic acid = 0.4 glycine = 0.5 alanine = 0.7 leucine = 0.9

Identify the two amino acids on the chromatogram.

A is ..... B is ..... [2]

(ii) Explain why the chromatogram must be exposed to a locating agent before R_f values can be measured.

..... [1]

(iii) Measuring R_f values is one way of identifying amino acids on a chromatogram. Suggest another.

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.....

[1]

(iv) The synthetic polymer, nylon, has the same linkage as proteins. Draw the structural formula of nylon.

[3]

(b) Enzymes called carbohydrases can hydrolyse complex carbohydrates to simple sugars which can be represented as HO — [ ] — OH. Draw the structure of a complex carbohydrate.

[2]

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(c) Fermentation can be carried out in the apparatus drawn below. After a few days the reaction stops. It has produced a 12% aqueous solution of ethanol.

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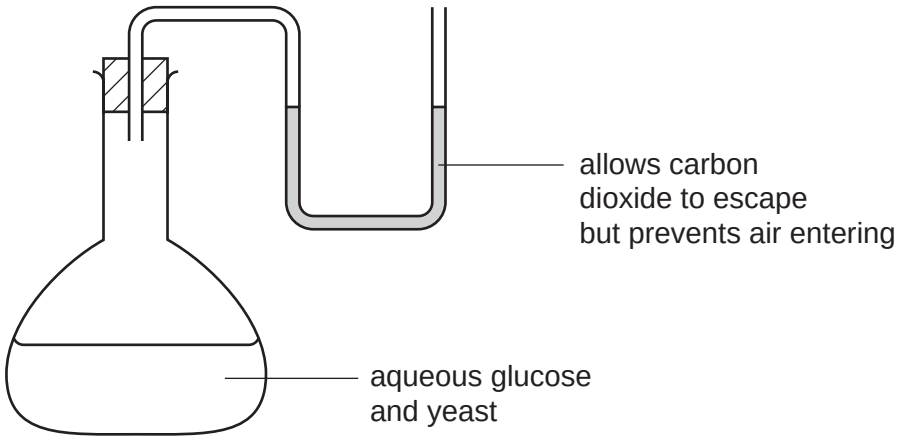

(i) Complete the equation.

$C_6H_{12}O_6 \rightarrow$ ..... + ...

glucose ethanol carbon dioxide [2]

(ii) Zymase catalyses the anaerobic respiration of glucose. Define the term *respiration*.

.....

..... [2]

(iii) Suggest a reason why the reaction stops after a few days.

..... [1]

(iv) Why is it essential that there is no oxygen in the flask?

..... [1]

(v) What technique is used to concentrate the aqueous ethanol?

..... [1]

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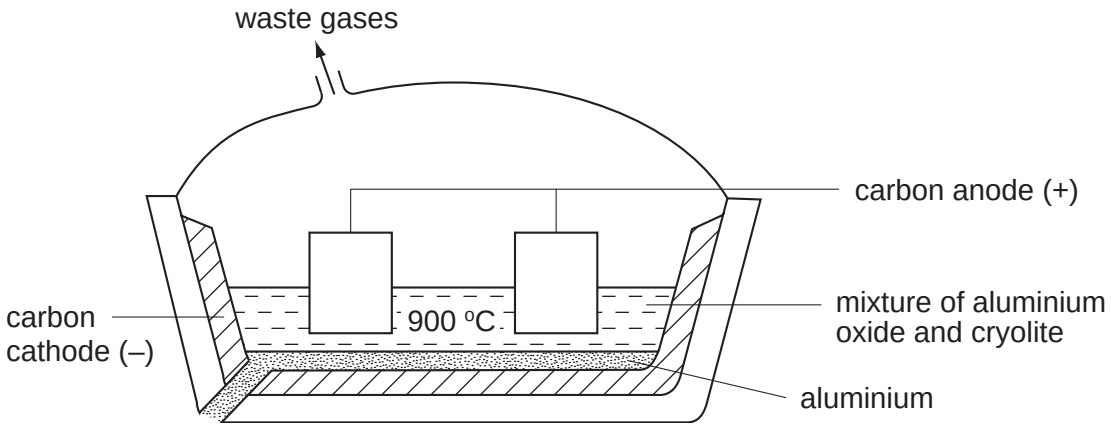
6 The position of aluminium in the reactivity series of metals is shown below.

magnesium
aluminium
zinc
copper

(a) Aluminium is extracted by the electrolysis of its molten oxide.



(i) Name the main ore of aluminium.

..... [1]

(ii) Why does the molten electrolyte contain cryolite?

..... [1]

(iii) Oxygen is produced at the positive electrode (anode). Name another gas which is given off at this electrode.

..... [1]

(b) Aluminium reacts very slowly with aqueous copper(II) sulphate.

$$2Al(s) + 3CuSO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$$

(i) Which of the two metals has the greater tendency to form ions?

..... [1]

(ii) Describe what you would see when this reaction occurs.

..... [1]

(iii) Explain why aluminium reacts so slowly.

..... [1]

(c) Complete the following table by writing "reaction" or "no reaction" in the spaces provided.

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oxide	type of oxide	reaction with acid	reaction with alkali
magnesium	basic	.....	.....
aluminium	amphoteric	.....	.....

[2]

(d) Predict the equations for the decomposition of the following aluminium compounds.

(i) ..... $Al(OH)_3$ ⟶ ..... + ... [2]

(ii) aluminium nitrate ⟶ ..... + ... + ...

.... [2]

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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.).

PMT