بسم الله الرحمن الرحيم

مقابل هذا المجهود ارجو منكم الدعاء لي بالمغفرة ولابنائي الهداية والنجاح والتوفيق

أرجو ان يساعد هذا المجهود على مساعدة ابنائنا طلبة ال IGCSE الثانوية البريطانية وتحصيلهم على افضل واحسن واعلى الدرجات انشاء الله.
وهذه الملفات موضوعة بصيغة ال PDF للكروبات فتعمل على جميع انواع الاجهزة ونظم الكمبيوتر وصيغة ال TIF لتعمل على اوفيس مايكروسوفت بحيث يتم القص واللصق بصيغة ال TIF بسهولة ويسر وطباعة صفحات محددة فقط حسب الطلب.

ابو احمد

للاستفسار والمساعدة اكتب لي على العنوان البريدي التالي :-
العنوان البريدي : jedeaaa@hotmail.com

In the name of god

Pry for me and my sons to success, mitigating and proselyting

This is a free past papers exams an answers scanned file's for our IGCSE sun's and daughters. The only thing I need you to do is "pry for me so GOD bless me and pry for my sons to success, mitigating and proselyting.

These file are in PDF format for portability and easy to see using any computer system and TIF file format to use with Microsoft Office (cut and past, print . . .etc).

If you need any help contact me at: jedeaaa@hotmail.com

IGCSE

CHEMISTRY

Examination

PAPER

3

Good luck

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
INTERNATIONAL EXAMINATIONS

Chemistry O.L

contents

Candidate Name ....

Centre Number	Candidate Number

0620/3 IGCSE JUNE

CHEMISTRY

PAPER 3

Tuesday 25 MAY 1993 Morning 1 h 15 min

Candidates answer on the question paper.
Additional materials:
Mathematical tables

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

Instructions to candidates

Write your name and examination number in the spaces provided at the top of this page.

Answer **all** *the questions.*

Write your answers in the spaces provided.

The intended marks for questions or parts of questions are given in brackets [ ].

Mathematical tables are available.

Calculators may be used.

A copy of the Periodic Table is printed on page 12.

This Question Paper consists of 11 printed pages and a data page.

[Turn over

1 The table below shows USSR's foreign trade in chemicals in 1989.

Product	*Export* (%)	*Import* (%)
Basic chemicals	22.1	5.0
Agrochemicals	40.4	5.6
Polymers	15.6	24.6
Paints	0.3	6.8
Dyes	1.9	1.8
Photochemicals	0.5	2.0
Detergents	0.9	3.0
Pharmaceuticals	4.4	27.0
Cosmetics	0.3	8.9
Other	14.0	15.2

(a) (i) Some cosmetics contain soft waxes.

Suggest the name of the raw material from which these waxes are obtained.

..... [1]

(ii) The pharmaceutical aspirin could be made from ethanoic acid and a compound which contains a C—OH group.

What type of compound is aspirin?

..... [1]

(b) "Basic chemicals" are used to manufacture other chemicals. A typical "basic chemical" is ammonia. The reaction used in the Haber Process to manufacture ammonia is reversible.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) How is the nitrogen obtained for the reaction?

..... [2]

(ii) What are two of the conditions for the reaction?

.....

..... [2]

(iii) Name a chemical that is manufactured from ammonia.

..... [1]

(iv) Give another example of a reversible reaction. Explain how changing a reaction condition, such as temperature or pressure, would affect it.

Example .....

Change in reaction condition .....

..... [2]

(c) Photochemicals are those used in photography. A film, which is coated with silver bromide particles, is exposed to light and the image "captured" on the film. When this film is developed, the developer changes only those silver ions that were exposed to light into silver atoms. Finally, the unreacted silver ions are removed.

(i) Complete the equation for the changing of silver ions into silver atoms.

$$Ag^+ + \ldots\ldots \rightarrow \ldots\ldots$$ [1]

(ii) What type of reagent is the developer?

..... [1]

(iii) Suggest a reason why the developed film should not be exposed to light until the unreacted silver ions have been removed.

..... [1]

(iv) Suggest two factors that would increase the rate of reaction between the developer and the silver ions in the solid silver bromide.

.....

..... [2]

(v) The diagram shows the image on the film and the same film after developing.

Fig.J1

Explain why some areas of the developed film are darker than others.

.....

.....

..... [3]

2 The table given below shows research done to compare powdered and liquid detergents.

		Powder	*Liquid*
Temperature range		60 °C to 90 °C	30 °C to 60 °C
Removal of:	*fat/oil*	••	•••
	soil	••	•
	coloured stains	•••	••
	protein	••	••
Performance on:	cotton	••	•
	wool	•	••
	man-made fibres	•	••

••• excellent •• very good • good

(a) (i) If the costs of the detergents needed are the same, suggest why it is cheaper to use liquid detergent.

..... [1]

(ii) Which one of the detergents would be the more effective at removing

soil from cotton, ...

oil from wool? ..... [2]

(iii) Two of the main constituents of food are mentioned in the table.

What is the third one?

..... [1]

(iv) Give the name and draw the structure of a man-made fibre.

.....

[3]

(b) An ingredient in the liquid detergent is soap. Name the reagents used to make soap.

..... [2]

(c) Major manufacturers are aware of the effect of their products on the environment. The liquid detergent is biodegradable and is sold in bottles made from recycled plastic.

(i) What is meant by *biodegradable*?

.....

..... [1]

(ii) What are two environmental advantages of recycling plastics?

.....

..... [2]

(d) The detergents contain a bleach, sodium perborate, which removes coloured stains. The structural formula of the perborate ion is drawn below.

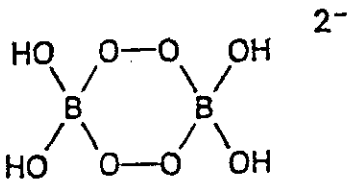


Fig.J2

(i) *There are chemicals, other than sodium perborate, that can bleach.*

Name a gas which bleaches damp litmus paper.

.....

Name the gas that is used industrially to bleach paper.

..... [2]

(ii) If the formula for sodium perborate is of the type

$$Na_xB_2H_4O_y,$$

what are the values of x and y?

x is ..... and y is ..... [2]

3 In 1818, the Swedish scientist Berzelius discovered the element selenium. It has similar chemistry to that of sulphur, which is in the same group in the Periodic Table.

Selenium is now obtained from the "anode sludge" in the refining of copper by electrolysis.

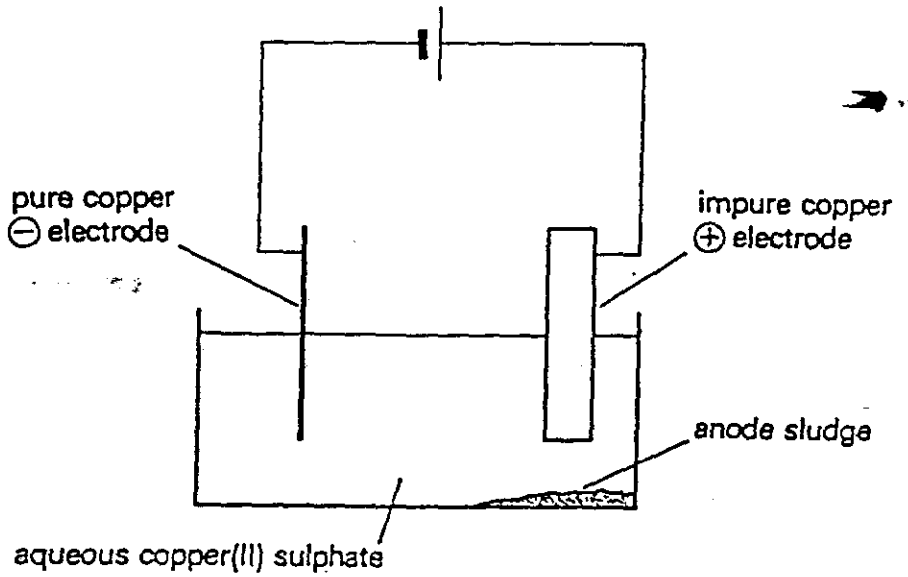


Fig.J3

(a) (i) Explain why the anode becomes smaller during this electrolysis.

..... [1]

(ii) Write an equation for the reaction at the negative electrode.

..... [1]

(iii) What technique could be used to separate the "anode sludge" from the electrolyte?

..... [1]

(iv) The pure copper is used to make alloys. Complete the following.

The alloy ..... contains copper and ..... . This alloy is preferred to pure copper, because it is ..... [3]

(b) There is more than one solid form of the element selenium. One form is a red solid. Its relative molecular mass is 632.

(i) How many atoms are there in one molecule of this form of selenium?

..... [1]

(ii) Write the formula for a molecule of selenium.

..... [1]

(c) Selenium atoms have the electron distribution 2.8.18.6.

(i) The compound sodium selenide contains the selenide ion.

What is the electron distribution of this ion?

..... [1]

(ii) Complete the following to show the arrangement of the valency electrons in the covalent compound selenium chloride.

Cl Se Cl

Use x to represent electrons from selenium.
Use o to represent electrons from chlorine. [2]

(iii) Predict which compound has the higher melting point, selenium chloride or sodium selenide.

Give a reason for your answer.

..... [2]

(d) Both sulphur and selenium have trioxides of the type XO_3, which react with water to form acids.

(i) Sulphur trioxide is used to make sulphuric acid.

Give a large-scale use of this acid.

..... [1]

(ii) Predict the formula of the acid formed when selenium trioxide reacts with water.

..... [1]

4 Minerals and fossil fuels are obtained from the Earth's crust. To find out about the rocks below the surface, a borehole is drilled.

(a) The tip of a drill is coated with diamonds. The structure of diamond is drawn below. Graphite could be used to lubricate the drill and as a conductor in the motor that drives the drill.

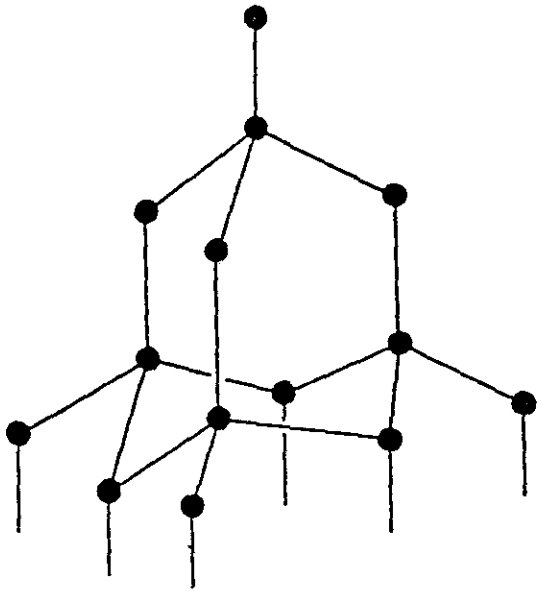


Fig.J4

(i) Describe the structure of graphite.

.....

.....

..... [2]

(ii) Why is diamond hard and graphite soft?

.....

..... [2]

(iii) Why is graphite a good conductor of electricity?

..... [1]

(b) In the last century, it was believed that natural gas, methane, had been formed by metal carbides in the ground reacting with water. It is now known that the gas was formed by the decay of vegetable and animal material.

(i) What is the source of the energy needed to make carbon compounds in plants?

..... [1]

(ii) Aluminium carbide reacts with water to form only methane. Calcium carbide reacts with water to form an unsaturated hydrocarbon.

Suggest a chemical test which could be used to distinguish between these carbides.

.....

.....

..... [3]

(iii) Give the formula of an unsaturated hydrocarbon.

..... [1]

(c) Limestone is an important mineral. It is used in the manufacture of iron and to make alkalis.

(i) Why is limestone used in the blast furnace?

..... [1]

(ii) Large amounts of limestone are used in Europe to treat the smoke from coal-fired power stations.

Name the acidic gas that is removed from the smoke, and explain why it should be removed.

..... [2]

(d) A mineral found on the shores of an African lake has the formula:

$$x\mathrm{Na_2CO_3}.y\mathrm{NaHCO_3}$$

Sodium carbonate does not decompose on heating but sodium hydrogencarbonate does.

$$2\mathrm{NaHCO_3} \rightarrow \mathrm{Na_2CO_3} + \mathrm{CO_2} + \mathrm{H_2O}$$

Both carbonates react with acids to form carbon dioxide. One mole of either carbonate forms one mole of carbon dioxide.

(i) One mole of the mineral reacts with an excess of acid to give 120 dm^3 of carbon dioxide at room temperature and pressure.

How many moles of carbon dioxide were formed?

..... [1]

(ii) When one mole of the mineral was heated, one mole of carbon dioxide was formed.

What is the value of y?

..... [1]

(iii) Use your answers to parts (i) and (ii) to work out the value of x.

..... [1]

5 The table below shows the elements in the second period of the Periodic Table and a selection of their common oxidation states.

Element	Li	Be	B	C	N	O	F	Ne
Number of electrons in outer shell	1	2	3	4	5	6	7	8
Oxidation state	+1	+2	+3	+4	−3	−2	−1	0

(a) (i) What does it mean when the only oxidation state of an element is zero?

..... [1]

(ii) Explain why these elements have different oxidation states.

.....

.....

..... [2]

(b) Beryllium hydroxide is amphoteric.

(i) Describe what would be observed when an excess of aqueous sodium hydroxide is gradually added to aqueous beryllium sulphate.

.....

..... [2]

(ii) Name another metal which has an amphoteric hydroxide.

..... [1]

(iii) Complete the ionic equation:

Be^{2+} + ... → $Be(OH)_2$ [1]

(c) Beryllium and chromium are both metals.

(i) Explain why they are both malleable.

..... [1]

(ii) Suggest a difference in the physical properties of these metals.

..... [1]

(iii) Suggest a difference in the chemical properties of these metals.

..... [1]

(d) Two different atomic forms of the element carbon are $^{12}_{6}C$ and $^{14}_{6}C$. One of the atoms is radioactive. When such an atom emits an electron, the nucleus then contains one more proton and an atom of another element **Y** is formed.

(i) What is the difference between the nuclei of these atoms of carbon?

..... [2]

(ii) What are different atoms of the same element called?

..... [1]

(iii) What is the symbol of the element **Y** formed from the radioactive carbon?

..... [1]

(iv) State **two** uses of radioactive elements.

.....

..... [2]

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

Centre Number | Candidate Number

Candidate Name ....

0620/3 IGCSE NOV

CHEMISTRY

PAPER 3

Wednesday 10 NOVEMBER 1993 Afternoon 1 h 15 min

Candidates answer on the question paper.
Additional materials:
Mathematical tables

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
INTERNATIONAL EXAMINATIONS

International General Certificate of Secondary Education

Instructions to candidates

Write your name, Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all** *the questions.*

Write your answers in the spaces provided.

The intended marks for questions or parts of questions are given in brackets [ ].

Mathematical tables are available.

Calculators may be used.

A copy of the Periodic Table and other data are given on Page 12.

1 The element hydrogen was first isolated in 1766 by the English scientist Cavendish.

(a) Cavendish reacted zinc with dilute acid. Because the zinc was impure, the hydrogen contained other gases, such as hydrogen arsenide.

(i) Complete the ionic equation.

$$Zn + 2H^+ \rightarrow \ldots\ldots\ldots + \ldots\ldots\ldots$$ [1]

(ii) What type of reaction is this?

..... [1]

(iii) Predict the formula of hydrogen arsenide, which contains hydrogen and arsenic (As) only.

..... [1]

(iv) Suggest how pure hydrogen could be obtained from a mixture of hydrogen and hydrogen arsenide.

.....

..... [2]

(b) Hydrogen can also be prepared by reacting metals with either water or steam. The following metals are given in order of reactivity. The most reactive is given first.

rubidium, sodium, aluminium, manganese, iron, copper, platinum

Predict whether the following metals would react with water or steam. If so, complete the word equation; otherwise, write "no reaction".

(i) manganese + water → .....

(ii) platinum + water → .....

(iii) rubidium + water → ..... [3]

(c) Uses of hydrogen include the manufacture of ammonia and of margarine. It was formerly used to fill balloons.

(i) Explain why helium, which has a higher density, is now used for filling balloons instead of hydrogen.

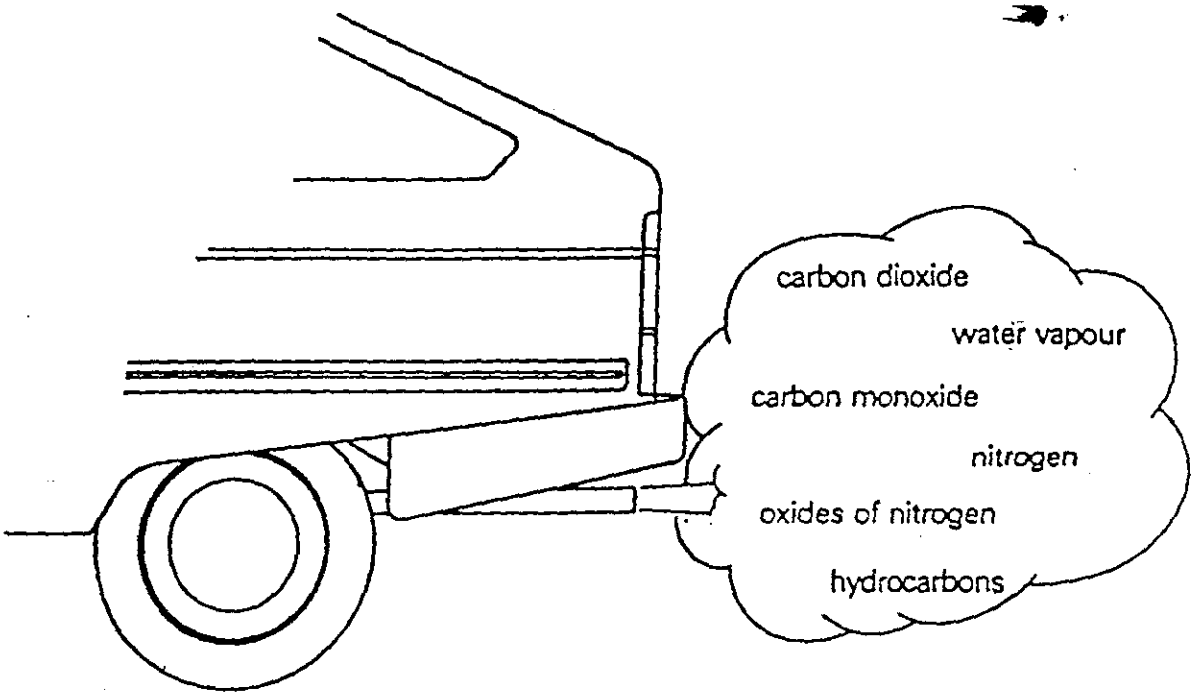
..... [1]

(ii) Use the data sheet to calculate the mass of one dm^3 of hydrogen at r.t.p.

..... [2]

(d) In a factory near Munich, a research car that runs on liquid hydrogen has been built. The aims of this research are to find an alternative to fossil fuels and to reduce atmospheric pollution.

(i) The diagram below shows the chemicals entering the atmosphere from the exhaust of a petrol-fuelled car.



Which of these would be lower in concentration if the car was fitted with a catalytic converter?

..... [2]

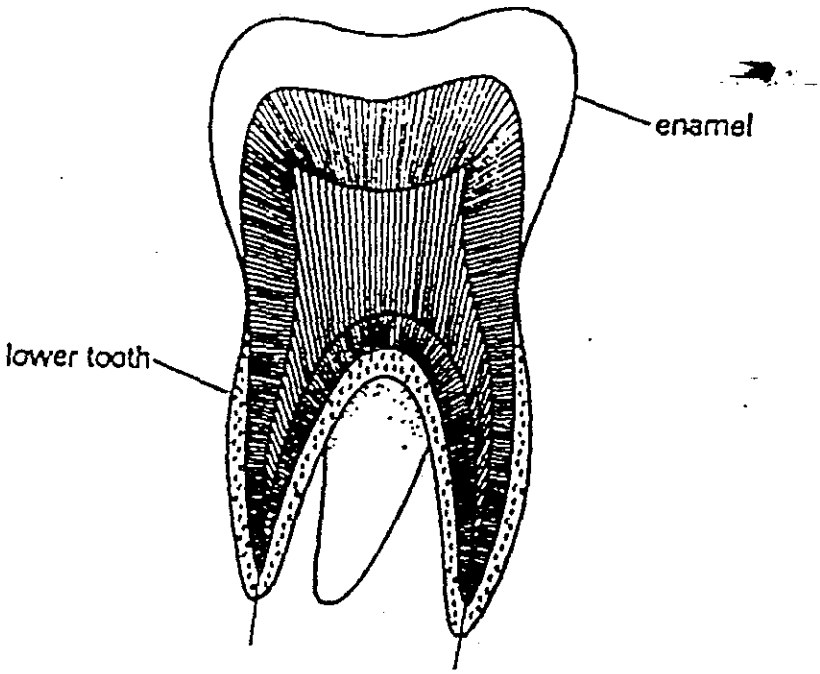
(ii) On short journeys, when the exhaust system is cold, the catalytic converter is inefficient. Suggest an explanation.

..... [1]

(iii) Name the chemicals which would leave the exhaust of a hydrogen-fuelled car.

..... [2]

2 The diagram shows the structure of a tooth.



(a) The enamel contains the compound hydroxyapatite, which has the formula:

$$Ca_x(PO_4^{3-})_6(OH^-)_2$$

(i) What is the symbol of the calcium ion?

..... [1]

(ii) What is the total charge on the negative ions in the compound?

..... [1]

(iii) This compound has no overall charge.

What is the value of x?

..... [1]

(b) Carbohydrates are oxidised to carboxylic acids, which attack the enamel and cause dental decay.

(i) Name another type of organic compound that can be oxidised to a carboxylic acid.

..... [1]

(ii) Draw the structural formula of the carboxylic acid that contains three carbon atoms in each molecule.

(c) To investigate how the rate of attack of an acid on tooth enamel depends on pH, the following experiment was carried out.

A tooth was weighed and placed in an acid solution. After a while, the tooth was removed from the acid. The tooth was washed, dried and weighed. The rate at which the tooth reacted with the acid was calculated.

The experiment was repeated, using different teeth and different concentrations of acid.

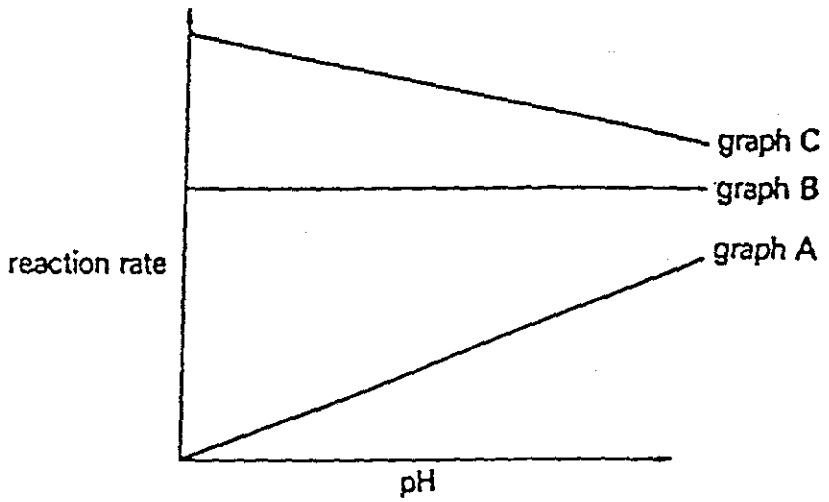
(i) Suggest two ways in which the experimental conditions could be controlled in order to make sure that the rate measured in each of the experiments depended only on the concentration of the acid.

.....

.....

..... [2]

(ii) From the results of this experiment, rate could be plotted against pH.



Which one of the graphs A, B or C could be the correct one? Give a reason for your choice.

.....

..... [2]

(d) The oxides of magnesium, aluminium and silicon are used in dental cements.

(i) Complete the following to show the arrangement of the valency electrons in the ionic compound magnesium oxide.

Use x to represent an electron from oxygen.
Use o to represent an electron from magnesium.

Mg O

[2]

(ii) Oxides can be classified as acidic, amphoteric or basic.

Classify the following.

Magnesium oxide is .....

Aluminium oxide is .....

Silicon(IV) oxide (silicon dioxide) is .....

[3]

(iii) Name a reagent that reacts with an amphoteric oxide but not with a basic oxide.

..... [1]

(iv) Name a reagent that reacts both with a basic oxide and with an amphoteric oxide.

..... [1]

3 The following is part of a newspaper article.

HOW LONG RUBBISH LASTS

This is how long experts say it takes for various items of litter to break down.

A piece of paper	*2 to 4 weeks*
A cotton rag	*1 to 5 months*
A woollen sock	*1 year*
A tin can	*100 years*
An aluminium can	*200 to 500 years*
A piece of plastic	*450 years*

(a) A tin can is made from mild steel coated with tin. The thin layer of tin reduces the rate at which the steel rusts.

(i) Name the two chemicals that must be present for steel to rust.

..... [2]

(ii) When the layer of tin is broken, the exposed steel rusts quickly.
But if steel is coated with zinc, any exposed steel rusts slowly.

Explain this difference.

.....

.....

..... [3]

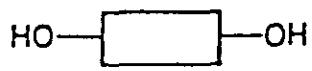
(iii) What is the name of the process that is used to coat steel with a protective layer of zinc?

..... [1]

(iv) Why does aluminium, a reactive metal, take so long to corrode?

..... [1]

(b) Cotton is a carbohydrate and can be thought of as a large number of sugar units joined together. A sugar unit may be represented as



Draw the structure of a carbohydrate such as cotton.

(c) Wool is another natural macromolecule. It is a protein.

Describe how a scientist could show that two samples of wool were identical, by breakin them down and identifying their monomers.

Reagent used to break down protein .....

Type of monomer formed .....

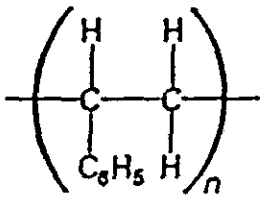
Method of identification ..... [3]

(d) Litter that persists for a long time causes a serious pollution problem.

(i) What is the scientific term (word or words) used to describe long-lasting litter, such as a piece of plastic?

..... [1]

(ii) *The piece of plastic might be polystyrene. The chemical name of this synthetic polyme* is poly(phenylethene) and it has the following structure.



What is the name and formula of the monomer?

Name of monomer .....

Formula of monomer

[3]

4 (a) *On a baby's nappy, urea changes into ammonium carbonate. This decomposes to form* ammonia. Both of these reactions are catalysed by enzymes.

(i) Complete the following equation.

$$(NH_4)_2CO_3 \rightarrow CO_2 + \ldots NH_3 + \ldots\ldots$$ [2]

(ii) How could you test for ammonium ions?

Reagent .....

Result of test ..... [2]

(iii) Ammonia reacts with water to form an alkaline solution. Water behaves as an acid and loses particles to the base, ammonia.

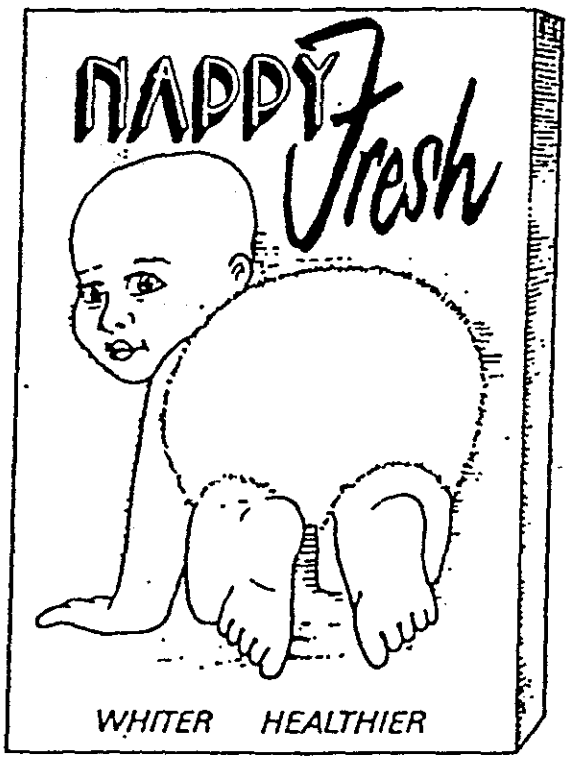
What is the name of these particles?

..... [1]

(iv) Other reactions are catalysed by enzymes. What is the reaction that is catalysed by enzymes from yeast?

..... [1]

(b) "Nappyfresh" is used to soak dirty nappies.



It contains the salts sodium chloride and sodium peroxodisulphate.

When dissolved in water, "Nappyfresh" slowly releases chlorine. The peroxodisulphate oxidises chloride ions to chlorine molecules.

(i) Why are dirty nappies soaked in "Nappyfresh" 'whiter' and 'healthier'?

.....

..... [2]

(ii) If a solution of "Nappyfresh" was added to aqueous potassium iodide, what would be observed? Explain the chemistry of the reaction.

Observation .....

Explanation .....

..... [2]

(iii) Suggest another way of oxidising chloride ions.

..... [1]

(c) Sodium peroxodisulphate contains 19.3% of sodium and 26.9% of sulphur, by mass. The only other element present is oxygen.

(i) What is the percentage of oxygen, by mass?

..... [1]

(ii) Complete the following to calculate how many moles of each element are present in 100 g of the compound.

Number of moles of sodium = 19.3/23 = 0.84

Number of moles of sulphur =

Number of moles of oxygen = [2]

(iii) What is the empirical formula of sodium peroxodisulphate?

..... [1]

(iv) The mass of one mole of sodium peroxodisulphate is 238 g.

What is the formula of sodium peroxodisulphate?

..... [1]

5 Zinc has been used for over two thousand years. The major ore is zinc blende, ZnS, which is mined in Canada, the USA and Australia.

(a) (i) Describe how zinc is extracted from zinc blende.

.....

.....

..... [3]

(ii) Sulphur dioxide is formed during this extraction. Sulphur dioxide is used to preserve food.

Why does it slow down the rate at which food goes 'bad'?

..... [1]

(b) Pure zinc can be obtained by the electrolysis of aqueous zinc sulphate. This solution is made from impure zinc oxide. Impurities in the solution include iron(II) sulphate, copper(II) sulphate and cobalt(II) sulphate.

(i) Describe how a solution of zinc sulphate could be made from the insoluble compound zinc oxide.

.....

.....

..... [3]

(ii) Manganese(IV) oxide, with a base, changes the aqueous iron(II) sulphate into iron(III) hydroxide.

What is the colour of iron(III) hydroxide and how could it be separated from the solution?

Colour of iron(III) hydroxide .....

Method of separation ..... [2]

(iii) Powdered zinc is now added to remove the other metals, leaving only zinc sulphate in solution.

Explain how zinc removes the other metals from solution.

.....

..... [2]

(iv) During the electrolysis, zinc and oxygen are formed at the electrodes.

What remains in the solution?

..... [1]

(c) An important use of zinc is in the manufacture of batteries.

(i) Why are batteries needed?

..... [1]

(ii) Describe how to find the order of reactivity of copper, silver and zinc by measuring the voltage of suitable cells.

.....

.....

..... [3]

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

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **19 MAY 1994** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME *1 hour 15 minutes*

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use your calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

1 Arsenic was first isolated by Albertus Magnus in 1220. This element is in Group V of the Periodic Table. It has the electron structure (configuration) of 2,8,18,5.

(a) Arsenic can be made by the reaction between arsenic(III) oxide, As_2O_3, and carbon.

(i) Balance the equation:

As_2O_3 + ... C ⟶ ..... As + ... CO [1]

(ii) In the reaction, which chemical is the oxidising agent?

..... [1]

(iii) In the reaction, which chemical is reduced?

..... [1]

(b) The following is an extract from an article on arsenic:

Arsenic has only one stable isotope, nucleon(mass) number 75. One of the crystalline forms of arsenic looks like a metal but does not behave as one.

(i) What is meant by the term *isotope?*

.....

..... [2]

(ii) Suggest two properties of arsenic from "*arsenic looks like a metal but does not behave as one*".

.....

..... [2]

(c) Arsenic(III) oxide, a white powder, is very poisonous. It was probably used to kill Pope Pius III in the 15th century. The lethal dose is 0.130 g.

(i) How many lethal doses are there in 1.04 g of this oxide?

..... [1]

(ii) Arsenic(III) oxide is amphoteric.

State how it would react, if at all, with sodium hydroxide and with hydrochloric acid.

with sodium hydroxide;

.....

with hydrochloric acid.

..... [2]

(d) (i) Arsenic reacts with gallium, which is in Group III, to form the compound gallium arsenide.

Deduce the formula of gallium arsenide.

..... [1]

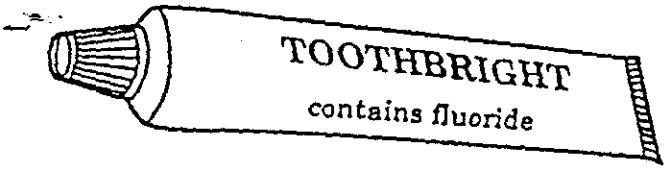
(e) Arsenic trichloride is a covalent compound.

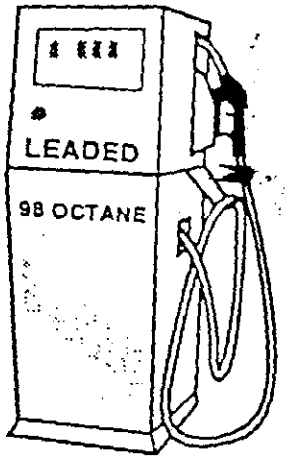
Draw a diagram showing the arrangement of valency electrons in one molecule of the compound.

Use x to represent an electron from arsenic. Use o to represent an electron from chlorine.

27 [3]

2 The elements in Group VII are called halogens. Compounds of the halogens are found in familiar substances.





(a) Complete the passage:

At room temperature and pressure, fluorine is a pale yellow ..... . A fluorine molecule is diatomic. This means that each molecule contains .... The number of occupied electron shells in a fluorine atom is ..... . The outer shell contains ..... valency electrons. [4]

(b) (i) Deduce the formula of oxygen fluoride.

..... [1]

(ii) A compound in toothpaste contains only the ions Na^+, PO_3^- and F^-. What is its simplest formula?

..... [1]

(c) The world's largest plant to extract bromine from sea water is in Britain. Chlorine is bubbled through acidified sea water. Bromine is formed.

(i) How is chlorine manufactured from concentrated aqueous sodium chloride?

.....

..... [2]

(ii) Combine the following equations to write the overall ionic equation for the reaction between chlorine molecules and bromide ions.

$Cl_2 + 2e^- \longrightarrow 2Cl^-$

$2Br^- - 2e^- \longrightarrow Br_2$

(iii) Bromine reacts with water.

$$Br_2 + H_2O \rightleftharpoons Br^- + BrO^- + 2H^+$$

To increase the yield of bromine, the pH of the sea water is adjusted to 3.5 by the addition of sulphuric acid.

Explain why a low pH increases the yield of bromine.

.....

.....

..... [3]

(d) Bromine is used to make 1,2-dibromoethane. This is an additive in leaded petrol.

(i) Name the compound that reacts with bromine to form 1,2-dibromoethane.

..... [1]

(ii) Draw the structure of 1,2-dibromoethane.

[1]

(e) 1,2-Dibromoethane reacts with sodium hydroxide to form a compound that has the composition by mass:

carbon, 38.7%; hydrogen, 9.7%; oxygen, 51.6%.

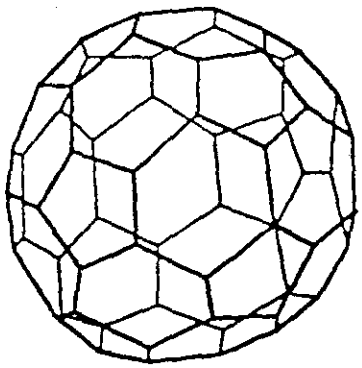
(i) Calculate its empirical formula

Empirical formula ..... [2]

(ii) The relative molecular mass of the compound is 62. What is its molecular formula?

..... [1]

3 (a) Fullerenes are newly discovered crystalline forms of carbon. The structure of one of them is shown below.



(i) Name **two** other crystalline forms of carbon.

..... [2]

(ii) Fullerenes dissolve in hydrocarbons. The other solid forms of carbon do not dissolve.

Soot is a mixture of fullerenes and other solid forms of carbon.

Describe how you could obtain crystals of fullerenes from soot.

.....

.....

..... [3]

(iii) *One of the fullerenes has a relative molecular mass of 720.*

How many carbon atoms are there in one molecule of this fullerene?

Number of carbon atoms is ..... [1]

(b) A mixture of a solid fullerene and potassium metal is an excellent conductor of electricity.

(i) Explain why metals are good conductors of electricity.

.....

..... [2]

(ii) What other form of solid carbon is a good conductor of electricity?

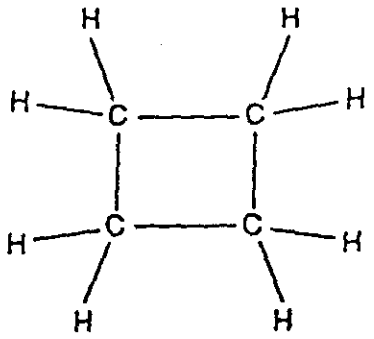
..... [1]

(iii) The mixture of fullerene and potassium has to be stored out of contact with air.

Name **two** substances in the air that react with potassium.

..... [2]

(c) Fullerenes have a ring structure as does cyclobutane.



(i) What is the molecular formula of cyclobutane?

..... [1]

(ii) Some of the isomers of cyclobutane are unsaturated hydrocarbons. Give the name and draw the structure of one of these isomers.

Name .....

Structure

[2]

(d) Unsaturated hydrocarbons take part in addition reactions.

(i) Write a word equation for the reaction between propene and hydrogen.

..... [1]

(ii) Write a symbol equation for the reaction between propene and steam.

..... [2]

4 An important polymer is poly(acrylonitrile). The world consumption for this polymer has increased from 0.2 million tonnes in 1960 to 3.8 million tonnes in 1990. Its principal use is as a fibre for clothes and bedding.

It is made by the polymerisation of acrylonitrile, $CH_2=CH-CN$.

Acrylonitrile is made by the reaction:

$$2CH_3-CH=CH_2 + 2NH_3 + 3O_2 \longrightarrow 2CH_2=CH-CN + 6H_2O$$

(a) Propene is made from the naphtha fraction of hydrocarbons in petroleum. The naphtha fraction is heated in the absence of air.

$$C_{10}H_{22} \longrightarrow 2C_3H_6 + \text{hydrocarbon } X$$

(i) What technique is used to obtain the naphtha fraction from petroleum?

..... [1]

(ii) Give the name and structure of hydrocarbon *X*.

Name .....

Structure

[2]

(iii) What is the name given to this process of decomposing alkanes to make alkenes?

..... [1]

(b) State *briefly* how oxygen is obtained from air.

.....

..... [2]

(c) The addition polymerisation of acrylonitrile forms poly(acrylonitrile).

Draw the structure of poly(acrylonitrile).

[2]

(d) The addition polymerisation of propene forms a different polymer.

(i) Name the polymer manufactured from propene by addition polymerisation.

..... [1]

(ii) Suggest a use for this polymer.

..... [1]

(e) Synthetic macromolecules have partially replaced natural products, such as the carbohydrate cotton, for bedding.

(i) Explain what is meant by the term *carbohydrate*.

.....

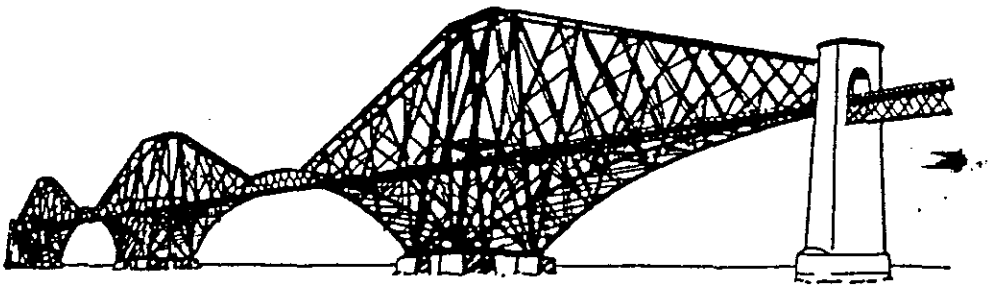
..... [2]

(ii) Why does the disposal, as rubbish, of a cotton sheet cause fewer environmental problems than the disposal of a poly(acrylonitrile) sheet?

.....

.....

5 In 1880, a railway bridge was built across the Firth of Forth in Scotland. To prevent the steel bridge from rusting, it has been necessary to paint it ever since. When a road bridge was built in 1964, the steel girders were galvanised by spraying with molten zinc. This reduced the cost of maintaining the bridge.



(a) Zinc ores are zinc blende (ZnS), calamine ($ZnCO_3$) and marmatite (ZnFeS). Countries that mine these ores include Peru and Canada.

(i) Which ore has the highest percentage by mass of zinc? Explain your choice.

.....

..... [2]

(ii) Describe how zinc is extracted from zinc blende.

.....

.....

..... [3]

(b) One of the products of this extraction is sulphur dioxide. This is used to make sulphuric acid. Most of the acid is neutralised to form ammonium sulphate.

(i) What is the main use of ammonium sulphate?

..... [1]

(ii) Complete the passage:

The neutralisation of an acid involves the transfer of protons. Compounds that can accept protons from acids are called ..... .

To make ammonium sulphate, sulphuric acid would need to react with the chemical ..... . [2]

(c) Half of the zinc extracted is used for galvanising. What is another use of zinc?

..... [1]

(d) When zinc metal is added to aqueous copper chloride, copper metal and zinc chloride are formed.

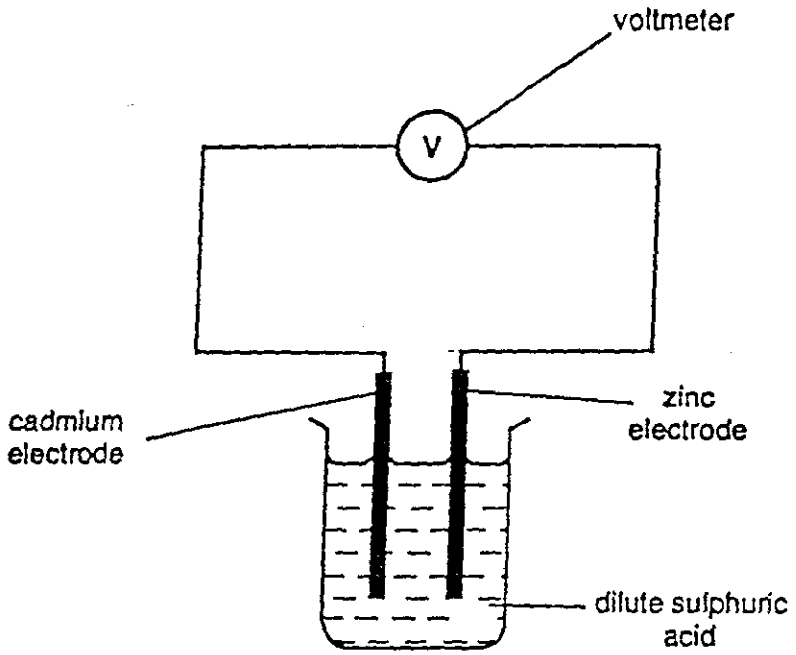
(i) Explain the difference in reactivity between copper and zinc in terms of the tendency of metallic atoms to form aqueous ions.

.....

.....

..... [3]

(ii) How could the simple cell shown below be used to find out if zinc is more reactive than cadmium?



.....

..... [2]

(e) The reactivity of a metal influences the chemistry of its compounds, for example how easily they are decomposed.

Write word equations to describe the action of heat on

(i) sodium nitrate ⟶ ..... + ...

(ii) zinc nitrate ⟶ ..... + ...

+ .....

[3]

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	163 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
190-103 Actinoid series

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

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

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Tuesday 15 NOVEMBER 1994 Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer all questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

Mathematical tables are available.

You may use your calculator.

A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

1 An extract from a magazine highlights how much energy can be saved by recycling:

ENERGY SAVED BY RECYCLING

material	*energy needed for original production, in* GJ/tonne	*energy saved by recycling* percentage %
aluminium	*250*	*95*
plastics	*100*	*88*
paper	*30*	*35*
glass	*16*	*5*

1 GJ = *1000 million joules*

To produce one tonne of paper from wood pulp requires 30 GJ *of energy. To make one tonne of paper recycling saves* 30 × 35/100 = 10.5 GJ.

(a) Very large savings of energy can be made by recycling aluminium.

(I) How much energy is needed to produce one tonne of aluminium by recycling?

..... [2]

(Ii) Describe how aluminium is extracted from pure aluminium oxide.

.....

.....

.....

.....

..... [4]

(III) Use the answer to (a) (II) to explain why recycling saves so much energy.

..... [1]

(iv) Most metals need some surface coating (for example, paint) to prevent corrosion.

Explain why aluminium does not need this protection.

..... [1]

(b) Glass is made from sodium carbonate, calcium carbonate and sand. Energy is supplied and the chemicals react to form a mixture of metal silicates. This is glass.

(i) What type of reaction takes place when glass is made?

..... [1]

(ii) Complete the equation:

$$CaCO_3 + SiO_2 \longrightarrow CaSiO_3 + \ldots\ldots\ldots\ldots$$ [1]

(c) Sand is silicon(IV) oxide (silicon dioxide). It has a macromolecular structure. Carbon dioxide has a molecular structure.

(i) Name a substance that has a similar structure to that of silicon(IV) oxide.

..... [1]

(ii) Give a difference in physical properties between silicon(IV) oxide and carbon dioxide.

..... [1]

(iii) Show the arrangement of valency electrons in a molecule of carbon dioxide by completing the diagram.

Use × to represent an electron from carbon.
Use ○ to represent an electron from oxygen.

O C O

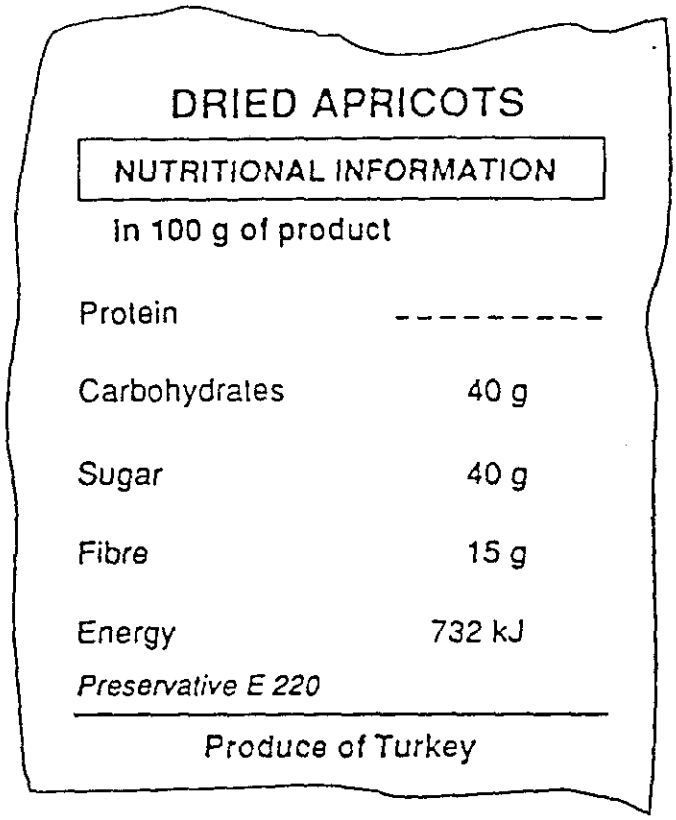
[2]

(iv) In the structure of silicon(IV) oxide:

how many oxygen atoms are there around each silicon atom; .....

how many silicon atoms are there around each oxygen atom? ..... [2]

2 The diagram shows the nutritional information on a packet of dried apricots.



(a) (I) Which one of the three main constituents of food is not listed?

..... [1]

(II) How much protein is there in 100 g of the dried apricots?

..... [1]

(b) Preservative E220 is sulphur dioxide.

(I) How does it preserve food?

..... [1]

(II) Sulphur dioxide can be made by burning sulphur in air.

Name a source of sulphur.

..... [1]

(III) Why is sulphur dioxide used in the manufacture of wood pulp?

..... [1]

(c) As part of her project, a pupil was studying dried apricots. She found out that sulphur dioxide would react with water to form sulphurous acid.

$$SO_2 + H_2O \rightarrow H_2SO_3$$

She left the dried apricots in water for several hours to extract the sulphur dioxide. The resulting solution of sulphurous acid was used for the following tests.

(I) Sulphurous acid is a reducing agent.

What would be observed on adding a few drops of aqueous potassium manganate(VII) to sulphurous acid?

..... [2]

(II) She added hydrogen peroxide to the sulphurous acid and then tested for a sulphate. The test was positive.

Describe the test for a sulphate.

Reagent ..... [1]

Result ..... [2]

(III) The hydrogen peroxide oxidised sulphurous acid, a weak acid, to sulphuric acid, a strong acid.

Explain each of the following:

acid ..... [2]

weak acid ..... [1]

strong acid ..... [1]

(d) The second part of the project was to identify some of the sugars present in the apricots.

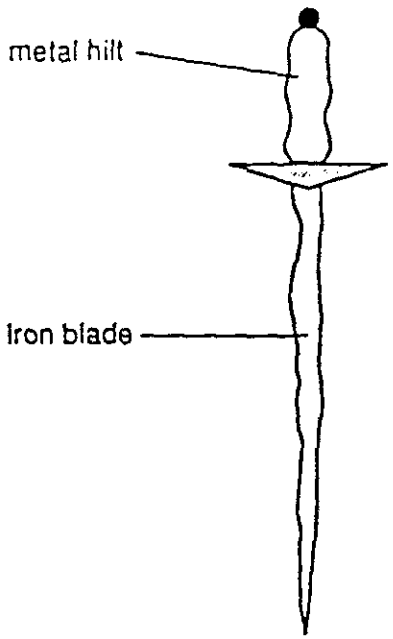
The apricots were ground with a mixture of water and ethanol. The sugars dissolved in this solvent.

Describe how you could separate and identify the sugars, which are colourless.

.....

..... [2]

3 (a) An all-metal Viking sword was discovered.



The hilt was not corroded. The iron blade was badly rusted, especially near the hilt.

(i) Name a metallic element that does not corrode.

..... [1]

(ii) Suggest a reason why the rusting was greatest near the hilt.

.....

..... [1]

(iii) A modern sword blade would be made out of an alloy of iron that does not corrode. What is the name of this alloy and what two other elements are in it?

Name of alloy ..... [1]

Names of other elements ..... [2]

(b) Metals are malleable and can be beaten into the shape of a sword. Why are metals malleable?

.....

..... [2]

(c) To find out if iron was more reactive than tin the following experiment was carried out:

The surface of a piece of iron was cleaned. The iron was added to aqueous tin(II) chloride and left for a few minutes. If iron is more reactive than tin, there would be deposits of tin on the surface of the iron.

This experiment could be repeated with different metals. The results of these experiments are given in the table below.

aqueous solution	iron	tin	scandium	mercury
iron(II) chloride		✗	✓	✗
tin(II) chloride	✓		✓	✗
scandium chloride	✗	✗		✗
mercury(II) chloride	✓	.....	✓	

✓ = reaction occurred
✗ = no reaction

(I) Complete the table. [1]

(II) What is the order of reactivity of the four metals?

1 (Most reactive) .....

2 .....

3 .....

4 (Least reactive) ..... [2]

(III) Write a symbol equation for the reaction between scandium atoms and tin(II) ions. A scandium ion has a charge of 3+.

..... [2]

(d) To analyse an alloy of gold, a small amount of it was added to concentrated nitric acid. All the metals in the alloy except gold reacted and formed their nitrates. The mixture was diluted and then filtered.

Separate portions of the filtrate were tested as follows.

Test 1 Aqueous potassium chloride was added to the filtrate. A white precipitate formed.

Test 2 An excess of aqueous ammonia was gradually added to the filtrate. A blue precipitate formed at first; it re-dissolved to leave a deep blue solution.

(i) The alloy contains gold and two other metals. What two other metals could be in the alloy?

..... [2]

(ii) What measurements would be needed to calculate the percentage of gold in the alloy?

.....

..... [2]

4 Hydrogen and bromine react to form hydrogen bromide.

$$H_2 + Br_2 \longrightarrow 2HBr$$

(a) When a reaction takes place, chemical bonds are broken and new chemical bonds are formed.

To break a chemical bond, energy has to be supplied; this is represented by +.

When a chemical bond forms, energy is given out; this is represented by −.

(i) Insert the missing signs and the missing value in the table below.

Energy to break H–H	=	+ 436 kJ
Energy to break Br–Br	=	...190 kJ
Energy to make H–Br	=	...366 kJ
Energy to make H–Br	=	..... kJ

[3]

(ii) Calculate the overall energy change for this reaction.

..... [1]

(iii) Is the overall reaction exothermic or endothermic?

..... [1]

(b) Bromine reacts with alkanes in a similar way to chlorine. Hydrogen bromide is made in the substitution reaction between propane and bromine.

PROPANE + BROMINE ⟶ BROMOPROPANE + HYDROGEN BROMIDE

(I) Draw the structure of propane.

[1]

(II) Draw the structure of a bromopropane.

[1]

(III) The reaction between propane and bromine is *photochemical.*

Suggest what is meant by *photochemical.*

.....

..... [2]

(c) A preparation of the insoluble compound lead(II) bromide is described below.

To 10 cm^3 of aqueous lead(II) nitrate, 20 cm^3 of aqueous potassium bromide was added. The concentration of each of these solutions was 1.00 mol/dm^3. The mixture was filtered and the precipitate was washed with water. Finally, the solid was dried in an oven.

(I) Complete the ionic equation.

$$Pb^{2+} + ...Br^- \longrightarrow .....$$ [2]

(II) Explain why the volume of aqueous potassium bromide used was double that of the aqueous lead(II) nitrate.

.....

..... [1]

(III) Why was it necessary to 'filter and wash'?

.....

..... [2]

(d) In the experiment, 0.010 mol of lead(II) nitrate was used and 2.21 g of lead(II) bromide were produced.

Calculate the percentage yield of lead(II) bromide.

.....

.....

..... [3]

5 The table shows some of the elements needed by green plants.

element	*taken up by plant as*	*use*
nitrogen	NO_3^- or NH_4^+	to make amino acids and proteins
magnesium	Mg^{2+}	part of chlorophyll molecule
sulphur	SO_4^{2-}	to make protein containing sulphur
potassium	K^+	making enzymes

(a) (I) What element, essential for plant growth, is not mentioned in the table?

..... [1]

(II) Why is chlorophyll essential for the growth of green plants?

.....

.....

..... [3]

(III) What are *enzymes*?

..... [1]

(b) When plant material is burnt, an alkaline ash is formed. In Africa, a useful product was made by heating a mixture of plant ash, animal fat and water.

(I) What type of reaction occurs between the alkali from the ash and the ester linkage in the fat?

..... [1]

(II) From your answer to (I), give the common name of the product.

..... [1]

(c) A shortage of the sulphate ion in plants causes chlorosis, a yellowing of the leaves. In industrial countries, this yellowing is not observed due to atmospheric pollution.

Suggest an explanation.

.....

.....

..... [3]

(d) Nitrogen is needed for the synthesis of amino acids and vegetable proteins.

(I) How can vegetable protein be broken down in to its constituent amino acids?

.....

..... [2]

(II) What is the name of the linkage common to both proteins and nylon?

..... [1]

(III) What difference in structure is there between protein and nylon?

.....

..... [2]

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
190-103 Actinoid series

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

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

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **18 MAY 1995** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

MFK (5059) QF53718

[Turn over

For Examiner's Use

1 Nickel is a transition element in the fourth period of the Periodic Table.

(a) Potassium and nickel are both metals.

(i) Give **one** property possessed by both metals.

.....[1]

(ii) Describe **two** differences in the properties of these metals.

.....

.....[2]

(b) Nickel was first isolated in 1751 in Sweden. Large amounts of nickel are now extracted in Canada. Nickel ore is heated in air to give nickel oxide. This is reduced to impure nickel by heating with carbon.

(i) Complete the equation

..... NiO + C → ..... + ... [1]

(ii) Carbon is the reducing agent.

Suggest **two** other chemicals that could reduce nickel oxide to nickel.

..... and .....[2]

(c) One way of refining nickel is to react the impure metal with carbon monoxide. Only nickel reacts with the carbon monoxide and forms a volatile compound, nickel carbonyl. This can be decomposed to give pure nickel and carbon monoxide.

(i) Suggest how nickel carbonyl might be decomposed.

.....[1]

(ii) What type is the reaction between nickel and carbon monoxide?

.....[1]

(iii) What is meant by *volatile*?

.....[1]

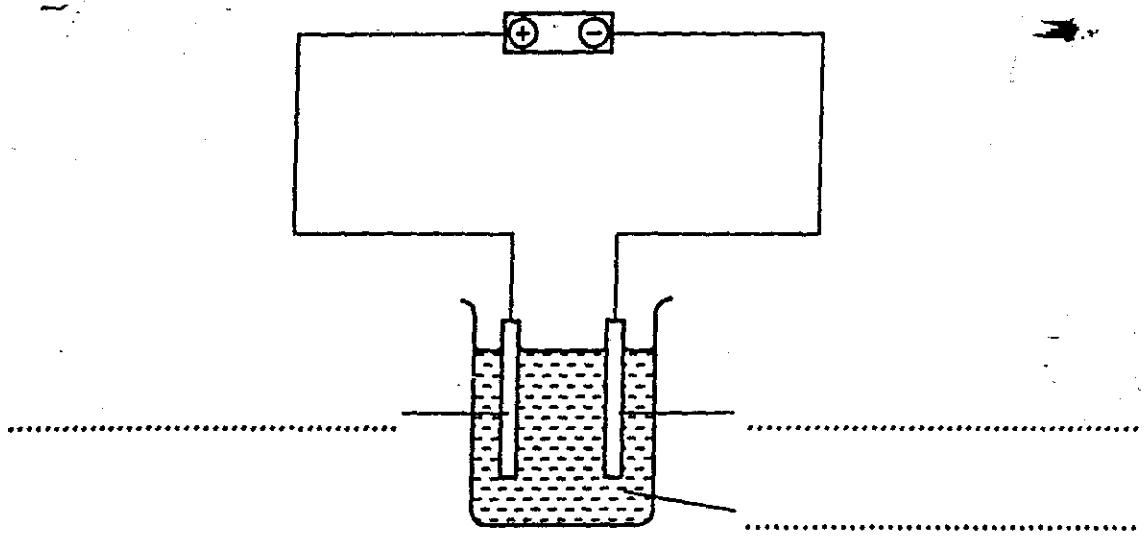
(iv) Explain how this method separates nickel from the impurities.

.....

.....[2]

(d) Like copper, nickel can be refined by electrolysis.

Label the diagram to show the purification of nickel in the laboratory.



[3]

(e) Nickel carbonyl has a formula of the type $Ni(CO)_n$.

Its relative molecular mass is 171.

Calculate the value of *n*.

[2]

2 The Kinetic Theory is important in Science. It links properties that can be seen or measured with the arrangement and movement of particles.

(a) Glass has the properties of a solid but the structure of a liquid.

Think of the usual links between properties and structure and complete the table below.

	properties	*arrangement and movement of particles*
solid	fixed shape and fixed volume	
liquid	fixed volume and takes the shape of the container	

[4]

(b) When a solid is heated, it melts.

(i) Use the ideas of the Kinetic Theory to explain why a solid melts when it is heated.

.....

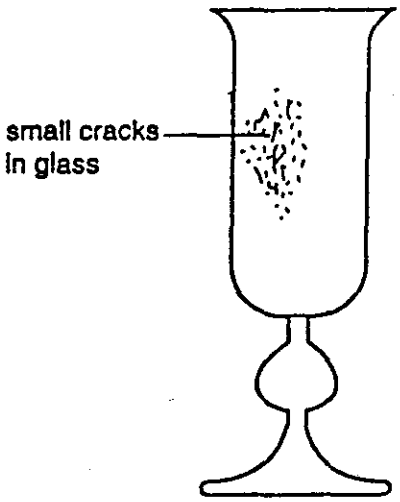
.....[1]

(ii) How does the melting point show if a solid is pure or impure?

.....

.....[2]

(c) In the Victoria and Albert museum in London, 17th century glasses are going opaque because small cracks are forming in the surface of the glass.



Glass is composed of silicon(IV) oxide and alkaline metal oxides, particularly sodium oxide.

(i) The cracks are caused by the diffusion of sodium ions to the surface and of hydrogen ions away from the surface.

What is *diffusion*?

.....

..... [2]

(ii) Explain why sodium and hydrogen ions do not diffuse at the same rate.

.....

..... [2]

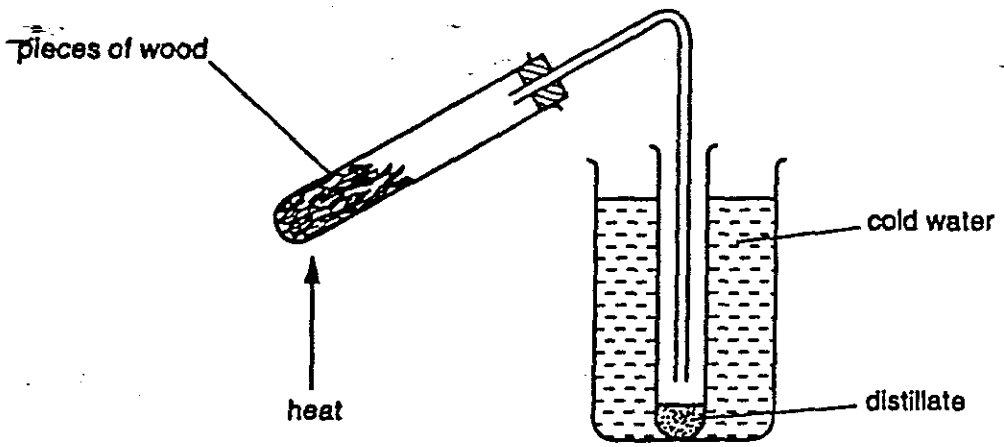
(iii) Describe a chemical test that would distinguish between sodium oxide and silicon(IV) oxide.

test .....

result ..... [2]

(d) Draw a diagram to show the arrangement of the valency electrons, the charges on the ions and the formula, for the ionic compound sodium oxide.

3 Methanol was made by heating wood in the absence of air. The carbon compounds in wood decompose to form a mixture of simpler compounds. These are collected as a distillate.



The distillate contains:

ethanoic acid
propanone
ethanal
methanol
and other chemicals

Methanol can be separated from this mixture.

(a) Describe how carbon compounds are made in plants by photosynthesis.

.....

.....

..... [3]

(b) The first step in this separation of methanol is the addition of calcium hydroxide, which is made from limestone.

(i) Calcium hydroxide is prepared from limestone in two stages. Write a word equation for each stage.

.....

..... [2]

(ii) Give two other large-scale uses of limestone.

.....

..... [2]

(c) The ethanoic acid is neutralised by the calcium hydroxide.

Name the salt formed in this neutralisation.

.....[1]

(d) Ethanal has a low boiling point and can be removed by warming. Its composition by mass is:

carbon 54.5%; hydrogen 9.1%; oxygen 36.4%.

Calculate the empirical formula of ethanal.

[2]

(e) Another compound in the distillate has the molecular formula C_3H_6O. This liquid reacts with ethanoic acid to form an ester.

(i) Write the name and formula of an ester.

.....[2]

(ii) What type of organic compound forms esters with carboxylic acids?

.....[1]

(iii) The liquid turns aqueous bromine from brown to colourless.

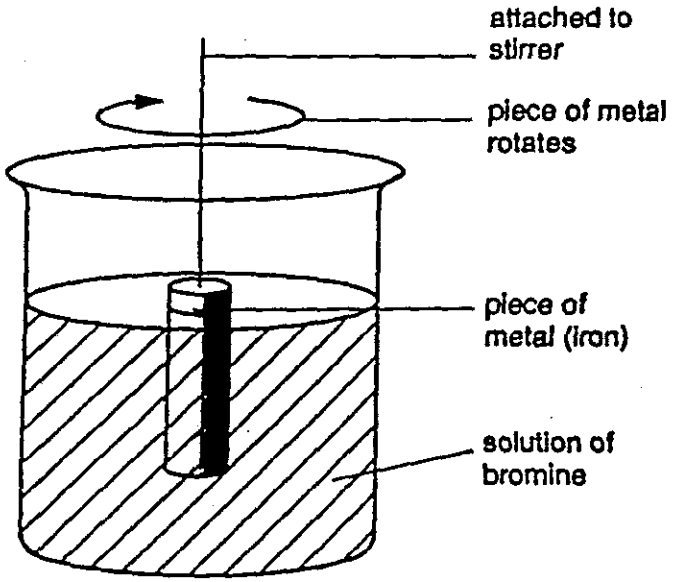
What functional group does this test show?

.....[1]

(iv) Use your answers to parts (e)(ii) and (iii) to give a structural formula of a compound having the molecular formula C_3H_6O.

[2]

4 The rate of reaction between a metal and bromine can be studied using the apparatus shown below.



A piece of metal, for example iron, was weighed and placed in the solution as shown above. The metal was removed at regular intervals and each time it was washed, dried and weighed. It was then replaced in the solution and the reaction continued.

From the results (mass of metal and time), the rate of the reaction can be calculated.

(a) (i) How would the rate change if more of the piece of metal was in the solution? Explain your answer.

.....

..... [2]

(ii) The experiment was conducted using different solutions of bromine. The following results were obtained.

concentration of bromine solution	*rate*
0.05 mol/dm^3	10 mg/min
0.1 mol/dm^3	20 mg/min

Explain the change in rate.

.....

..... [2]

(b) In a reaction between a solid and a solution, the rate may depend on the speed of stirring.

Describe how you could find out if the rate of the reaction between solid iron and bromine solution depends on the speed of stirring.

.....

.....

.....[3]

(c) Iron has two oxidation states so it can form two ions: Fe^{2+} and Fe^{3+}.

(i) How could you test a solution to find out which ion is present?

test .....

result for Fe^{2+} .....

result for Fe^{3+} .....[3]

(ii) Complete the ionic equation for the reaction that forms Fe^{2+}.

$$Fe + Br_2 \rightarrow \text{.....} + \text{.....}$$

[2]

(d) In the reaction between iron and bromine:

iron atoms change into iron ions;

bromine molecules change into bromide ions.

(i) Which of these changes is a reduction? Explain your choice.

.....

.....[2]

(ii) If iodine was used instead of bromine, predict how the rate of the reaction would change: increase, decrease or stay the same. Give a reason for your answer.

.....

.....[2]

5 Sulphuric acid is made by the Contact Process. The annual production in the U.K. is 3.5 million tonnes. The manufacture of fertilisers is the largest use for the acid.

In this process, sulphur dioxide is oxidised to sulphur trioxide, which is converted into sulphuric acid.

Most of the sulphur dioxide is made from the element sulphur, the rest is a by-product of the extraction of zinc.

(a) (i) What is one source of the element sulphur?

.....[1]

(ii) Write a symbol equation for the reversible reaction between sulphur dioxide and oxygen.

.....[2]

(iii) Name the catalyst used in the Contact Process.

.....[1]

(iv) Describe how sulphur trioxide is converted into concentrated sulphuric acid.

.....

.....[2]

(b) An important ore is zinc blende, ZnS.

Describe how zinc is extracted from this ore.

.....

.....

.....[3]

(c) Rock phosphate is mined in North Africa. It is insoluble in water and must be changed into a more soluble phosphate for use in fertilisers. Sulphuric acid changes rock phosphate into superphosphate.

$$Ca_3(PO_4)_2 + 2H_2SO_4 \rightarrow Ca(H_2PO_4)_2 + 2CaSO_4$$

(i) Use the above equation to deduce the charge on the phosphate ion.

.....[1]

(ii) Why must the chemicals in fertilisers be soluble in water?

.....[1]

(iii) The phosphate ion is behaving as a base in this reaction.

What is a *base*?

.....[2]

(iv) What other fertiliser is made using sulphuric acid?

.....[1]

(d) Sulphuric acid is used to make the monomer, $H_2N(CH_2)_5CO_2H$ from petroleum. This monomer polymerises to make a nylon. Draw the structure of this monomer.

[2]

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 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.)

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Tuesday **14 NOVEMBER 1995** Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use your calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

1 The following is an extract from an article on zirconium:

Zirconium is a hard silvery metal. It is extracted from the ore zircon, $ZrSiO_4$. Zirconium is used to make alloys for nuclear reactors and for magnets.

(a) (i) How many elements are there in zircon?

.....[1]

(ii) Why are alloys often used instead of pure metals?

.....[1]

(iii) Pure metals have a lattice of identical positive ions.

Draw a diagram to show the arrangement of ions in an alloy.

[2]

(b) Zirconium is used in nuclear reactors because it does not 'capture' neutrons.

(i) Which isotope of a different element is used as a fuel in nuclear reactors?

.....[2]

(ii) Nuclear reactors can be used to make radioactive isotopes.

State an industrial use of a radioactive isotope.

.....[1]

(c) In the extraction of zirconium, zircon is changed into zirconium(IV) chloride. This is reduced to impure zirconium by heating with magnesium.

(i) Which is the more reactive – zirconium or magnesium?

Explain your choice.

.....

.....

.....[2]

(ii) The impure zirconium is heated with iodine to form zirconium(IV) iodide (ZrI_4). When this is heated to a higher temperature it splits up to produce pure zirconium and iodine.

Write a single equation that shows both of these reactions occurring.

.....[2]

(d) Zirconium(IV) oxide has macromolecular structure and is a basic oxide. Silicon(IV) oxide is also macromolecular, but it is an acidic oxide.

(i) State two physical properties common to both oxides.

.....

.....[2]

(ii) Suggest a chemical test that could be used to distinguish between these oxides.

reagent .....

result with silicon(IV) oxide .....

result with zirconium(IV) oxide .....

.....[3]

2 The world reserves of natural gas are greater than those of petroleum. Some of the largest reserves are in remote areas, such as Siberia, and the cost of transporting natural gas is high. Research is being carried out on ways of converting methane into higher hydrocarbons and methanol, which are more easily transported.

(a) Suggest a reason why higher hydrocarbons and methanol are easier and cheaper to transport than methane.

.....[1]

(b) Methane can be converted into a waxy, high boiling point hydrocarbon mixture.

(i) State one use of petroleum waxes.

.....[1]

(ii) Name the process used to break down large hydrocarbon molecules into a mixture of simpler hydrocarbons.

.....[1]

(iii) How is this mixture of hydrocarbons separated into more useful components?

.....[1]

(c) Reactions between methane and oxygen are particularly important to the chemical industry. Under different conditions it is possible to obtain different products, examples include methanol and ethene by the following equations.

$$2CH_4 + O_2 \rightarrow 2CH_3OH$$
$$2CH_4 + O_2 \rightarrow C_2H_4 + 2H_2O$$

(i) Draw a diagram to describe the arrangement of the valency electrons in methanol.

Use o to represent an electron from carbon
Use x to represent an electron from hydrogen
Use ● to represent an electron from oxygen

[3]

(ii) Write the equation for the reaction between methane and oxygen to form ethane and water.

.....[2]

(iii) Both ethane and ethene can be made by a reaction of methane with oxygen, but more ethene than ethane is needed for the manufacture of chemicals.

Give the structural formula of two chemicals manufactured from ethene.

[2]

(d) The rate of the following reaction depends on temperature.

$$2CH_4 + O_2 \rightarrow C_2H_4 + 2H_2O$$

(i) Explain why the rate of the reaction is faster when a higher temperature is used.

.....

.....[2]

(ii) State two other ways of increasing the rate of this reaction.

.....

.....[2]

(e) Methane and air are used as raw materials in the Haber process for the manufacture of ammonia.

State the essential conditions in this process for the reaction between nitrogen and hydrogen.

.....

.....[2]

(f) A substance for feeding animals called 'pruteen' is made from methane, ammonia and air in the presence of micro-organisms.

Prediction:
Pruteen contains protein molecules. These molecules contain a number of different units held together by an amide linkage.

(i) If the prediction is correct, what type of compound is formed when 'pruteen' is hydrolysed?

.....[1]

(ii) Describe how the products of the hydrolysis of 'pruteen' could be separated and identified.

.....

.....

.....

.....[3]

(iii) Which man-made polymer contains units held together by the amide linkage?

.....[1]

3 The land between the rivers Euphrates and Tigris is one of the birthplaces of modern Chemistry. A ceramic jar, copper sheet and an iron rod, the remains of a 2000 year-old electrical cell, have been discovered in this area. In the same village, there was evidence of silver plating.

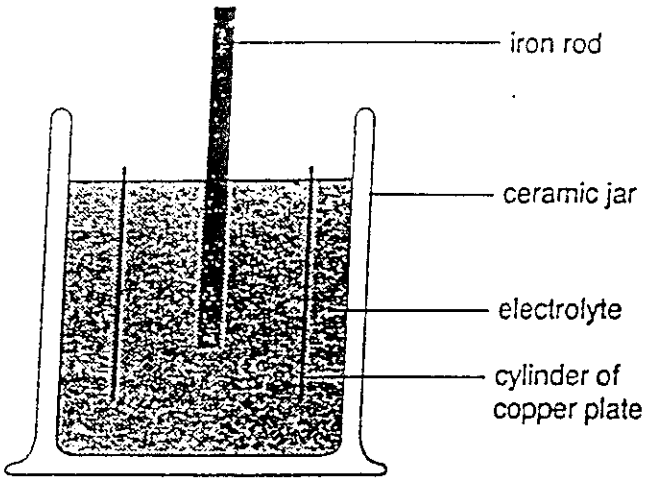


Fig. 3.1

Centuries later, but in the same area, sulphuric acid was made for the first time.

(a) It is thought that the electrolyte in the 2000 year-old cell was ethanoic acid, which had been made from the sugars in grape juice.

(i) Yeast was added to the grape juice and the solution gave off a gas. Name the two products of this reaction.

.....[2]

(ii) When the fermentation was complete, the mixture was left in the open container for several weeks. A solution of ethanoic acid was formed.

Explain how the ethanoic acid formed.

.....

.....[2]

(iii) Draw the structural formula of ethanoic acid.

[2]

(iv) Suggest why sulphuric acid is a better choice than ethanoic acid for the electrolyte.

.....

.....[2]

(b) (i) In the cell shown in Fig. 3.1, which metal, copper or iron, will lose electrons and go into solution as positive ions?

.....[1]

(ii) These electrons move to the other electrode. They combine with ions from the electrolyte to form a gas.

What is the gas formed?

.....[1]

(iii) The voltage of an iron/copper cell is about 0.8 volts.

Predict whether the voltage of a zinc/copper cell would be less, the same or bigger. Explain your answer.

.....

.....[2]

(c) To silver plate an article by electrolysis, the following arrangement could be used.

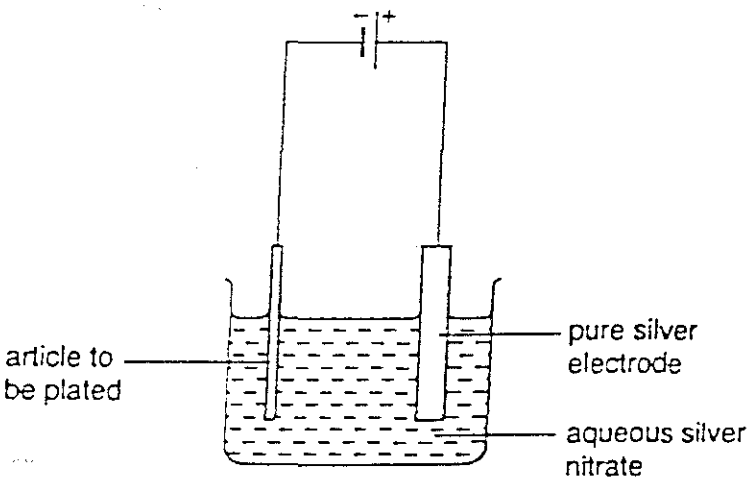


Fig. 3.2

(i) What would happen to the positive electrode (anode)?

.....[1]

(ii) The formula of a silver ion is Ag^+. Write an equation for the reaction at the negative electrode (cathode).

.....[1]

(d) Electricity from the mains is much cheaper than electricity from an electrical cell or battery. Why are batteries used?

.....[1]

(e) Electrical cells involve the transfer of electrical energy.

(i) Use one of the words 'exothermic' and 'endothermic' to complete the following sentence.

The chemical change in a cell is an .....reaction.

(ii) Explain your choice in (e) (i).

.....[2]

4 The ability to predict and to test the prediction by experiment are important parts of Science.

(a) The table shows the melting points and densities of some Group 1 elements.

element	Li	Na	K	Rb	Cs
mp / °C	181	98	64	.....	28
density in g/cm^3	0.53	0.97	0.86	1.53	.....

(i) Predict the melting point of rubidium.

.....[1]

(ii) Why is it more difficult to predict the density of caesium?

.....[1]

(iii) Construct the balanced equation for the reaction between caesium and cold water.

.....[2]

(iv) Suggest two observations that could be made if caesium is added to water.

.....

.....[2]

(b) It has been possible to make accurate predictions about the elements since Mendeleev constructed a Periodic Table.

An element **X** has five electrons in its outer shell.

(i) What is the formula of a chloride of **X**?

.....[1]

(ii) Would element **X** react with dilute hydrochloric acid to form a salt and hydrogen? Give a reason for your answer.

.....

.....[2]

(iii) A chloride of **X** is covalent. Predict two properties of this chloride of **X**.

.....

.....[2]

5 Originally compounds were given common names. In 1787, Guyton de Morveau introduced the idea that the name of compound should both describe its composition and suggest a method of preparation.

common name	*modern name*
Glauber' salts	sodium sulphate
Vitriol of Venus	copper(II) sulphate
Green vitriol	iron(II) sulphate

(a) Describe a laboratory preparation of crystals of copper(II) sulphate from sulphuric acid.

.....

.....

.....

.....

.....

.....[4]

(b) Sodium sulphate solution can be prepared from sulphuric acid and sodium hydroxide.

(i) Name the apparatus used and any additional chemical needed for this preparation.

apparatus .....

.....

additional chemical .....[3]

(ii) Why must a different experimental method be used to the one that should be used to make copper(II) sulphate?

.....

.....[2]

(c) Insoluble salts are made by precipitation. An equation for the preparation of barium sulphate is:

$$FeSO_4 + BaCl_2 \rightarrow BaSO_4 + FeCl_2$$

This reaction can be used in an experiment to find the value of x in the formula for hydrated iron(II) sulphate crystals:

$$FeSO_4 . xH_2O$$

A known mass of the crystals of hydrated iron(II) sulphate was dissolved in water. Excess barium chloride solution was added. The precipitate of barium sulphate was filtered, washed and dried. Finally it was weighed.

Mass of hydrated iron(II) sulphate crystals = 1.390 g
Mass of barium sulphate formed = 1.165 g

Complete this calculation to find x.

(i) The mass of one mole of $BaSO_4$ is 233 g.
How many moles of $BaSO_4$ were formed?

= .....

(ii) How many moles of the hydrated iron(II) salt were used in the experiment?

= .....

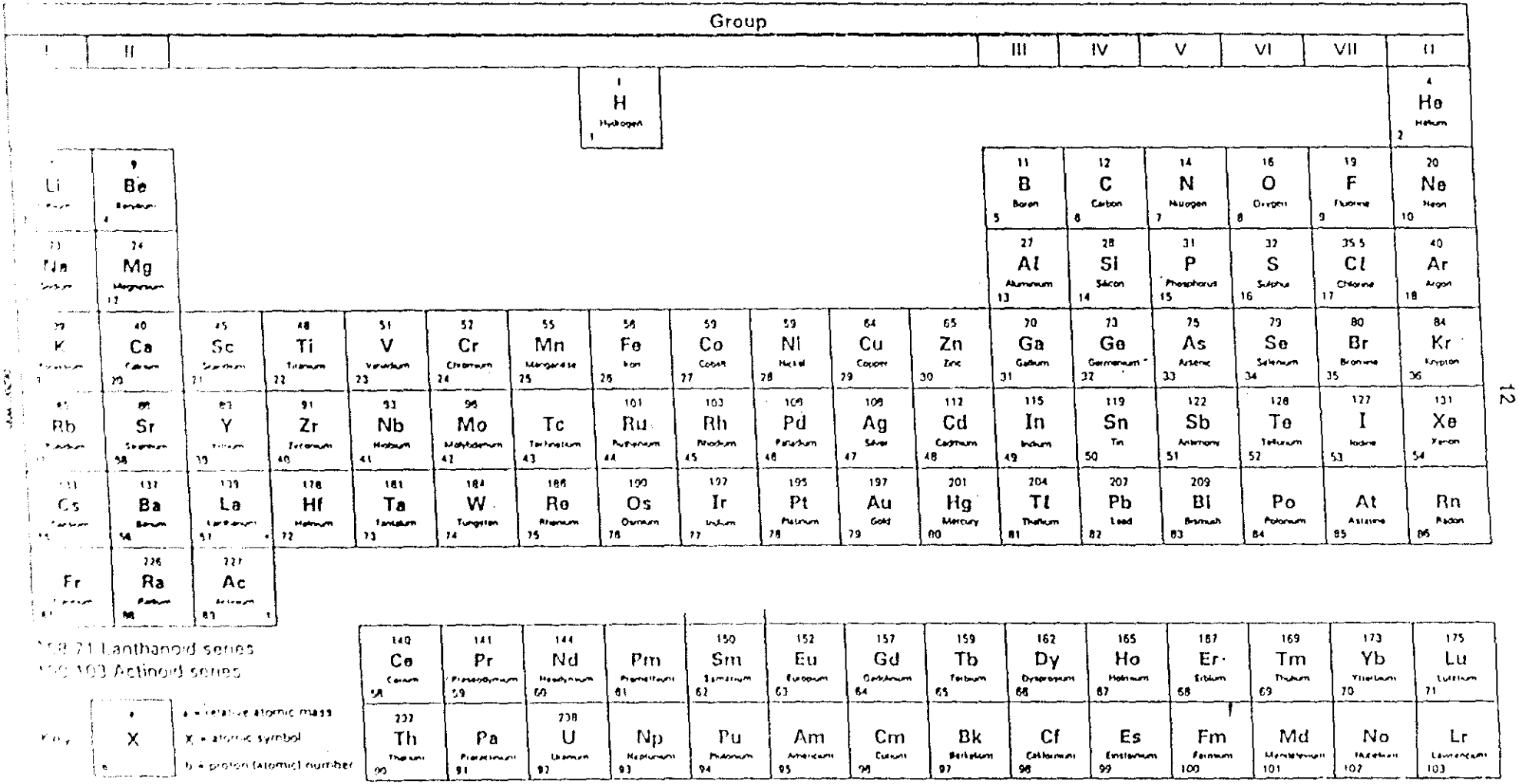
(iii) Calculate the mass of one mole of $FeSO_4 . xH_2O$

= .....g

(iv) The mass of one mole of $FeSO_4$ is 152 g. Calculate x.

x = ...
[5]

DATA SHEET
The Periodic Table of the Elements



The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **16 MAY 1996** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

1 Thallium is a metal in Group III of the Periodic Table.

(a) Thallium has valencies of 1 and 3. The electron distribution of a thallium atom is 2, 8, 18, 32, 18, 3.

(i) Predict the formulae of thallium(I) carbonate and of thallium(III) oxide. The formula of the carbonate ion is CO_3^{2-} and the formula of the oxide ion is O^{2-}.

thallium(I) carbonate .....

thallium(III) oxide ..... [2]

(ii) Thallium(III) fluoride is an ionic compound. Draw a diagram that shows the arrangement of the valency electrons in this compound.

Use x to represent an electron from thallium.
Use o to represent an electron from fluorine.

[3]

(b) Like silver chloride, thallium(I) chloride is sensitive to light. Suggest an explanation for the following observations.

Thallium(I) chloride is a white solid. In dim light it slowly darkens but in bright light rapidly goes black.

.....

.....

..... [2]

(c) Thallium(I) hydroxide has similar chemical properties to sodium hydroxide.

(i) Given 0.1 mol/dm^3 solutions of thallium(I) hydroxide and of ammonia, describe how you could show that thallium(I) hydroxide is the stronger base.

.....

.....

..... [3]

(ii) Complete the following word equation.

thallium(I) hydroxide + ammonium chloride → ..... + ... + water

[2]

(iii) Suggest how you could prepare in the laboratory a sample of the soluble salt thallium(I) sulphate from the soluble base thallium(I) hydroxide.

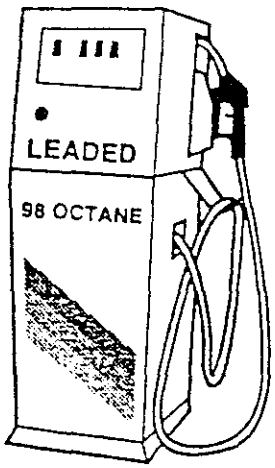
.....

.....

.....

..... [4]

2 In 1916 Thomas Midgley discovered that a lead compound would improve the combustion of fuel in petrol engines. This was the beginning of leaded petrol.



(a) Heptane is a constituent of petrol. Write the balanced equation for the complete combustion of heptane.

$$C_7H_{16} \quad + \quad O_2 \quad \rightarrow \quad +$$

[2]

(b) The lead compound is made from chloroethane and an alloy of sodium and lead. Chloroethane is one of the chemicals manufactured from ethene.

(i) Ethene is made from the naphtha fraction (C_4 to C_{10} alkanes) which is obtained from petroleum.

What is the name of the process used to make ethene?

..... [1]

What are the reaction conditions? .....

..... [2]

Complete the following equation for this process

$$C_7H_{16} \quad \rightarrow \quad 2C_2H_4 \quad + \quad .....$$

[1]

(ii) Name the compound that reacts with ethene in an addition reaction to give chloroethane.

..... [1]

(iii) Draw the structural formula of chloroethane.

[1]

(c) Chloroethane can also be made by a substitution reaction. What are the reagents and reaction conditions for this reaction?

reagents ..... [2]

conditions ..... [1]

(d) The lead compound used by Midgley can be represented by the formula $Pb(C_2H_5)_n$. It contains 64% by mass of lead.

(i) Calculate the composition by mass of 100 g of $Pb(C_2H_5)_n$ by the following steps.

Mass of lead in 100 g of the compound = 64 g

Mass of $(C_2H_5)_n$ in 100 g of the compound = ...g

(ii) The number of moles of Pb in 100 g of $Pb(C_2H_5)_n$ = ...

(iii) The mass of one mole of C_2H_5 = ...g

(iv) The number of moles of C_2H_5 in 100 g of the compound= .....

(v) The mole ratio Pb: C_2H_5 is .....

(vi) The value of n is ..... [5]

3 (a) Steel alloys can be coated with a thin layer of artificial diamond. A mixture of hydrogen and methane is passed over a heated filament. The methane decomposes to carbon in the form of diamond which is deposited on the alloy.

(i) Describe how iron from the blast furnace is converted into steel.

.....

.....

..... [3]

(ii) Name a type of steel and give one of its uses.

..... [2]

(iii) Suggest an advantage of coating the alloy with diamond.

..... [1]

(iv) The alloy has to be heated above 800 °C to ensure that all the carbon is deposited as diamond. What other form of crystalline carbon might be deposited at lower temperatures?

..... [1]

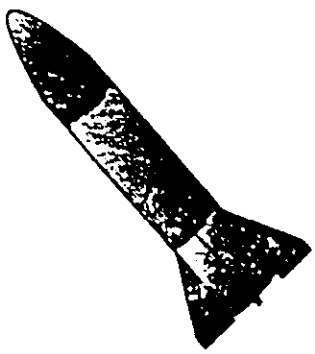
(v) If the mixture of hydrogen and methane diffused out of a storage cylinder through a small hole, the percentage of methane in the storage cylinder would increase. Explain why.

.....

.....

..... [3]

(b) Aluminium alloys are used in spacecraft. They can be reinforced with silicon carbide (SiC). These reinforced alloys are both strong and resistant to corrosion.



(i) What property, other than those given, makes an aluminium alloy suitable for use in spacecraft?

..... [1]

(ii) Why are aluminium alloys resistant to corrosion?

..... [2]

(iii) Silicon carbide has a macromolecular structure. Each atom in the structure is strongly bonded to four other atoms. *Predict* **three** properties of silicon carbide.

.....

.....

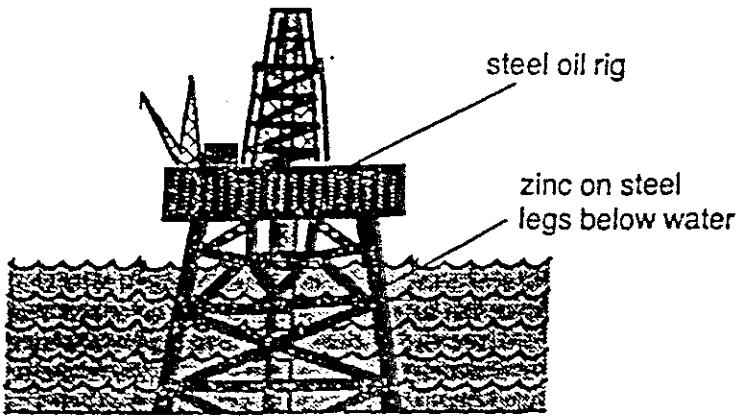
..... [3]

4 Zinc was discovered in India in ancient times. Brass, an alloy of zinc, was used by the Romans for coinage and ornaments. Another important use of zinc is to protect iron and steel from rusting.

(a) (i) Name the other metal in brass.

..... [1]

(ii) At sea, oil rigs have bars of zinc bolted to their steel legs. Explain how the zinc reduces the rate at which the steel legs rust.



.....

.....

..... [3]

(b) One method of extracting zinc is by electrolysis. Zinc ore is changed into aqueous zinc sulphate using sulphuric acid.

Complete the following description of the extraction of zinc.

The electrolyte is aqueous zinc sulphate and the cathode is made from

.....

The anode is made from carbon and the product at the anode is

.....

The equation for the reaction at the cathode is

..... [4]

(c) Sulphuric acid is made from sulphur dioxide, air and water.

(i) Write the equation for the reversible reaction that makes sulphur trioxide from sulphur dioxide.

..... [2]

Ex.

(ii) Describe how concentrated sulphuric acid is made from sulphur trioxide.

.....

..... [2]

(iii) Give one other large scale use of sulphuric acid.

..... [1]

(d) Both zinc oxide and zinc carbonate are white powders which are used in ointments. Describe a chemical test that would distinguish between them.

test .....

result with zinc oxide .....

result with zinc carbonate.....

..... [3]

5 (a) In 1662, Robert Boyle wrote an article entitled 'The Spring of Air'. This article contained Boyle's Law which states:

If the pressure of a gas is increased the volume of the gas becomes smaller (provided the temperature stays the same).

(i) Describe the arrangement and movement of the particles in a gas.

.....

.....

..... [3]

(ii) Why can an increase in pressure decrease the volume of a gas but hardly has any effect upon the volume of a liquid?

.....

.....

..... [3]

(b) William Ramsay in 1894 showed that the atmosphere contained about 1% of the Noble Gases; mainly argon but with traces of the other gases.

Potassium and chlorine, which are next to argon in the Periodic Table, react violently together but neither will react with argon.

(i) Explain why potassium and chlorine react together.

.....

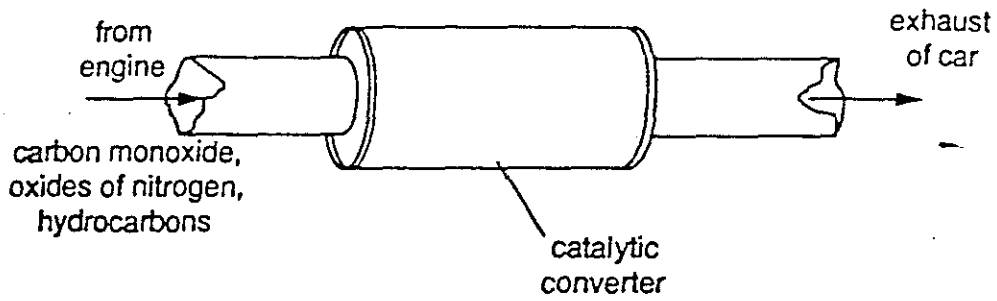
..... [2]

(ii) Explain why argon does not react with either.

.....

..... [1]

(c) In the last decade, cars exhausts have been fitted with catalytic converters to reduce air pollution.



Explain how a converter reduces the emission of pollutants.

.....

.....

..... [3]

(d) The following is an extract from a newspaper report.

GLOBAL WARMING JUST A MYTH

The complete combustion of fossil fuels produces both a gas which could cause global warming and minute crystals of sulphates. High up in atmosphere these white crystals reflect sunlight and cause global cooling.

(i) Name the gas that could cause global warming.

..... [1]

(ii) Suggest how sulphate ions could be formed by the combustion of a fossil fuel, such as coal.

.....

.....

..... [3]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4						1 H Hydrogen 1					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	163 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 dm³ at room temperature and pressure (r.t.p.)

Centre Number	Candidate Number

Candidate Name ________________________________

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Tuesday 5 NOVEMBER 1996 Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer all questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

Mathematical tables are available.

You may use your calculator.

A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

SB (PU) OK67853

[Turn over

For Examiner Use

1 Cadmium was first isolated by Stromeyer in Sweden. Recently laws have been passed in Europe restricting the uses of cadmium and its compounds, because they are very poisonous.

Zinc ores usually contain cadmium compounds.

(a) The reduction of the oxides obtained from the ore produces a mixture of the two metals. This mixture can be separated into the pure metals by fractional distillation.

(i) How is the ore, zinc blende, changed into zinc oxide?

.....[2]

(ii) Write a balanced equation for the reduction of zinc oxide by carbon.

.....[1]

(iii) Why is fractional distillation able to separate zinc from cadmium?

.....[1]

(b) A cadmium/aluminium alloy is used to absorb neutrons in nuclear reactors. The isotope of a different element is used as a fuel in nuclear reactors.

(i) Name the isotope used as a fuel and give its symbol, including nucleon number.

.....[2]

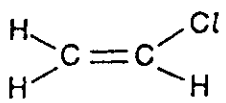
(ii) If one atom of cadmium $^{118}_{48}Cd$ absorbs one neutron, what is the nucleon number and proton number of the atom formed?

nucleon number is .....

proton number is .....

[2]

(c) Cadmium compounds are used as catalysts in the manufacture of the polymer poly(chloroethene). Draw the structure of this polymer. The structure of the monomer is given below.



[2]

(d) Cadmium hydroxide, a white solid, is basic; zinc hydroxide is amphoteric. Describe what would be seen if an excess of aqueous sodium hydroxide is gradually added to:

(i) aqueous cadmium sulphate,

.....

.....[2]

(ii) aqueous zinc sulphate.

.....

.....[2]

(e) Cadmium sulphide (CdS) is a brilliant yellow pigment. It is insoluble in water. Describe the preparation of cadmium sulphide from the soluble salts, cadmium sulphate and sodium sulphide.

.....

.....

.....[2]

2 For many years domestic rubbish has been disposed of in landfill sites. These sites produce a mixture of gases called landfill gas, which contains methane and carbon dioxide. Landfill gas is formed in three stages.

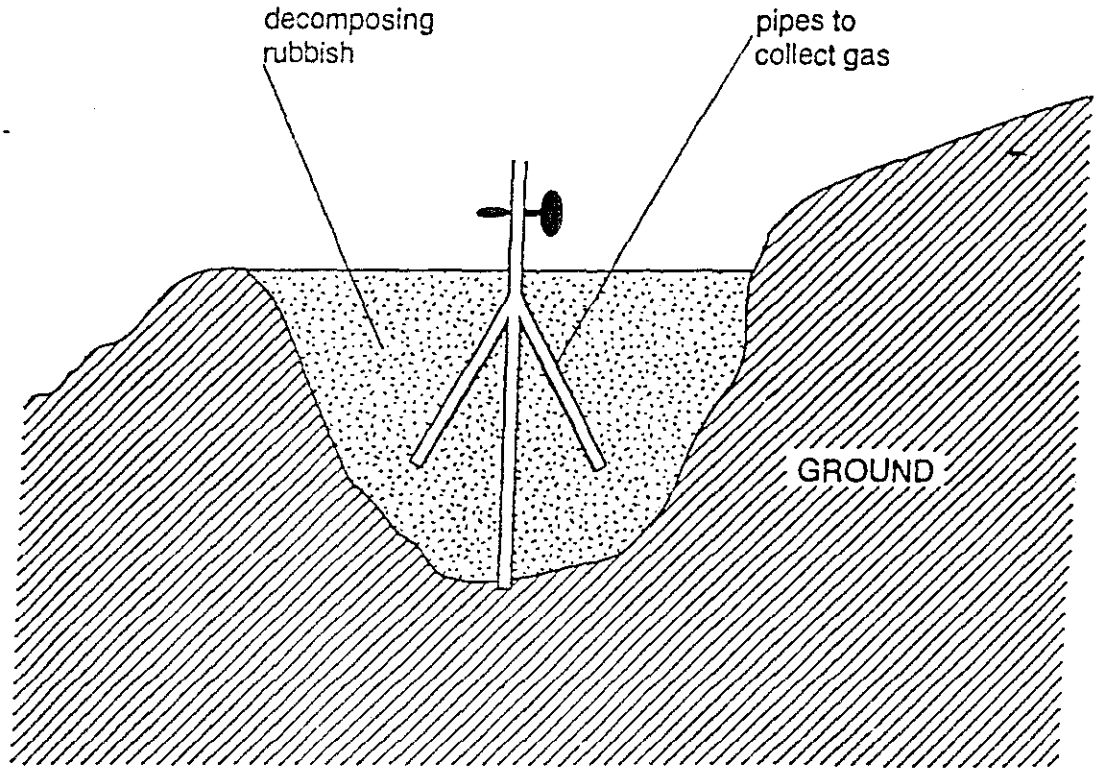


Fig. N1

(a) In the first stage, natural macromolecules are broken down by hydrolysis.

(i) Complete the following:

Proteins hydrolyse to .....

Carbohydrates hydrolyse to .....[2]

(ii) What type of linkage in fats is broken by hydrolysis?

.....[1]

(iii) What synthetic macromolecule contains this type of linkage?

.....[1]

(b) In the second stage, the chemicals formed by hydrolysis decompose even further to form a mixture that contains methanoic acid, ethanoic acid, propanoic acid and alcohols.

(i) Give the structure and name of the next organic acid in the series.

Name .....

Structure

[2]

(ii) Methanoic acid is a reducing agent, but ethanoic acid is not. Describe how acidified potassium manganate(VII) could be used to distinguish between them.

.....

.....

.....[3]

(c) In the final stage, bacteria decompose these molecules to form carbon dioxide and methane.

Construct the balanced equation for the decomposition of ethanoic acid to form methane and carbon dioxide.

.....[2]

(d) Suggest **two** advantages, economic or environmental, of making landfill gas from rubbish.

.....

.....[2]

3 Some students were investigating the rate of the reaction between sodium thiosulphate and hydrochloric acid.

$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + SO_2(g) + S(s) + H_2O(l)$$

A beaker containing 50 cm^3 of 0.2 mol/dm^3 sodium thiosulphate solution was placed on top of a black cross. Then 5 cm^3 of 2 mol/dm^3 hydrochloric acid was added and the clock started.

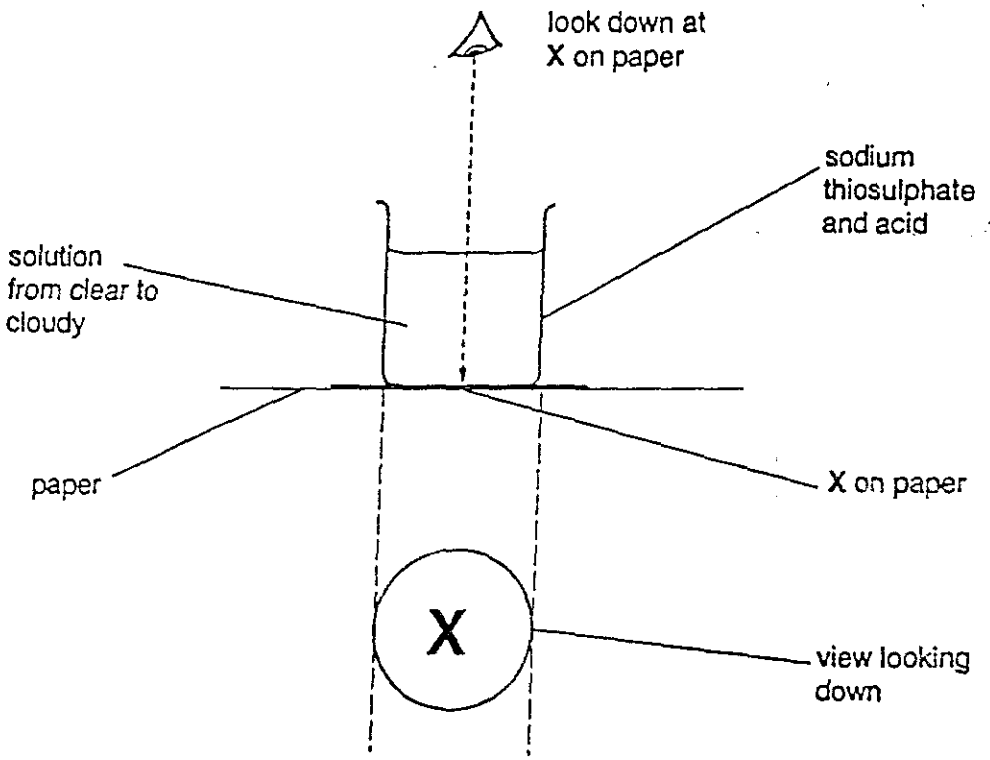


Fig. N2

At first the cross could be seen clearly. When the solution became cloudy and the cross was no longer visible, the clock was stopped and the time recorded.

(a) Why did the solution go cloudy?

.....[1]

For Examiner's Use

(b) 50 cm^3 of 0.2 mol/dm^3 sodium thiosulphate solution contains **0.01** moles of $Na_2S_2O_3$.

5 cm^3 of 2.0 mol/dm^3 hydrochloric acid contained **0.01** moles of HCl.

(i) Explain how to calculate the number of moles of HCl in 5 cm^3 of 2.0 mol/dm^3 hydrochloric acid.

.....

.....[2]

(ii) Use the equation to work out which reagent, sodium thiosulphate or hydrochloric acid, is used up completely.

.....

.....[2]

(iii) What is the maximum volume of sulphur dioxide, measured at room temperature and pressure, that could be obtained in this experiment?

.....

.....[2]

(c) The experiment was repeated with 25 cm^3 of 0.2 mol/dm^3 sodium thiosulphate solution and 25 cm^3 of water. Then 5 cm^3 of 2 mol/dm^3 hydrochloric acid was added and the time taken for the cross to 'disappear' was measured. Typical results are given in the table.

experiment	*A*	*B*
volume of sodium thiosulphate/cm^3	50	25
volume of water/cm^3	0	25
total volume/cm^3	55	55
time/s	28	56

(i) In which experiment, *A* or *B*, was the rate of reaction faster?

.....[1]

(ii) Explain why the rates of reaction are different in these two experiments.

.....

.....[2]

(d) The idea of collisions between reacting particles is used to explain changes in reaction rate. Use this idea to explain the following reults.

volume of sodium thiosulphate/cm^3	30	30
volume of water/cm^3	20	20
temperature/°C	23	40
time/s	55	24

.....

.....

.....

.....[4]

(e) The reaction between sodium thiosulphate and hydrochloric acid produced small amounts of sulphur dioxide.

(i) How is this gas made on a large scale?

.....

.....[2]

(ii) State two industrial uses of sulphur dioxide.

.....

.....[2]

4 Michael Faraday made important discoveries in both Chemistry and Physics.

(a) In 1820 he determined the structure of a number of important organic compounds.

(i) The hydrocarbon benzene has an empirical formula CH and its relative molecular mass is 78. What is its molecular formula?

.....

.....

.....[2]

(II) He discovered a compound that had the molecular formula C_4H_8. It reacted with bromine water. Suggest a name and structural formula for the compound.

.....

.....

.....[3]

(III) Faraday prepared compounds called sulphonic acids which are stronger acids than carboxylic acids. Describe how you could show that they are stronger.

.....

.....

.....[3]

(b) In 1830 he studied reactions between gases that are catalysed by solids. Ammonia is produced in this way.

(i) Complete the following for the manufacture of ammonia.

reacting gases .....[2]

equation .....[2]

catalyst .....[1]

(ii) State **two** uses of ammonia.

.....

.....[2]

(c) Faraday studied electrolysis. Electrolysis is used to extract aluminium.

(i) Name the main ore of aluminium.

.....[1]

(II) The electrolyte used in this extraction contains two aluminium compounds. Name these two compounds.

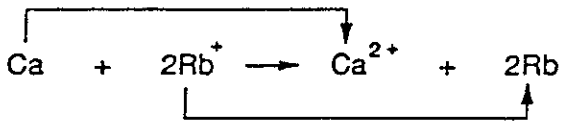
.....

.....[2]

5 Rubidium has similar properties to sodium and potassium. Rubidium is used in photocells.

(a) Rubidium was first isolated by R Bunsen in 1861 by heating rubidium chloride with calcium. Label on the equation below:

the change which is oxidation
the change which is reduction
the chemical which is the oxidising agent.



[3]

(b) Photocells change light energy into electrical energy.

(i) Name a process that changes light energy into chemical energy.

.....[1]

(ii) Name a device that changes chemical energy into electrical energy.

.....[1]

(c) Aqueous rubidium chloride can be electrolysed using carbon electrodes. Name the products of this electrolysis.

(i) product at negative electrode .....

(ii) product at positive electrode .....

[2]

(d) The next element to rubidium in the Periodic Table is strontium. Strontium is similar to calcium. The rubidium ion is Rb^+ and the strontium ion is Sr^{2+}. Because these ions have different charges, ionic compounds of rubidium and strontium behave differently when heated.

(I) Explain why rubidium and strontium form ions that have different charges.

.....

.....[2]

(II) The hydroxides of rubidium and strontium are heated. If the compound decomposes, complete the word equation, otherwise write "no reaction."

rubidium hydroxide ⟶ .....

strontium hydroxide ⟶ .....[2]

(III) Construct balanced equations for the decomposition of the nitrates of these two metals.

$RbNO_3$ ⟶ .....

$Sr(NO_3)_2$ ⟶ .....

[4]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
																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 †															

† 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 = 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.)

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday 22 MAY 1997 Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials: 1
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 16.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 13 printed pages and 3 blank pages.

1 A newspaper headline said:

FBI supports poison theory on Napoleon

Napoleon died in 1821 under mysterious circumstances. The article explained that the analysis of samples of his hair showed levels of arsenic compounds that were consistent with arsenic poisoning. The poisoning could have been deliberate or accidental.

(a) Hair is a natural protein. As the first step in the analysis, the hair was hydrolysed to release the arsenic compounds.

(i) Name a reagent which could have been used to hydrolyse the protein.

.....[1]

(ii) What type of compound is formed by the hydrolysis of proteins?

.....[1]

(b) If the poisoning was deliberate, arsenic(III) oxide was probably used.

(i) The empirical formula of this oxide is As_2O_3. Its relative molecular mass is 396. What is its molecular formula?

.....[2]

(ii) One mole of As_2O_3 reacts with one mole of oxygen **molecules** to form one mole of a different oxide of arsenic. What is the formula of this oxide?

.....[1]

(iii) A 0.1 mol/dm^3 solution of arsenic(III) oxide has a pH of 5. An excess of this solution was added to acidified potassium manganate(VII) solution, which changed from pink to colourless.

Give **two** deductions about the chemistry of arsenic(III) oxide that can be made from the above information.

.....

.....[2]

(c) The poisoning could have been accidental. A bright green compound copper(II) arsenate(III) was used to decorate walls. Micro-organisms can act on this pigment to produce the poisonous gas arsine, AsH_3.

(i) The formula of the arsenate(III) ion is AsO_3^{3-}. Write the ionic equation for the reaction:

copper(II) ions + arsenate(III) ions → copper(II) arsenate(III)

.....[2]

(ii) Draw a diagram showing the arrangement of the valency electrons in a molecule of the covalent compound arsine, AsH_3.

Use o to represent an electron from arsenic
Use x to represent an electron from hydrogen

[3]

(d) Another volatile arsenic compound has the composition by mass:

arsenic	62.5%
carbon	30.0%
hydrogen	7.5%

Calculate the empirical formula of this compound.

.....

.....

.....[3]

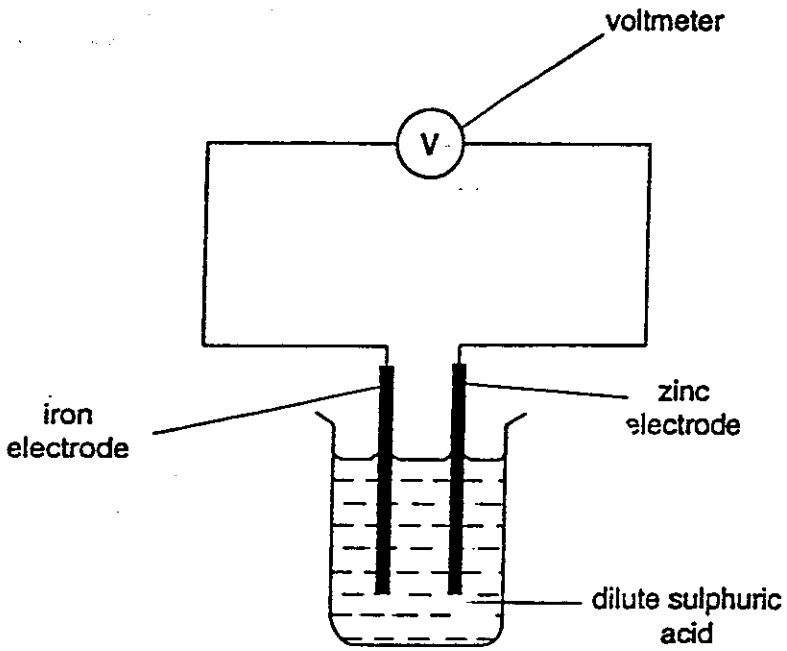
2 A cell changes chemical energy into electrical energy and heat energy. Two types of cell are simple cells and fuel cells.

(a) Is the reaction occurring in a cell endothermic or exothermic? Explain your answer.

.....

.....[2]

(b) A simple cell contains two metallic electrodes in an electrolyte. The more reactive metal loses electrons and goes into solution as ions. The electrons move to the less reactive metal where a gas is formed.



(i) Which is the more reactive metal in the cell?

.....[1]

(ii) Name the gas.

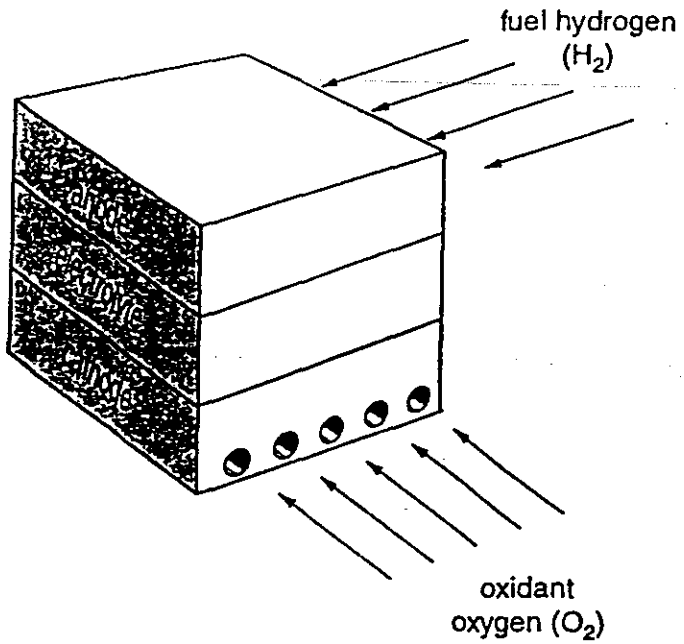
.....[1]

(iii) Would the voltage of the cell increase, decrease or stay the same if the iron electrode was replaced by a copper electrode? Explain your answer.

.....

.....[2]

(c) In 1839 the first fuel cell was made by a Welsh lawyer, W. Grove. Hydrogen and oxygen react in the cell to produce electrical energy and water. The diagram below shows a modern fuel cell.



reaction 1	hydrogen molecules change into hydrogen ions and electrons
reaction 2	oxygen molecules combine with electrons to form oxide ions
reaction 3	hydrogen ions and oxide ions form water $2H^+ + O^{2-} \rightarrow H_2O$

(i) Balance the equation for reaction 2.

$O_2 +$ ..... $e^- \rightarrow$ ..... O^{2-}. [2]

(ii) Write the equation for reaction 1.

.....[2]

(d) Oxygen is supplied to the cell. Describe how oxygen is obtained on a large scale from air.

.....

.....[3]

(e) The cell also needs hydrogen. This can be made by the catalytic decomposition of alkanes.

(i) Explain the term *alkane.*

.....[2]

(ii) Calculate the volume of hydrogen, measured at r.t.p., that could be obtained by cracking 5 moles of the hydrocarbon C_6H_{14}.

$C_6H_{14} \rightarrow C_6H_6 + 4H_2$

.....

.....[2]

3 Around 1810, Sir Humphrey Davy was involved in the discovery and naming of eight elements. Four of which were:

potassium,
magnesium,
boron,
chlorine.

(a) He used electrolysis to extract reactive metals. Potassium was obtained by the electrolysis of molten potassium chloride.

(i) Potassium chloride is an ionic salt. Why was molten potassium chloride used rather than the solid salt?

.....[1]

(ii) What would have been the products if an aqueous solution of potassium chloride had been electrolysed?

.....[3]

(b) Reactive metals were used to extract the non-metal boron. Boron oxide was heated with magnesium to give a mixture of solids.

$3Mg + B_2O_3 \rightarrow 2B + 3MgO$

This mixture could contain magnesium, boron, boron oxide and magnesium oxide. Boron oxide is acidic and magnesium oxide is basic.

The first step in separating boron from the mixture was to add excess hydrochloric acid.

(i) What type of chemical reaction is the change from boron oxide to boron?

.....[1]

(ii) Name the **two** chemicals in the mixture that would react with hydrochloric acid.

.....[2]

(iii) Name the salt formed when the acid was added to the mixture.

.....[1]

(iv) How could the unreacted solids be separated from the solution of the salt?

.....[1]

(c) Boron has a macromolecular structure.

(i) Name another element that has this type of structure.

.....[1]

(ii) Predict **two** physical properties of boron.

.....

.....[2]

(d) Give an explanation, in terms of electronic structures, for each of the following statements.

(i) Potassium and chlorine both have a valency of one.

.....

.....[3]

(ii) Potassium and rubidium have similar properties.

.....

.....[2]

4 In India, Oil of Neem is extracted from plant material. This vegetable oil is an important raw material. Soap and other detergents are among the many products that can be made from it.

(a) Plants need energy to make vegetable oils. The sugar, glucose, is made by photosynthesis and polymerises to form more complex carbohydrates. These are stored in the plant as a source of energy.

Describe the formation of a complex carbohydrate from a sugar. The sugar can represented as

.....

.....

.....[2]

(b) Oil of Neem contains a number of different organic groups, including a double bond.

(i) Describe a test to show that the oil contains a double bond.

.....

.....[3]

(ii) The oil can be hydrolysed to a soap. Name a reagent used for this hydrolysis and identify an organic group that can be hydrolysed to a soap.

reagent used .....[1]

organic group .....[1]

(iii) A different organic group in the oil can easily be oxidised by potassium dichromate(VI) to a carboxylic acid group.

Name an organic compound that is oxidised by potassium dichromate(VI). Give the name and structural formula of the carboxylic acid formed.

organic compound .....[1]

name of the carboxylic acid formed .....[1]

structural formula of this acid

.....[2]

(c) Sulphuric acid is a strong acid and the carboxylic acid made by the oxidation of Oil of Neem is a weak acid. Both acids will react with magnesium carbonate.

(i) Describe what you would see when solid magnesium carbonate is added to an aqueous solution of either acid.

.....

.....[2]

(ii) Aqueous solutions of the two acids, with the same concentration, react at different rates with the solid carbonate. Suggest a reason why they react at different rates.

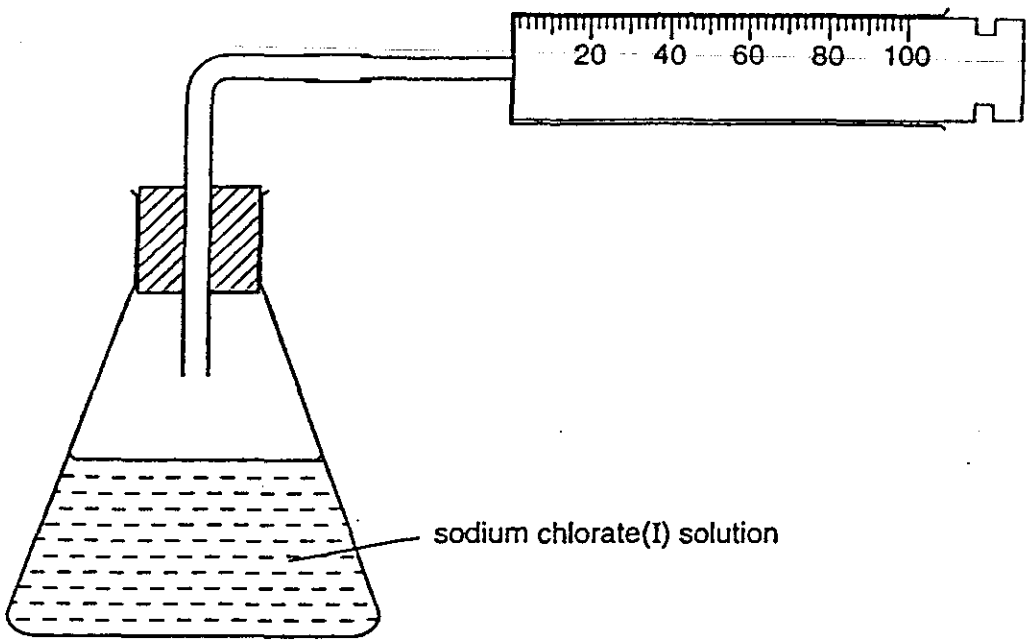
.....

.....[2]

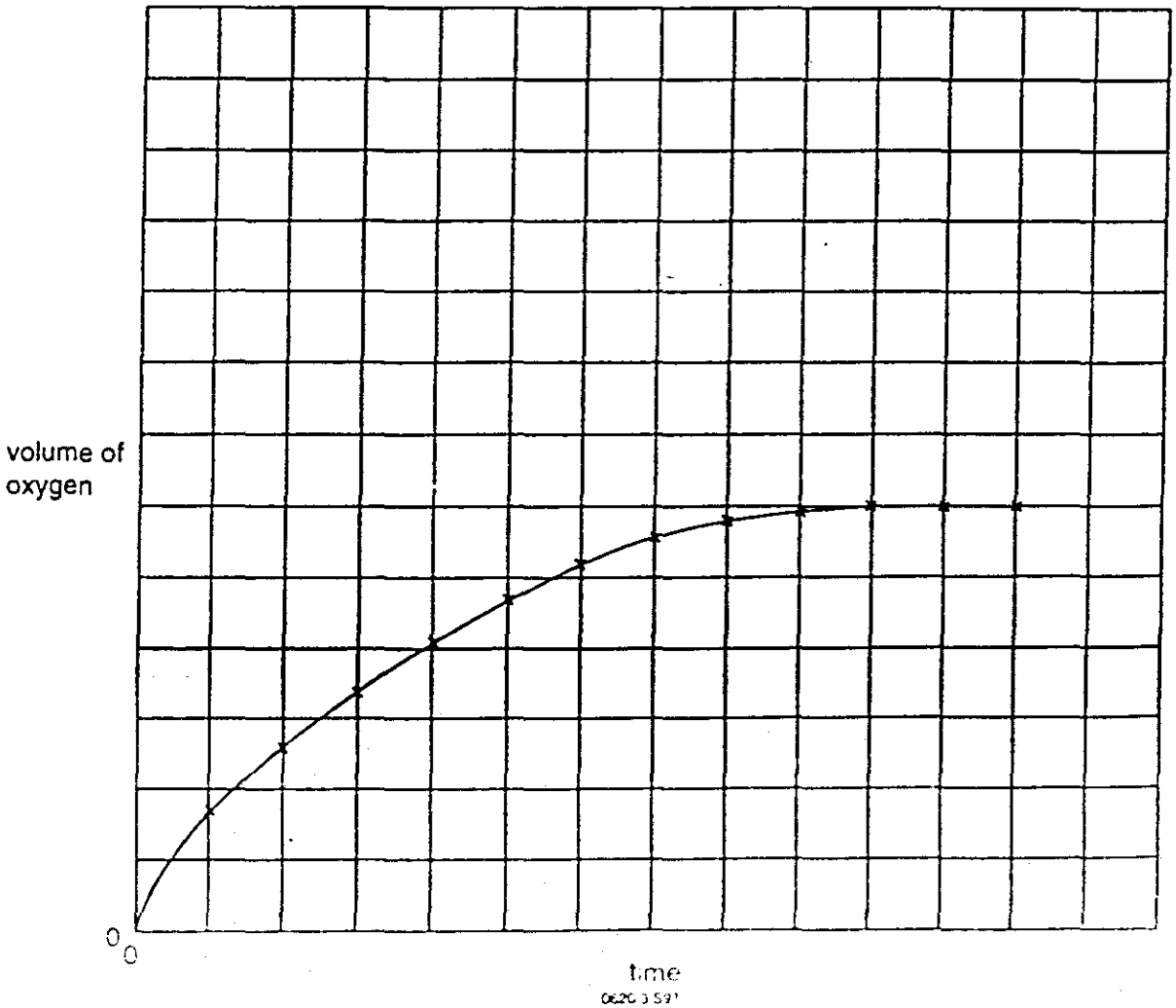
For Examiner Use

5 Sodium chlorate(I), NaC*l*O, decomposes to form sodium chloride and oxygen.

(a) 50 cm^3 of 0.1 mol/dm^3 sodium chlorate(I) solution was placed in the flask. A catalyst was added and the volume of oxygen collected was measured every minute.



The results were plotted to give a graph.



(i) At the end of the experiment how could you show that the solution in the flask contained the chloride ion?

.....

.....[2]

(ii) The rate of reaction is measured by the slope of the graph. How does the rate of reaction change during the experiment?

.....[1]

(iii) Why does the rate of reaction change during the experiment?

.....

.....[2]

(iv) The experiment was repeated using 50 cm^3 of 0.2 mol/dm^3 sodium chlorate(I) solution. All the other variables remained the same. The results from this experiment gave a different graph. Sketch this graph on the grid above and label it X. [2]

(b) Sodium chlorate(I) is an oxidising agent. When it is acidified, chlorine is produced. Describe what would you see when aqueous potassium iodide is oxidised by sodium chlorate(I).

.....[2]

(c) To show that sodium chlorate(I) can oxidise iron(II) ions to iron(III) ions, it is necessary to identify which of these ions is present.

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

(i) Name a reagent that can be used to test for both iron(II) and iron(III) ions.

.....[1]

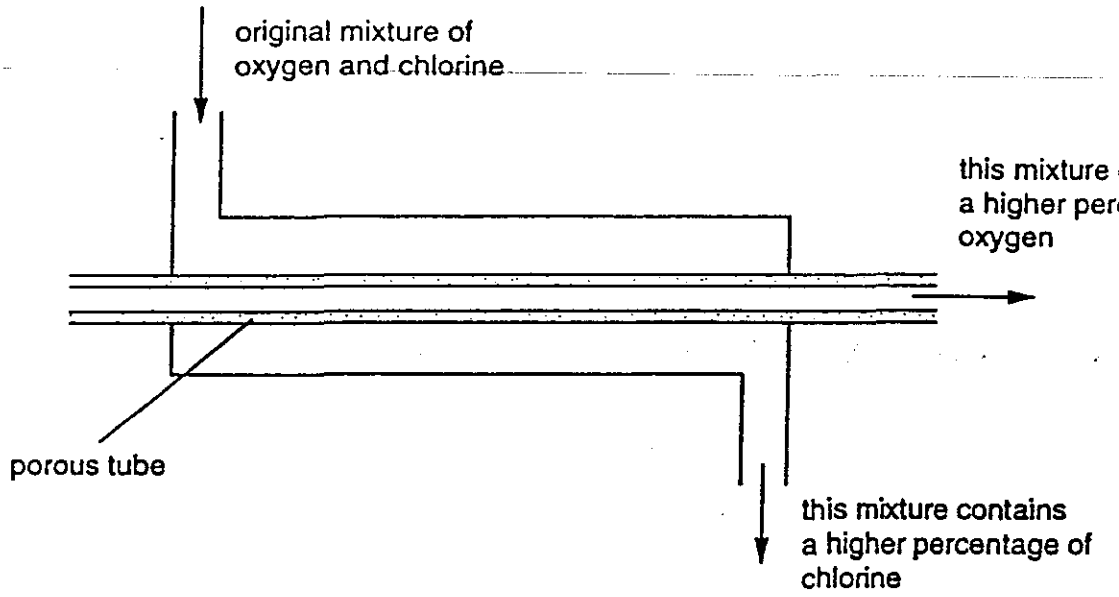
(ii) State the result of the above test on iron(II) ions.

.....[2]

(iii) State the result of the same test on iron(III) ions.

.....[1]

(d) Under certain conditions, a solution of sodium chlorate(I) will give off a mixture of oxygen (O_2) and chlorine (Cl_2). This mixture of gases can be partially separated by diffusion using the apparatus illustrated below.



Explain why the percentages have changed.

.....

.....

.....[3]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Friday 7 NOVEMBER 1997 Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use your calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

For Examiner's Use

1 (a) Tin has been used for over three thousand years. Bronze, a copper/tin alloy, has been used for even longer.

(i) Name another alloy that contains copper.

.....[1]

(ii) Suggest a reason why bronze might be used instead of pure copper.

.....[1]

(b) The position of tin in the reactivity series is:

iron
tin
copper

(i) The main ore of tin is tin(IV) oxide, SnO_2. By writing a word equation, suggest how this ore could be reduced to tin.

.....[2]

(ii) For each of the following decide if a reaction would occur. If there is a reaction, complete the equation, otherwise write 'no reaction'.

$Fe + SnCl_2 \rightarrow$ .....

$Sn + CuSO_4 \rightarrow$ .....

$Sn + Fe^{2+} \rightarrow$ .....

[4]

(c) Aqueous tin(II) sulphate is electrolysed using carbon electrodes. This electrolysis is similar to that of copper(II) sulphate using carbon electrodes.

(i) What is the product at the negative electrode?

.....[1]

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

.....[2]

(iii) Name the acid which is formed during the electrolysis.

.....[1]

For Examiner's Use

(d) The element tin can exist in two different solid forms. Grey tin has a diamond type structure and white tin has a metallic structure.

(i) What type of chemical bond, ionic, covalent or metallic, is present in grey tin?

.....[1]

(ii) Describe how the carbon atoms are arranged in diamond.

.....

.....[2]

(iii) Describe a typical metallic structure.

.....

.....

.....[3]

(iv) Which solid form of tin would be the better conductor of electricity?

Explain your answer.

.....

.....[2]

2 A reaction in photography is the reduction of silver(I) ions. Film is coated with particles of silver(I) bromide or iodide.

(a) (i) What effect does light have on the rate of reduction of silver(I) ions?

.....

.....[2]

(ii) Write an ionic equation for the reduction of silver(I) ions.

.....[2]

(b) The exposed film has to be processed. The first chemical reaction in processing is the development of the film. It is placed in a solution of a developer which reacts with the particles of silver(I) iodide. The following information was supplied with the developer.

temperature of developer/°C	*time needed to develop the film/s*
38	200
37	220
36	250
35	280

(i) Estimate the time needed to develop a film at 34 °C.

.....[1]

(ii) Explain why more time is needed to develop the film at lower temperatures.

.....

.....[2]

(iii) Would the time needed for development increase, decrease or stay the same if a more concentrated solution of the developer was used at the same temperature?

Explain your answer.

.....

.....[2]

(iv) Explain why a smaller particle size of the silver(I) iodide shortens the time needed for development.

.....

.....[2]

For Examiner's Use

3 The disposal of plastic waste presents problems. The waste usually contains a number of *different polymers which are difficult to separate. The best way of disposing of plastic waste* is to make useful products from it by recycling.

(a) Describe two environmental problems caused by the disposal of plastics.

.....

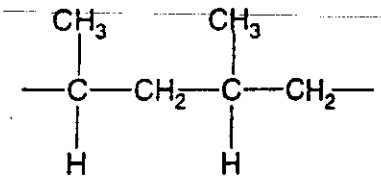
.....

.....[2]

For Examiner's Use

(b) Plastic waste could contain a mixture of addition and condensation polymers.

(i) For the following addition polymer, deduce the structure and the name of the monomer.



name .....

structure

[2]

(ii) A condensation polymer can be formed from the monomers $NH_2(CH_2)_6NH_2$ and $HOOC(CH_2)_8COOH$. Draw the structure of this polymer.

[2]

(c) The first stage in recycling is to melt the plastic waste. If the plastic contains chlorine, hydrogen chloride is formed, which can be oxidised back to chlorine. Chlorine reacts with methane to give two useful products chloromethane and dichloromethane.

(i) What are the conditions for the reaction between methane and chlorine?

.....[1]

(ii) Draw the structure of:

chloromethane,

dichloromethane.

[2]

(d) In the second stage, the plastic is heated to a higher temperature and it decomposes to a mixture that contains ethene, propene and naphtha. Naphtha is a mixture of liquid alkanes.

(i) Suggest the name of the technique used to separate mixtures of liquid alkanes.

.....[1]

(ii) The alkanes in naphtha can be cracked. Construct an equation for the cracking of decane, $C_{10}H_{22}$.

$C_{10}H_{22}$ → .....[2]

(e) Alkenes are used to make a range of important organic chemicals.

(i) Name the product of the reaction between butene and steam.

.....[1]

(ii) Write an equation and name the product of the reaction between propene and bromine.

.....

.....[3]

4 The element cerium was discovered in Sweden in 1803 by Berzelius. Its symbol is Ce and its proton number is 58. It resembles calcium in terms of reactivity and general chemical properties. There are also similarities with aluminium; both have a valency of three and the same method is used to extract both metals.

(a) Complete the following for an atom of cerium, nucleon number is 140.
One atom of cerium contains

58 protons ... neutrons and ... electrons

[2]

(b) Cerium has valencies of 3 and 4 but aluminium just has a valency of 3 in its compounds.

(i) Give the electronic structure of an atom of aluminium.

.....[1]

(ii) Use your answer to (i) to explain why aluminium has only one valency in its compounds.

.....

.....[2]

(c) Aluminium is extracted from aluminium oxide by electrolysis. An identical method is used to extract cerium from cerium oxide.

(i) What material are the electrodes made from in these extractions?

.....[1]

(ii) At which electrode is molten cerium formed?

.....[1]

(d) Cerium and aluminium are both reactive metals. Cerium burns easily when it is heated in air. Explain why aluminium is more difficult to burn in air.

.....[1]

(e) Cerium is very similar to calcium. Complete the following word equations.

(i) Cerium reacts violently with cold water.

cerium + water → ..... + ...

(ii) Cerium nitrate decomposes when heated.

cerium nitrate → ..... + ... + ...

[5]

(f) 4.2 g of cerium reacted with oxygen to form 5.16 g of an oxide of cerium. Complete the following to determine the formula of this oxide.

Number of moles of cerium atoms used

.....

Mass of oxygen that reacted

..... g

Number of moles of oxygen atoms in oxide

.....

Ratio by moles of cerium atoms to oxygen atoms

....

Formula of this oxide of cerium is

.....

[4]

5 The table gives information about the exhaust emissions of cars.

pollutant	*petrol car no catalytic converter*	*petrol car catalytic converter*	*diesel car no catalytic converter*	*diesel car catalytic converter*
nitrogen oxides (NO_x)	xxx	x	xx	xx
carbon monoxide	xxx	xx	xx	x
hydrocarbons	xxx	xx	xx	x
particulates	xx	x	xxx	xx
carbon dioxide	xx	xxx	x	xx

Key:
highest emissions xxxx intermediate xx lowest emissions x

(a) (i) Particulates are very small particles of a black solid. Suggest the name of this black solid.

.....[1]

(ii) Explain how the oxides of nitrogen are formed in car engines.

.....

.....

.....[3]

(iii) Why does the catalytic converter increase the emission of carbon dioxide but decrease the emission of the other pollutants?

.....

.....[2]

For Examiner's Use

(b) The oxides of nitrogen are one cause of acid rain. Acid rain increases the rate of rusting of steel.

(i) Name and describe the source of the other gas that causes acid rain.

name of gas .....[1]

source of gas .....[2]

(ii) Explain why the rate at which steel rusts is lessened by 'sacrificial protection'.

.....

.....[2]

(c) Carbon dioxide is formed by the complete combustion of carbon-containing compounds. Another reaction that produces carbon dioxide is fermentation.

(i) Complete the following equation for the fermentation of glucose.

$C_6H_{12}O_6 \rightarrow$ ..... + ...[2]

(ii) Give the conditions for this reaction.

.....[1]

(d) Ozone is a serious air pollutant. It is formed by the following reaction.

$NO_2 + O_2 \rightleftharpoons O_3 + NO$

(i) What type of reaction is this?

.....[1]

(ii) Predict the effect upon the concentration of ozone of increasing emissions of nitrogen monoxide, NO.

.....[1]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday 21 MAY 1998 Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

1 The scientific study of ancient bronzes and their corrosion products was started in 1779 by M. Sage in France and has continued until the present time.

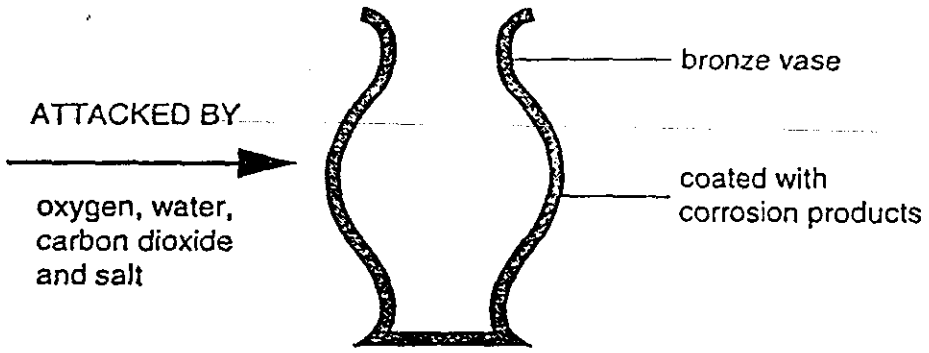


Fig. J1

The following table gives information about some of the chemicals formed when bronzes corrode.

product	*formula*	*mass of mole/g*	*% of copper*
A	Cu_2O	144	88.9
B	$CuCO_3.Cu(OH)_2$	222	57.7
C	$Cu(OH)_2.2CuCO_3$	346	55.5
D	$Cu_2(OH)_3Cl$		

(a) (i) Complete the table. [2]

(ii) Describe how you could show that product B contained carbonate ions.

.....

.....[3]

(iii) Product D was dissolved in an excess of dilute nitric acid. How could you show that the solution formed contained chloride ions?

.....

.....[2]

(b) Each of corrosion products **A**, **B** and **C** can be reduced to copper by heating in hydrogen.

(i) Name another reagent that could reduce them to copper.

.....[1]

(ii) In an experiment, 3.105 g of a corrosion product was reduced to 1.790 g of copper. Which one, **A**, **B** or **C** was used in this experiment? Explain your choice.

.....

.....[2]

(c) The following test can be used to show that an alloy contains copper.

A small sample of the alloy is dissolved in nitric acid. This solution is tested for the presence of copper(II) ions by the addition of aqueous ammonia.

(i) Describe the result of this test.

.....

.....[3]

(ii) Name an alloy, other than bronze, that would give a positive result to this test.

.....[1]

(d) Copper and its alloys are malleable. Why are metals malleable?

.....

.....[2]

2 Chlorine and sodium hydroxide are made by the electrolysis of concentrated aqueous sodium chloride. A recent economic survey predicted the percentage change in demand for these chemicals during the next ten years.

industry	*percentage change for sodium hydroxide*	*percentage change for chlorine*
wood pulp	+2.2	–2.7
poly(chloroethene)	not used	+4.0
extraction of aluminium	+1.5	not used
other industries	+2.0	+2.4

(a) (i) Name a chemical, other than chlorine, that is used to bleach wood pulp.

.....[1]

(ii) Why is chlorine used in the treatment of water?

.....[1]

(iii) Sodium hydroxide is used to hydrolyse fats. What useful product is made by this reaction?

.....[1]

(iv) Chlorine is used to make chloroethene which has the structure shown below.

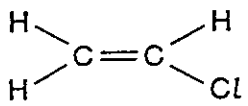


Fig. J2

Draw the structure of the polymer poly(chloroethene).

[2]

(b) Concentrated aqueous sodium chloride contains the following ions.

Na^+, H^+, OH^-, Cl^-

It is electrolysed to make chlorine and sodium hydroxide.

(i) Name the product formed at the cathode.

.....[1]

(ii) Write an equation for the formation of chlorine molecules at the anode.

.....[2]

(iii) Explain how a solution of sodium hydroxide is formed.

.....[1]

(c) Bauxite, the major ore of aluminium, is impure aluminium oxide. From this ore, pure aluminium oxide is obtained. This is electrolysed in molten cryolite and aluminium is formed at the cathode.

(i) An impurity in bauxite is the basic oxide, Fe_2O_3. Suggest why the addition of aqueous sodium hydroxide separates this basic oxide from the amphoteric oxide, Al_2O_3.

.....

.....

.....[3]

(ii) Name two products formed at the anode during the electrolysis of molten aluminium oxide.

.....[2]

(iii) Aluminium is a reactive metal, yet foods that are acidic are safely supplied in aluminium containers. Explain why the acid in the food does not attack the metal.

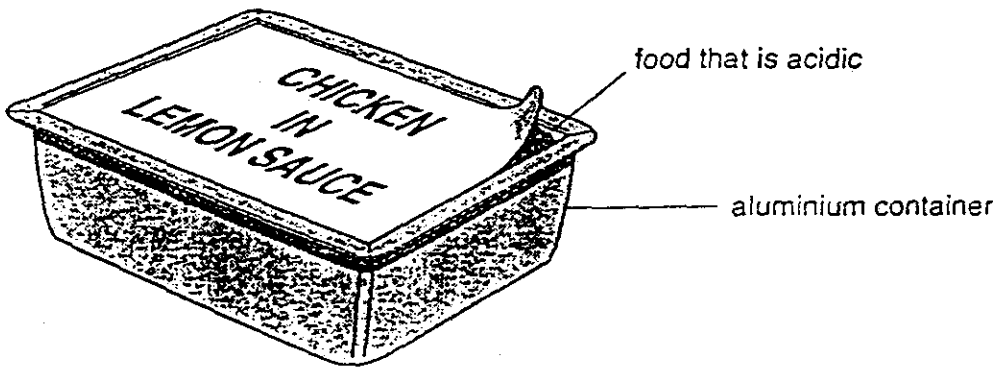


Fig. J3

.....

.....[2]

3 (a) Ethanol can be made by the fermentation of glucose. Yeast is added to an aqueous solution of glucose. Carbon dioxide is given off and, after a while, the solution becomes warm because the reaction is exothermic.

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

The graph below shows how the rate of reaction changed over several days.

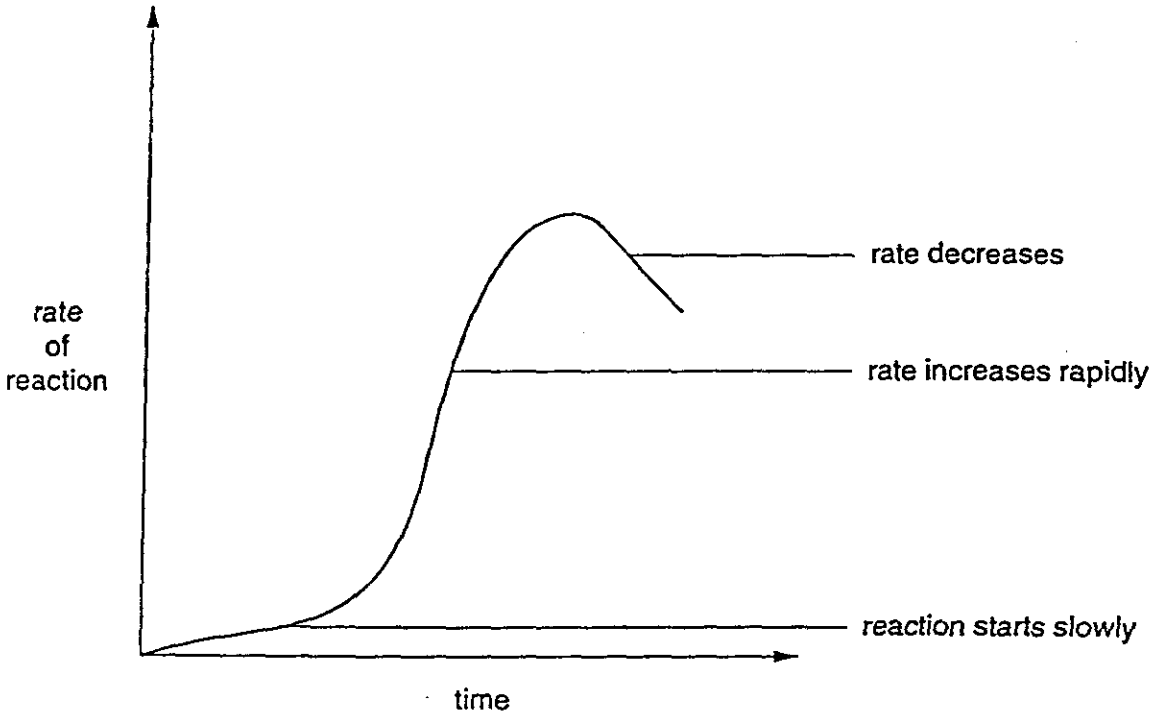


Fig. J4

(i) Suggest a method of measuring the rate of this reaction.

.....

.....[2]

(ii) Suggest a reason why the reaction rate increases initially.

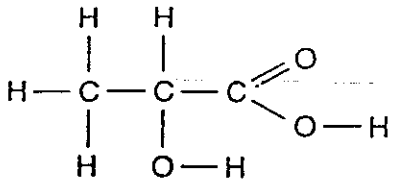
.....[1]

(iii) Suggest a reason why the reaction rate eventually decreases.

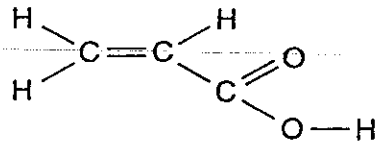
.....

.....[2]

(b) Micro-organisms, different to those produced by yeast, change glucose into lactic acid. When lactic acid is heated, it decomposes to form acrylic acid and one other product. The structural formulae of these acids are shown below.



lactic acid



acrylic acid

Fig. J5

(i) Give the empirical formula of lactic acid.

.....[1]

(ii) Complete the word equation

lactic acid ⟶ acrylic acid + ... [1]

(iii) Describe a test that would distinguish between these two acids.

test .....

result .....

.....[3]

(iv) Other than using an indicator, describe a test that would show that both of these chemicals contain an acid group.

.....

.....[2]

(v) Suggest the name of the chemical that reacts with acrylic acid to form the ester ethyl acrylate.

.....[1]

(c) Organic chemicals are made from petroleum as well as from natural materials such as glucose. The following steps are needed to make propanol from petroleum:

step 1 petroleum is cracked to make the suitable alkene;

step 2 this alkene reacts with steam to form propanol.

(i) Name the 'suitable alkene'.

.....[1]

(ii) Give the structural formula of propanol.

[1]

(iii) What type of reaction takes place between the alkene and steam?

.....[1]

4 Sulphuric acid is an important chemical both industrially and in the laboratory.

(a) In the 18th century, sulphuric acid was manufactured by burning a mixture of sulphur and potassium nitrate. The mixture of gases formed was reacted with water. The sulphuric acid produced by this method was impure and expensive.

(i) The impure sulphuric acid contained another acid. Suggest the name of this acid.

.....[1]

(ii) Write an equation for the action of heat on potassium nitrate.

.....[2]

(b) In 1831, Philips, an English vinegar maker, invented the Contact Process. It made pure, concentrated sulphuric acid cheaply. All of the worldwide production of 150 million tonnes per annum is made by this process.

$S + O_2 \longrightarrow SO_2$

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

(i) Why is the Contact Process preferred to the older method of making sulphuric acid?

.....[1]

(ii) Sulphur dioxide is made by burning sulphur. Name a source of the element sulphur.

.....[1]

(iii) Name the catalyst used for the reaction between sulphur dioxide and oxygen.

.....[1]

(iv) What would be the effect of decreasing the temperature on the position of equilibrium in the reversible reaction between sulphur dioxide and oxygen? The forward reaction is exothermic.

.....[2]

(v) In the older process, sulphur trioxide was reacted directly with water. Describe how the sulphur trioxide is changed into sulphuric acid in the Contact Process.

.....

.....[2]

(vi) State **two** large-scale uses of sulphuric acid.

use **1** .....

use **2** .....[2]

(c) Copper(II) sulphate-5-water was prepared by the following reactions.

$CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$

$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$

In an experiment, 25 cm^3 of 2.0 mol/dm^3 sulphuric acid was neutralised with an excess of copper(II) oxide. The yield of crystals, $CuSO_4.5H_2O$, was 7.3 g. Complete the following to calculate the percentage yield.

(i) Number of moles of H_2SO_4 in 25 cm^3 of 2.0 mol/dm^3 solution .....

(ii) Maximum number of moles of $CuSO_4.5H_2O$ that could be formed .....

(iii) Maximum mass of crystals, $CuSO_4.5H_2O$, that could be formed .....g

[The mass of one mole of $CuSO_4.5H_2O$ is 250 g.]

(iv) Percentage yield .....

.....

[4]

5 The non-metals in Group VII are called the halogens.

(a) The table below gives some information about four of the halogens.

name	*symbol*	*appearance*	*electron distribution*
fluorine	F	**********	2, 7
chlorine	Cl	yellow-green gas	2, 8, 7
bromine	Br	brown liquid	2, 8, 18, 7
iodine	I	black solid	**********

(i) Predict the appearance of fluorine at room temperature.

.....[2]

(ii) Give **one** way in which the electron distribution of iodine is the same as that of bromine and **one** way in which it is different.

same .....

different .....[2]

(b) Bromine was first isolated from salt deposits in 1826 by the Frenchman A. J. Balard. Nowadays, chlorine is bubbled through seawater after its pH has been adjusted to 3.5. The equation for this redox reaction is given below.

$$Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$$

(i) Describe how you could adjust the pH of a small sample of seawater to approximately 3.5.

.....

.....[2]

(ii) Explain why the equation above is an example of a redox reaction.

.....

.....[2]

(c) Chlorine reacts with other elements to form chlorides.

chloride	*formula of type*	*melting point / °C*	*electrical conductivity of liquid chloride*
A	XCl	770	high
B	YCl_2	782	moderately high
C	ZCl_4	–23	zero

(i) Which of the chlorides **A**, **B** or **C** is covalent? Give an explanation for your answer.

.....

.....

.....[3]

(ii) Suggest an identity for element *X* in chloride **A** and for element *Z* in chloride **C**.

element X could be .....

element Z could be .....[2]

(d) Give a diagram to show the arrangement of the 'outer shell' electrons in one molecule of the covalent chloride phosphorus trichloride.

Use x to represent an electron from a phosphorus atom.
Use o to represent an electron from a chlorine atom.

[3]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday 12 NOVEMBER 1998 Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use your calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages. 131

1 At present, most car bodies are made from either mild steel or plastic. A large German car manufacturer is investigating the use of an alternative material made from plant fibres for this purpose.

(a) Plant fibres contain natural polymers, which are complex carbohydrates. These are made in green plants from simpler carbohydrates, such as glucose, by a process called *condensation polymerisation.*

(i) Describe the formation of glucose by photosynthesis in a green plant.

.....

.....

.....

.....[4]

(ii) Explain *condensation polymerisation.*

.....

.....[2]

(iii) Give the structure of a synthetic polymer that is made by condensation polymerisation.

[2]

(b) Haematite, iron(III) oxide, is reduced to impure iron in a blast furnace. Two impurities in the iron are carbon and silicon. The impure iron is changed into mild steel using oxygen and powdered calcium carbonate.

(i) Complete the equation for the reduction of iron(III) oxide.

Fe_2O_3 + ...CO ⟶ ..... + ... [2]

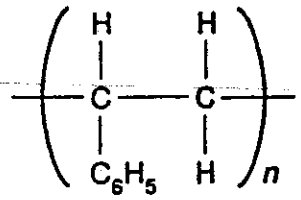
(ii) How are the impurities removed when steel is made from impure iron?

.....

.....

.....[3]

(c) Poly(phenylethene) is a synthetic polymer, usually called polystyrene. Its structure is given below.



(I) Deduce the structure of the monomer of poly(phenylethene).

[1]

(II) Name the raw material from which most synthetic polymers are made.

.....[1]

(d) (I) Suggest an environmental advantage of using the natural fibre material rather than a synthetic polymer.

.....[1]

(II) Suggest an advantage of using either the natural or a synthetic polymer rather than mild steel for car bodies.

.....[1]

2 **(a)** Hydrogen usually exists as covalent molecules. Evidence from the spacecraft Galileo indicates that the atmosphere of the planet Jupiter is a mixture of molecular hydrogen and helium but the core of the planet is 'metallic hydrogen'. Since this discovery, scientists in California have produced 'metallic hydrogen' at very low temperatures and high pressures.

(i) Describe the structure of a typical metal.

.....

.....

.....[3]

(ii) Suggest a test to show that a sample of hydrogen has a metallic rather than a molecular structure.

.....[1]

(b) Below a temperature of 6 K, molecular hydrogen exists as colourless crystals and above 20 K it is a colourless gas.

(i) Predict the appearance of hydrogen at 15 K

.....[1]

(ii) Describe the arrangement of the molecules in both solid hydrogen and gaseous hydrogen in terms of their separation and order.

solid .....

.....

gaseous .....

.....[4]

(c) Hydrogen forms covalent molecules with other non-metals. Draw a diagram showing the arrangement of the valency electrons in one molecule of the hydrocarbon ethene, C_2H_4

[3]

Use x to represent an electron from carbon.
Use o to represent an electron from hydrogen.

(d) A large scale use of hydrogen is in the Haber Process. Nitrogen and hydrogen react together at 200 atmospheres pressure to form ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(I) What are the other essential conditions for this reaction?

.....

.....[2]

(II) Predict the effect on the position of equilibrium of reducing the pressure.

.....[2]

3 The formula of ethanoic acid is CH_3COOH. It can be made from either ethanol or from petroleum.

(a) Ethanol is slowly oxidised by the oxygen in the air to ethanoic acid.

(I) Name another reagent that can oxidise ethanol to ethanoic acid.

.....[1]

(II) Write a symbol equation for the following word equation.

ethanol + oxygen ⟶ ethanoic acid + water

.....[2]

(b) Hydrocarbons from petroleum are oxidised by oxygen to a mixture of methanoic, ethanoic and propanoic acids. A typical reaction would be of the following type.

$$2C_4H_{10} + 5O_2 \longrightarrow 4CH_3COOH + 2H_2O$$

(I) Name the hydrocarbon C_4H_{10}.

.....[1]

(II) The three acids are in the same homologous series. Give **two** characteristics of a homologous series.

.....

.....[2]

(c) A piece of magnesium was added to 100 cm^3 of aqueous ethanoic acid. The time taken for the metal to react completely was measured. This experiment was repeated with the same volume of acid and identical pieces of magnesium. The results are given in the table.

experiment	*acid*	*concentration* mol/dm^3	*temperature* /°C	*time*/minute
1	ethanoic	1.0	20	5
2	ethanoic	1.0	30	3
3	hydrochloric	1.0	20	0.5

(i) Why was the rate in experiment 3 faster than that in experiment 1?

.....

.....[2]

(ii) The rate of experiment 2 was greater than that of experiment 1 because the temperature of the acid was higher. Explain why an increase in temperature increases the rate of a reaction.

.....

.....[2]

(iii) Other than increasing the temperature of the acid, suggest **two** ways of increasing the rate of reaction between magnesium and aqueous ethanoic acid.

.....

.....[2]

(d) Ethanoic acid and ethanol react to form an ester. Give the name and formula of this ester.

name .....

formula .....[2]

4 Barium is in Group II of the Periodic Table. The chemistry of this metal and of its compounds is very similar to that of calcium.

(a) Barium reacts vigorously with cold water.

(i) Suggest the name of another metal in the same period that reacts with cold water.

.....[1]

(ii) Complete the word equation.

barium + water ⟶ ..... + ...[2]

(b) Use the information given below to predict the formula of barium sulphate and of barium phosphate.

the formula of the barium ion is Ba^{2+}
the formula of the sulphate ion is SO_4^{2-}
the formula of the phosphate ion is PO_4^{3-}

the formula of barium sulphate is .....[1]

the formula of barium phosphate is .....[1]

(c) Complete the equations for the action of heat on barium carbonate and on barium nitrate.

$BaCO_3$ ⟶ ..... + ... [1]

....$Ba(NO_3)_2$ ⟶ ..... + ... + ... [2]

(d) Barium is used to extract the element americium from the compound americium(III) fluoride.

$3Ba + 2AmF_3 \longrightarrow 2Am + 3BaF_3$

(i) Complete the following equations by including the electron transfer.

$Ba \longrightarrow Ba^{2+}$

$Am^{3+} \longrightarrow Am$ [2]

(ii) Which of these equations represents oxidation?

.....[1]

(e) An excess of hydrochloric acid was added to 1.23 g of impure barium carbonate. The volume of carbon dioxide collected at r.t.p. was 0.120 dm^3. The impurities did not react with the acid. Calculate the percentage purity of the barium carbonate.

$BaCO_3 + 2HCl \longrightarrow BaCl_2 + CO_2 + H_2O$

Molar gas volume at r.t.p. is 24 dm^3.

(i) The number of moles of CO_2 collected ..... [1]

(ii) The number of moles of $BaCO_3$ reacted ..... [1]

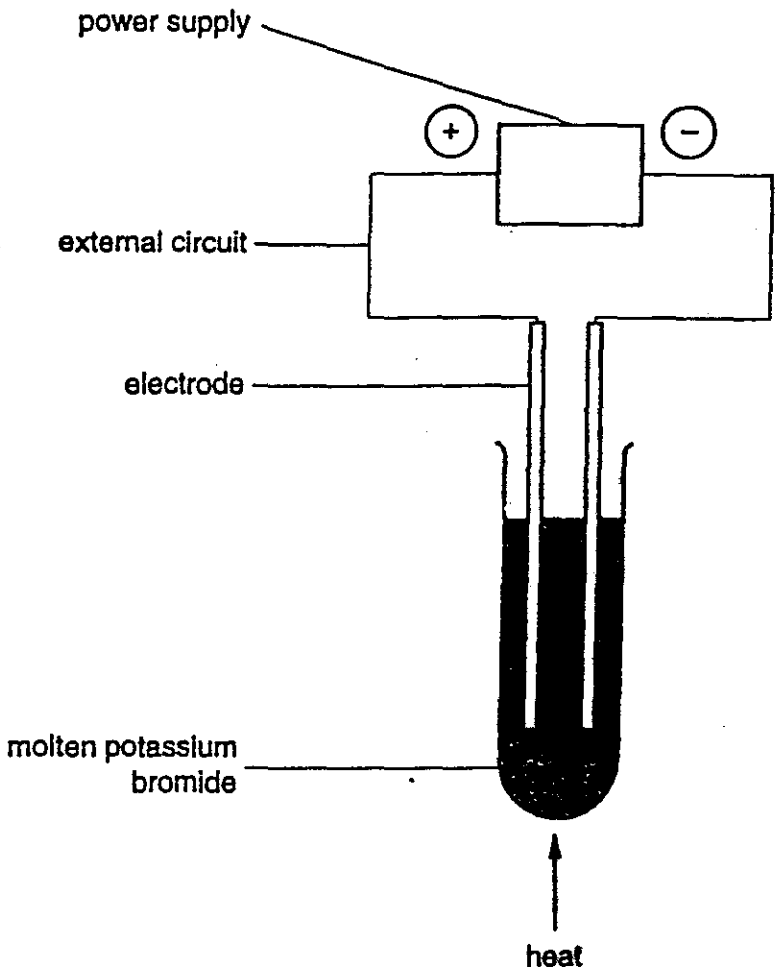
(iii) Mass of one mole of $BaCO_3$ .....g [1]

(iv) Mass of barium carbonate .....g [1]

(v) Percentage purity of the barium carbonate ..... [1]

5 Chemistry is concerned with the transfer of electrons and of energy.

(a) During electrolysis, electrical energy is supplied, electrons move in the external circuit and ions move in the electrolyte. The diagram below show the electrolysis of molten potassium bromide.



(i) Draw an arrow on the diagram to show the direction of the electron flow in the external circuit. [1]

(ii) Is the following reaction exothermic or endothermic? Give a reason for your choice.

$$2KBr \longrightarrow 2K + Br_2$$

.....

.....[2]

(iii) Electrons are removed from the external circuit. How and where is this done?

.....

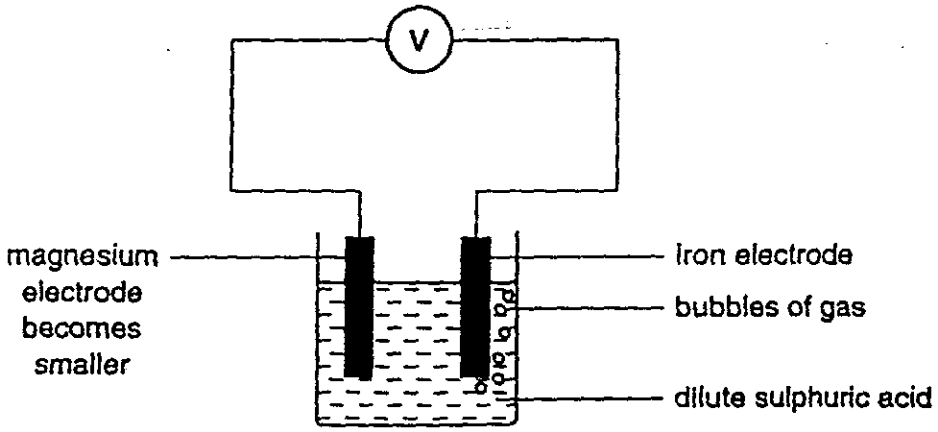
.....[2]

(iv) The results of experiments on electrolysis are shown in the following table. Complete the table; the first line has been completed as an example.

electrolyte	*electrodes*	*change at cathode*	*change at anode*	*change to electrolyte*
molten potassium bromide	carbon	potassium metal formed	bromine formed	used up
aqueous copper(II) sulphate	copper			stays the same
	carbon	hydrogen gas evolved	chlorine formed	potassium hydroxide formed

[4]

(b) The diagram shows a simple cell.



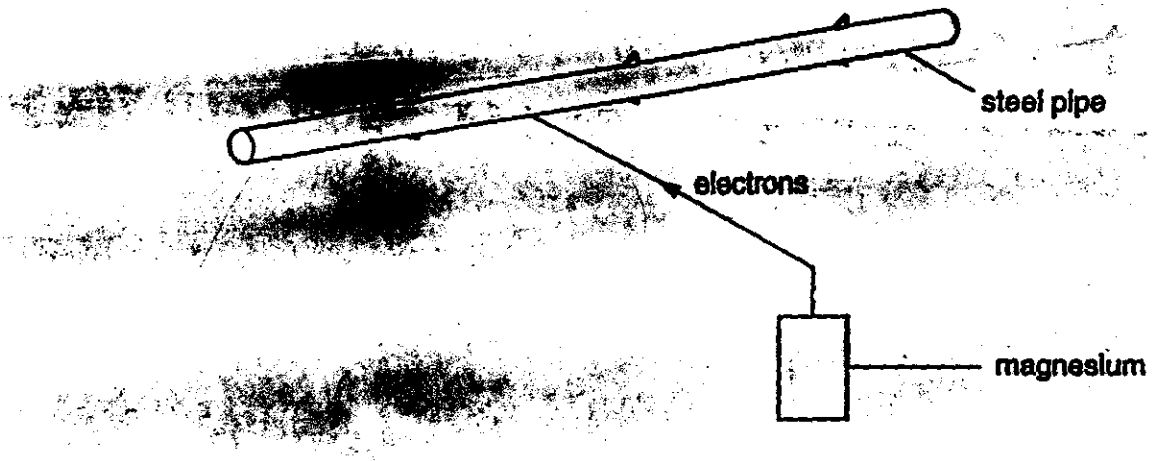
(I) Name the gas formed at the iron electrode.

.....[1]

Write an equation for the reaction at the magnesium electrode.

.....[1]

(II) Explain why attaching blocks of magnesium to steel pipelines prevents them from rusting.



.....

.....

.....[3]

(III) Aqueous iron(II) sulphate is a pale green solution. What would you observe when a piece of magnesium was added to the solution? Would the temperature of the mixture stay the same, decrease or increase?

observations .....

.....[2]

temperature would .....[1]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **27 MAY 1999** Afternoon 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages. 142

1 Lead has been used on roofs since about 5000 BC. It is suited to this use because it is both malleable and resistant to corrosion. Lead rapidly becomes coated with a layer of basic lead(II) carbonate that protects it from further corrosion.

(a) (i) Describe the structure of a typical metal such as lead.

.....

.....[2]

(ii) How does the structure of a metal explain why it is malleable?

.....

.....[2]

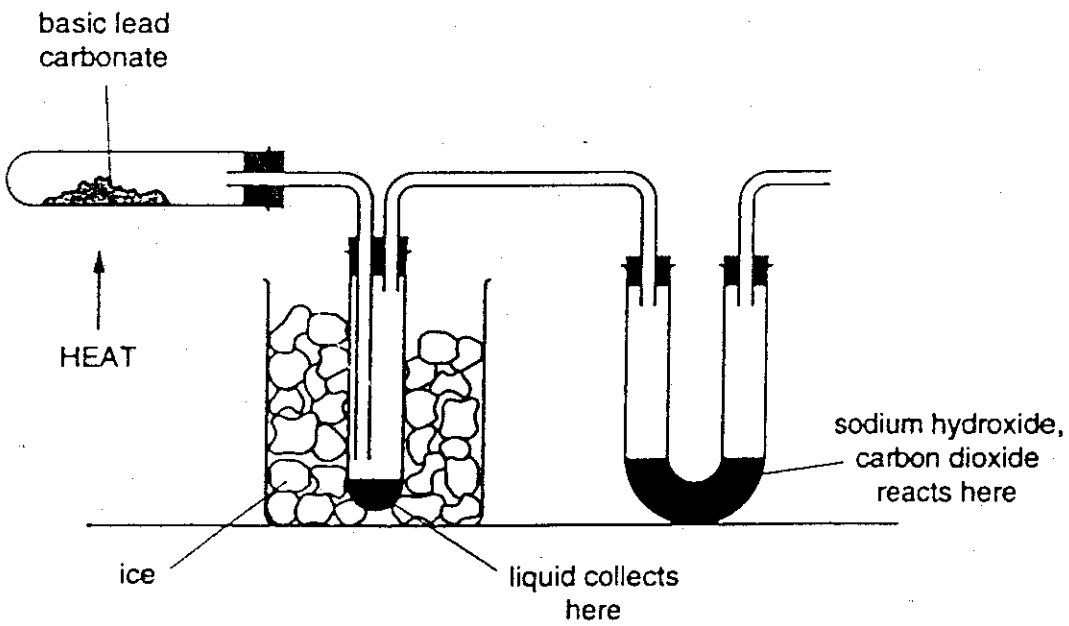
(b) Suggest an explanation why exposure to atmospheric pollution changes basic lead(II) carbonate into lead(II) sulphate.

.....

.....

.....[3]

(c) Basic lead(II) carbonate has a formula of the type $xPbCO_3.yPb(OH)_2$, where x and y are whole numbers. Basic lead(II) carbonate was heated in the apparatus shown below.



(i) How could you show that the liquid collected contained water?

.....[2]

(ii) How could you show that the carbonate gave off carbon dioxide on heating?

.....[2]

(iii) Explain why sodium hydroxide reacts with the non-metal oxide carbon dioxide.

.....

.....[2]

(d) Use the following information to calculate *x* and *y* and to write the formula for the basic lead(II) carbonate.

$$PbCO_3 \longrightarrow PbO + CO_2$$
$$Pb(OH)_2 \longrightarrow PbO + H_2O$$

The basic lead(II) carbonate when heated gave 1.056 g of carbon dioxide and 0.216 g of water.

The mass of one mole of CO_2 = ... g [1]

Number of moles of CO_2 formed = ... [1]

The mass of one mole of H_2O = 18 g

Number of moles of H_2O formed = ... [1]

Therefore x = ... and y = ...

The formula for the basic carbonate is ..... [1]

2 In both Europe and the USA, scientists are investigating the use of hydrogen as a fuel for aeroplanes and cars. It is more efficient and produces less pollution than the existing petroleum-based fuels.

(a) (i) Name the fuel obtained from petroleum that is used for jet aircraft.

.....[1]

(ii) Name **two** pollutants formed by the combustion of petroleum fuels and then explain why the combustion of hydrogen would produce less pollution.

.....

.....

.....

.....[3]

(b) Describe a method of manufacturing hydrogen.

raw material .....

brief description of process .....

.....

.....

[2]

(c) Hydrogen could be transported in heavy cylinders as a gas under pressure or as a liquid at low temperatures.

(i) The pressure exerted by a gas is caused by the molecules of the gas colliding with the walls of the container. Why would the pressure inside a cylinder increase if the temperature was increased?

.....

.....[2]

(ii) Explain what happens to the molecules in gaseous hydrogen as it changes into a liquid at –253 °C.

.....

.....[3]

(d) An alternative method of 'transporting' hydrogen is to change it into methanol. This liquid is easily transported and can be decomposed to re-form hydrogen. Methanol can be made by the following reaction.

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

The gases are passed over a catalyst at 300 °C.
On cooling, the methanol becomes a liquid.

(i) The reaction is carried out at high pressure. What effect would this have on the position of equilibrium?

.....[1]

(ii) Explain why an increase in pressure would increase the rate of the reaction.

.....

.....[2]

(iii) What would be the effect of decreasing the temperature on the concentration of methanol at equilibrium? Give a reasoned explanation for your answer.

.....

.....

.....[2]

3 (a) The alcohols form a homologous series. Their names, formulae and heats of combustion are given below. The heat of combustion is the quantity of heat energy given out when one mole of the alcohol is burned in an excess of oxygen.

name	formula	mass of one mole / g	heat of combustion / kJ per mole
methanol	CH_3OH	32	−720
ethanol	CH_3CH_2OH	46	−1370
propanol	$CH_3CH_2CH_2OH$	60	−2020
butanol			

(i) Complete the last line in the table by writing the formula for butanol, calculating the mass of one mole and by predicting the heat of combustion. [3]

(ii) It is possible to predict physical properties of the members of a homologous series. Describe **two** other characteristics of a homologous series.

.....

.....[2]

(iii) The alcohol $CH_3CH(OH)CH_3$ is a structural isomer of the propanol in the table. Explain the term *structural isomer*.

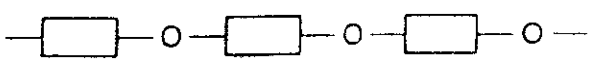
.....

.....[2]

(b) Give a diagram to show the arrangement of the valency electrons in one molecule of the covalent compound methanol.

Use x to represent an electron from a carbon atom.
Use o to represent an electron from a hydrogen atom.
Use ⊗ to represent an electron from an oxygen atom. [3]

(c) Ethanol can be made from starch. Starch is a complex carbohydrate with a structure of the type shown.



This can be broken down by enzymes to simple sugars with formulae of the type shown.

(i) What other method changes starch into simple sugars?

.....[2]

(ii) Give a brief description of how sugars are changed into ethanol.

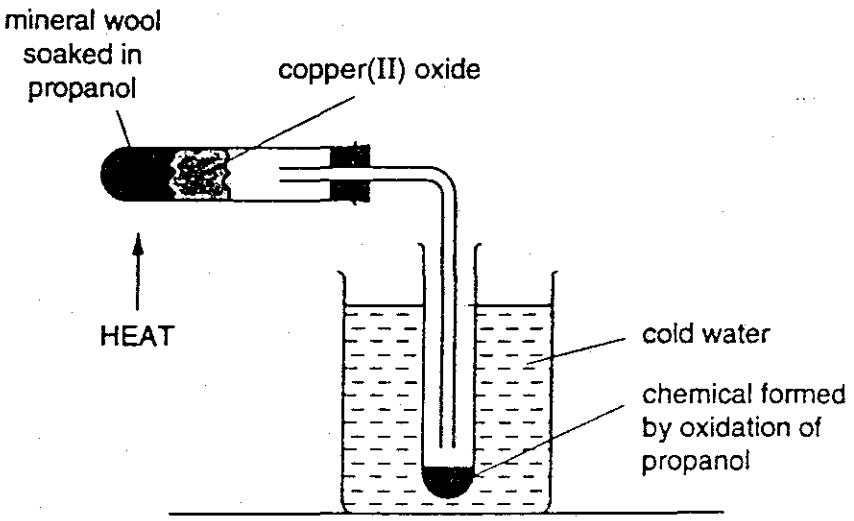
.....

.....

.....

.....[3]

(d) Some alcohols are easily oxidised.



The chemical formed has a pH of 2. Give the name and structural formula of the chemical formed.

name .....[1]

structural formula

[1]

4 Sulphur production in the USA is about ten million tonnes per year. 90% of this sulphur is used to make sulphuric acid.

(a) Sulphur dioxide is made by burning sulphur in air. Most of it is used in the Contact Process. Give **one** other use of this gas.

.....[1]

(b) Bacteria can oxidise the sulphur in coal to sulphuric acid. Water draining off coal tips contains sulphate ions and hydrogen ions.

(i) Describe how you could show the presence of sulphate ions in the water.

.....

.....[2]

(ii) Without using an indicator, how could you show that the water from the coal tips is acidic?

.....

.....[2]

(c) In the Contact Process, sulphur dioxide is made by spraying molten sulphur into air.

(i) Suggest why the molten sulphur is used in the form of a spray.

.....[1]

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

.....

.....

.....[3]

(iii) Complete the equations for the formation of sulphuric acid from sulphur trioxide.

SO_3 + ... $\longrightarrow$ $H_2S_2O_7$

$H_2S_2O_7$ + ... $\longrightarrow$ ..... H_2SO_4

[2]

(d) Over 50% of the sulphuric acid is used to make fertilisers such as the nitrogen-based fertiliser ammonium sulphate.

(i) Give **one** other use of sulphuric acid.

.....[1]

(ii) Nitrogen is one of the three elements essential for plant growth that is added to soil in fertilisers. Name the other two.

..... and .....[2]

(iii) The base ammonia is neutralised by sulphuric acid to form ammonium sulphate. Define the term *base*.

.....

.....[2]

For Examiner's Use

5 You will need to use the Periodic Table of the Elements to answer this question.

(a) A radioactive isotope of the element iodine, ^{125}I, is used to treat cancer. How many electrons and how many neutrons are there in one atom of this isotope of iodine?

number of electrons .....[1]

number of neutrons .....[1]

(b) Given below are the formulae of the oxides of some of the elements. They are given in the same order as in the Periodic Table.

MgO	Al_2O_3	SiO_2	P_2O_3
CaO			
SrO			

(i) Use the electronic structures of the elements to explain why oxides of elements in the same group have the same type of formula.

.....

.....

.....[2]

(ii) Use the electronic structures of the elements to explain why oxides of elements in the same period have different formulae.

.....

.....

.....[1]

(iii) Complete the table that shows the reaction, if any, of the oxides with acid and alkali. Indicate a reaction with "R" and no reaction with "NR".

oxide	type of oxide	reaction with acid	reaction with alkali
magnesium oxide	basic		
aluminium oxide	amphoteric		
silicon(IV) oxide	acidic		

[3]

(c) (i) Predict the formula for:

the strontium ion, ...

the phosphide ion. .....

[2]

(ii) Write the formula for strontium phosphide .....[1]

(d) The reactivity of elements in the same group varies in a predictable way.

(i) Name a metal that reacts more violently with cold water than does potassium.

.....[1]

(ii) Complete the word equation.

potassium + water ⟶ ..... + ...

..... [2]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **11 NOVEMBER 1999** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator and/or Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

1 Zinc was manufactured in India as early as the 14th century. Zinc oxide was heated with carbon. Zinc distilled out of the reaction mixture and was collected as the impure metal in cooled receivers.

(a) (i) A major ore of zinc is zinc blende. Describe how it is changed into zinc oxide.

.....

.....[2]

(ii) Write an equation for the reduction of zinc oxide by carbon.

.....[2]

(iii) Zinc can be refined by electrolysis. The method is similar to that used to refine copper. Complete the following statements about the refining of zinc.

The cathode is made from .....[1]

The anode is made from .....[1]

The electrolyte is aqueous .....[1]

(iv) State **two** large scale uses of zinc.

.....

and .....[2]

(b) Aluminium is more reactive than zinc. Both metals are very important in industry.

(i) Explain why aluminium cannot be obtained by heating its oxide with carbon.

.....

.....[2]

(ii) Aluminium is extracted by the electrolysis of its molten oxide. Suggest why aluminium cannot be obtained by electrolysis of an aqueous solution of an aluminium salt.

.....[1]

(c) Zinc nitrate and sodium nitrate behave differently when heated.

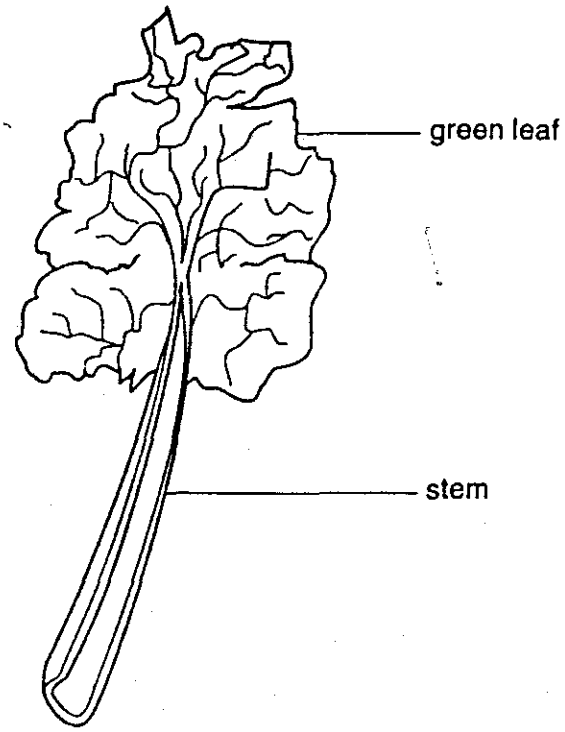
(i) Write an equation for the action of heat on zinc nitrate.

.....[2]

(ii) What difference would be observed when sodium nitrate is heated?

.....[1]

2 The diagram below shows the leaf and stem of the rhubarb plant.



(a) When the leaf is crushed and mixed with the solvent propanone, the coloured pigments are extracted to give a deep green solution. One of the pigments in this solution is chlorophyll.

(i) What is the role of chlorophyll in a green plant?

.....

.....

.....[3]

(ii) How could you show that chlorophyll is not the only pigment in the solution? Name the technique used and give a brief description.

technique .....[1]

description .....

.....

.....[2]

For Examiner Use

(b) From the plant, an organic acid can be extracted. This is called oxalic acid and its salts are called oxalates. What can be deduced about oxalic acid from each of the following experiments?

Aqueous oxalic acid has a pH of 3 whereas hydrochloric acid of the same concentration has a pH of 1.

deduction .....[1]

When added to acidified potassium manganate(VII), the colour changes from purple to colourless.

deduction .....[1]

One mole of oxalic acid reacts with two moles of sodium hydroxide.

deduction.....[1]

(c) Outline the preparation of crystals of the soluble salt, sodium oxalate, from a solution of oxalic acid.

.....

.....

.....

.....

.....

.....[4]

(d) The M_r of oxalic acid is 90 and its composition by mass is:

carbon = 26.7% hydrogen = 2.2% oxygen = 71.1%

(i) Calculate the empirical formula of oxalic acid.

.....

.....

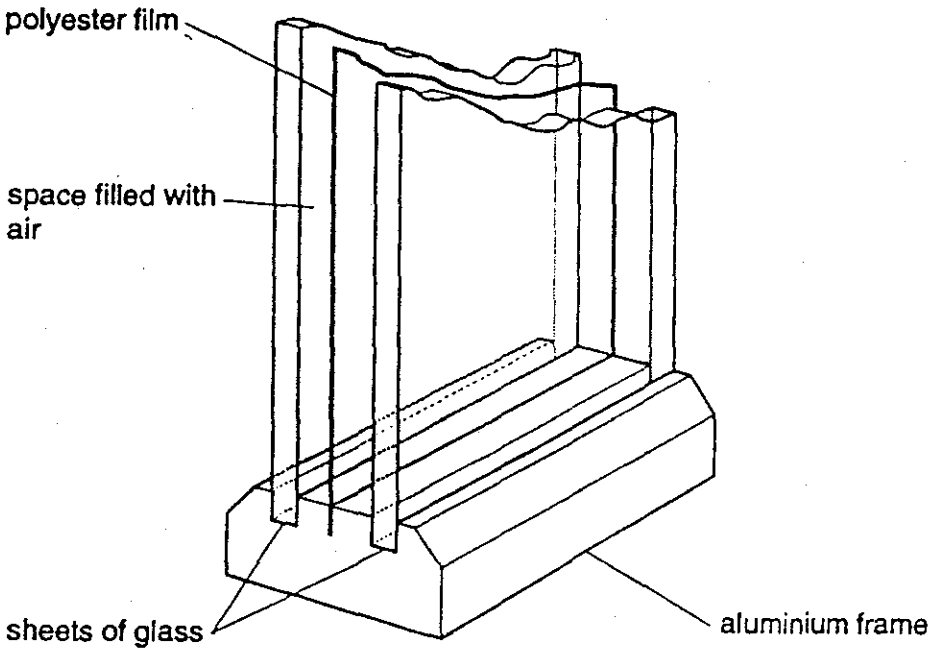
.....[3]

(ii) What is the molecular formula of the acid?

.....

.....[1]

3 A double-glazed window was developed in Silicon Valley, USA. It has two sheets of glass mounted in an aluminium frame and between these sheets there is a polyester film coated with a very thin layer of silver. This arrangement controls the transmission of both heat and light.



(a) Glass can be made by reacting a basic oxide, such as calcium oxide, with the acidic oxide, silicon(IV) oxide.

(i) Calcium oxide is ionic. Draw a diagram that shows the charges on the ions and gives the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from an oxygen atom.
Use o to represent an electron from a calcium atom. [3]

(ii) Silicon(IV) oxide is macromolecular. Describe its structure.

.....

.....

.....[2]

(b) (i) Ethyl ethanoate is a simple ester. Name **two** chemicals which react to form ethyl ethanoate.

.....and .....[2]

(ii) Draw a structure for a polyester such as *Terylene*.

[2]

(c) An analyst was asked to show that the polyester film had been coated with silver. A piece of the polyester was dropped into dilute nitric acid; this dissolved the silver. Suggest how the solution formed could be tested for silver ions.

reagent used .....[1]

result of test .....[2]

(d) The window was improved in Switzerland by filling the space between the sheets of glass with krypton which is one of the noble gases. Krypton is a poorer conductor of heat than air because it exists as single atoms rather than the diatomic molecules of oxygen and nitrogen.

(I) Give another use for a noble gas.

.....[1]

(II) Explain why krypton remains as separate atoms but nitrogen exists as diatomic molecules.

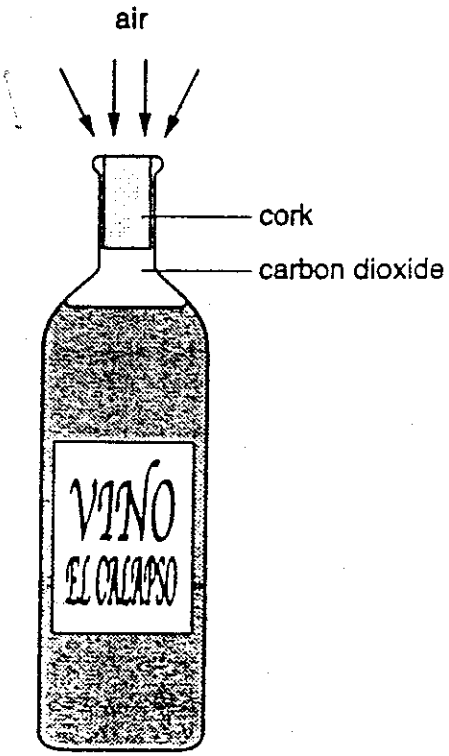
.....

.....

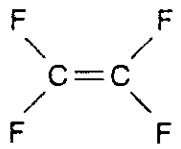
.....[3]

4 Carbon dioxide is formed by the complete combustion of fossil fuels, by the action of heat or of acids on carbonates, and during fermentation.

(a) In Italy, corks for bottles may be coated with the polymer poly(tetrafluoroethene). This coating makes it easier to remove the cork and it prevents the diffusion of gases through the cork.



(I) The structure of tetrafluoroethene is given below.



Predict the structure of the polymer poly(tetrafluoroethene).

[2]

(II) Explain why the molecules of oxygen and nitrogen in air would diffuse into the bottle through an uncoated cork faster than carbon dioxide would diffuse out through the cork.

.....

.....[2]

For Examiner's Use

(b) Carbon dioxide is formed when a carbonate reacts with an acid. In the following experiments, solid calcium carbonate was added to hydrochloric acid and the rate at which carbon dioxide was produced was measured. Some of the results are given in the table below.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

experiment	concentration of acid in mol/dm^3	size of particles of calcium carbonate	rate of reaction in g/min of carbon dioxide
A	1.0	lumps	0.14
B	2.0	lumps	0.28
C	2.0	powder	0.35
D	...	lumps	0.21

(i) Suggest a method of measuring the rate of this reaction.

.....

.....

.....[2]

(ii) Predict the concentration of the acid used in experiment **D**.

.....[1]

(iii) Why is the rate in experiment **C** faster than that in experiment **B**?

.....

.....[2]

(c) The thermal decomposition of calcium carbonate is a reversible reaction.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g) \qquad \Delta H = +178\,kJ$$

(i) Explain why the forward reaction is described as *endothermic.*

.....[1]

(ii) Describe **two** ways of moving the position of the above equilibrium towards the right-hand side.

.....

.....[2]

(d) Exhaust gases from a car include carbon dioxide, carbon monoxide and oxides of nitrogen. A catalytic converter does not decrease the emission of carbon dioxide but does decrease the amounts of carbon monoxide and of the oxides of nitrogen.

(I) Explain how oxides of nitrogen are formed.

.....

.....

.....[2]

(II) How does a catalytic converter decrease the emission of carbon monoxide and of the oxides of nitrogen?

.....

.....

.....[2]

For Examiner's Use

5 Chemistry is concerned with patterns of reactivity and the reasons for differences in reactivity.

(a) The reactivity of a metal is a measure of its ability to form positive ions. A piece of zinc was added to aqueous copper(II) nitrate. The reaction that occurred can be represented by the following equation.

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$

(i) Describe the observations for this reaction.

.....

.....[2]

(ii) Write the ionic equation for copper(II) ions changing to copper atoms.

.....[1]

(iii) Which metal, copper or zinc, is the more reactive? Give a reason for your choice.

.....

.....[2]

(b) Some non-metals are placed in order of reactivity in the following series.

$Cl_2 + 2e^- \longrightarrow 2Cl^-$	chlorine is the most reactive
$Br_2 + 2e^- \longrightarrow 2Br^-$	
$I_2 + 2e^- \longrightarrow 2I^-$	
$S + 2e^- \longrightarrow S^{2-}$	sulphur is the least reactive

(i) Name a non-metal that is more reactive than chlorine.

.....[1]

(ii) If the reactivity of a metal is determined by its ability to form positive ions, suggest what is a measure of the reactivity of non-metals.

.....[1]

(iii) Which substance(s) in the above series could be oxidised by bromine?

.....[2]

(c) Ethane and ethene are both hydrocarbons but with halogens ethene is more reactive than ethane.

(i) Ethane reacts with chlorine when the reaction mixture is exposed to bright light. What type of reaction is this? Name an organic product of this reaction.

type of reaction .....[1]

organic product .....[1]

(ii) Ethene reacts readily with bromine. Name the product, write an equation and describe what you would observe.

name of product .....[1]

equation .....[2]

observations .....

.....[1]

(iii) The reaction between ethene and bromine is an addition reaction. Name **one** other substance that takes part in an addition reaction with ethene.

.....[1]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

MAY/JUNE SESSION 2000 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Mathematical tables.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 16.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 14 printed pages and 2 blank pages.

[Turn over

1 Germanium is an element in Group IV. It was first isolated in Germany by C Winkler in 1886.

(a) It has a similar macromolecular structure to diamond. Predict **two** physical properties of germanium.

.....

.....[2]

(b) Explain why graphite, which is also a macromolecular form of carbon, has different physical properties to diamond and germanium.

.....

.....[2]

(c) The electron distribution of a germanium atom is 2.8.18.4.
Draw a diagram to show the arrangement of the valency electrons in the covalent compound germanium tetrachloride.

Use o to represent an electron from germanium.
Use x to represent an electron from chlorine. [3]

(d) Germanium forms a series of saturated compounds with hydrogen which resemble the alkanes.

(i) Predict the general molecular formula of these compounds of germanium and hydrogen.

.....[1]

(ii) Draw the structural formula for one of the above compounds that contains four germanium atoms per molecule.

[1]

(e) When aqueous solutions of germanium(II) chloride and of iron(III) chloride are mixed, the following reaction occurs.

$$GeCl_2 + 2FeCl_3 \longrightarrow 2FeCl_2 + GeCl_4$$

or $Ge^{2+} + 2Fe^{3+} \longrightarrow 2Fe^{2+} + Ge^{4+}$

(i) Is the germanium(II) chloride acting as an oxidising agent or reducing agent? Explain your choice using the idea of electron transfer.

.....

.....[2]

(ii) Describe a test to show that an iron(III) salt had been changed into an iron(II) salt.

test .....

result for iron(III)salt .....

result for iron(II) salt .....

[3]

2 Ammonia is made by the Haber process from nitrogen and hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92\,kJ/mole \text{ (reaction is exothermic)}$$

(a) Describe how nitrogen can be obtained from the air.

.....

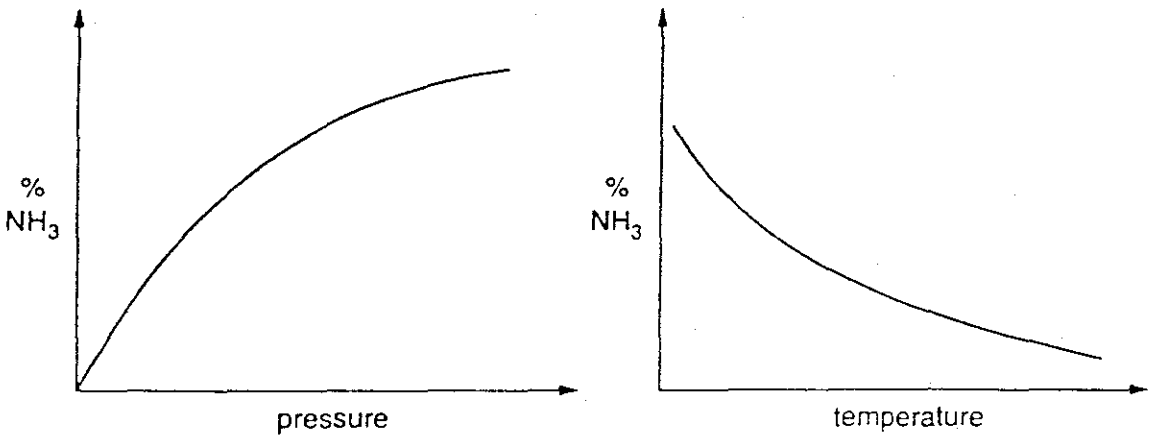
.....[2]

(b) Describe how hydrogen can be made from an alkane.

.....

.....[2]

(c) The diagram below shows how the percentage of ammonia in the equilibrium mixture changes with the conditions.



The y axis is the percentage of ammonia at equilibrium.

Fig. 2.1

(i) What is the effect of increasing the temperature on the percentage of ammonia in the equilibrium mixture?

.....[1]

(ii) What is the effect of increasing the pressure upon the position of equilibrium. Does it move to the the left, stay the same or move to the right?

.....[1]

(iii) Why does the position of equilibrium move as stated in (ii)?

.....

.....[2]

(iv) Suggest an explanation why an increase in pressure increases the reaction rate.

.....

.....[1]

(d) Large amounts of ammonia are used in the manufacture of ammonium sulphate.

(i) What is the main use of this salt?

.....[1]

(ii) Describe how crystals of ammonium sulphate can be made in the laboratory from aqueous ammonia.

.....

.....

.....

.....[4]

(e) Car engines and flue gases from power stations both release oxides of nitrogen into the air. These oxides are a cause of acid rain.

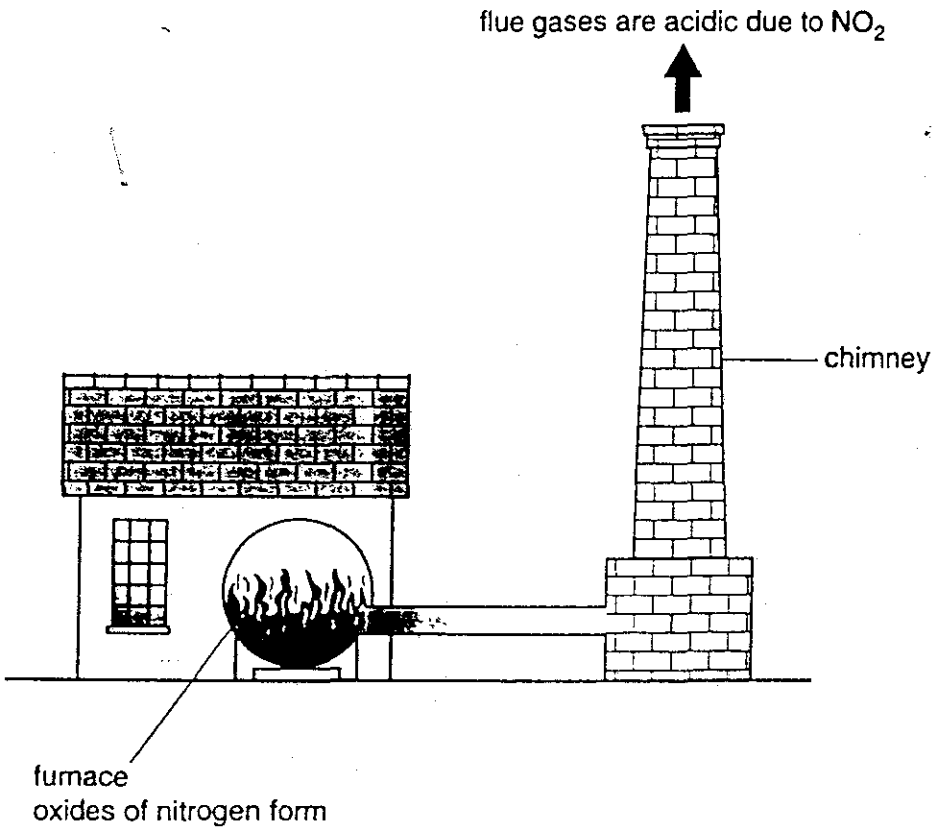


Fig. 2.2

(i) Explain how these oxides are formed.

.....

.....[2]

(ii) The emission of the oxides is decreased by mixing the flue gases with ammonia and passing over a catalyst. Complete the balancing of the equation.

$6NO_2$ + ...NH_3 ⟶ $7N_2$ + ...H_2O [1]

(iii) Suggest how the pH of the flue gases can show that just the right amount of ammonia is being used.

.....

.....

.....[2]

3 Nantucket is an island twenty five miles off the coast of the USA. Some of the different fuels and sources of energy that have been used on the island over the years are listed below.

wood	earliest
whale oil	↓
coal and coal gas	↓
petroleum products	at present
electricity by cable from mainland	future

(a) Wood was the first carbon-based fuel used. Explain why the cycle of cutting down trees, burning the wood and the regrowth of the forest does not cause any long term changes in the amount of carbon dioxide in the atmosphere.

.....

.....

.....[3]

(b) Whale oil contains unsaturated esters. As well as being used as a fuel, a number of valuable products can be made from this oil.

(i) Describe how you could show that whale oil contains compounds that have carbon-carbon double bonds.

.....

.....

.....[3]

(ii) How could a soap be made from the oil?

.....

.....[2]

(iii) Margarine used to be made from the oil by changing the unsaturated hydrocarbon chains into saturated hydrocarbon chains. Complete the word equation for this reaction.

unsaturated hydrocarbon + ... ⟶ saturated hydrocarbon [1]

(c) Coal gas was made on the island by heating coal. It is a mixture of hydrogen, methane, carbon monoxide, nitrogen etc. Explain how the percentage of hydrogen in the mixture is increased by diffusion through a porous barrier.

.....

.....

.....[3]

(d) A typical electricity cable would have a copper core surrounded by a polymer as an outer casing.

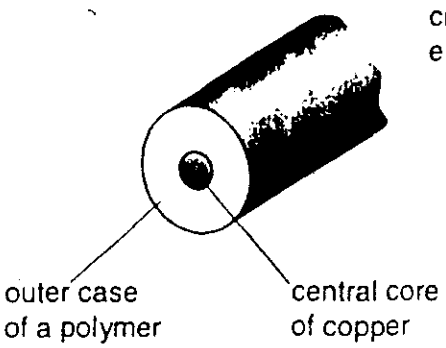


Fig. 3.1

(i) Give **two** reasons why the core is made from copper.

.....

.....[2]

(ii) Give **two** reasons why a polymer might be a suitable material for the outer casing.

.....

.....[2]

4 (a) Copper is refined by electrolysis.

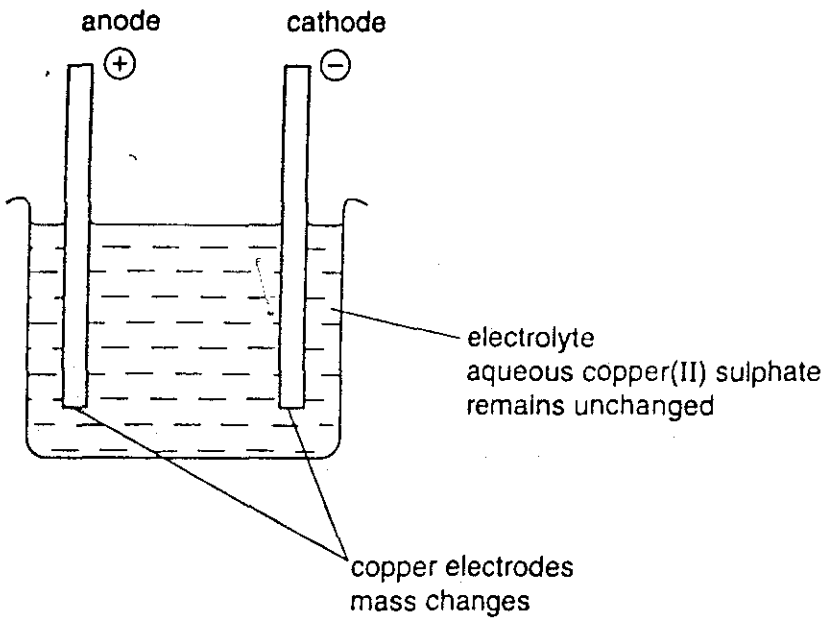


Fig. 4.1

Explain with equations why the electrodes change in mass and why the concentration of aqueous copper(II) sulphate remains unchanged.

.....

.....

.....

.....[4]

(b) An alloy contains contains zinc and copper. A small sample of this alloy was dissolved in acid to give a solution containing zinc and copper ions. Explain what would happen when an **excess** of each of the following reagents is separately added to this solution.

(i) iron filings

.....

.....[2]

(ii) sodium hydroxide

.....

.....[2]

(c) The following diagram shows a simple cell.

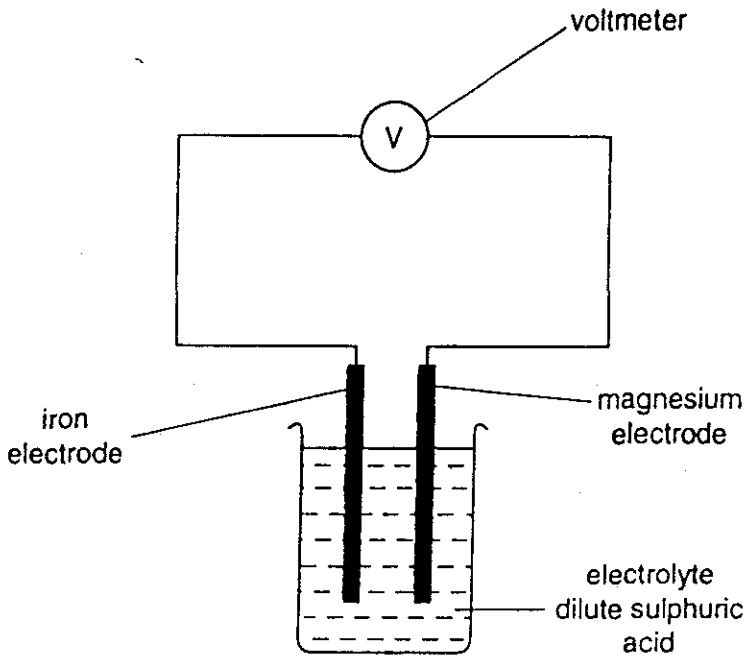


Fig. 4.2

(i) What is a *cell*?

.....

.....[2]

(ii) Mark on the diagram the direction of the electron flow. [1]

For Examiner's Use

(d) A sample of impure copper was dissolved in nitric acid. The solution of copper(II) nitrate was filtered to remove solid impurities and evaporated to dryness. The solid nitrate was heated to constant mass to leave only copper(II) oxide.

Results
Mass of impure copper = 4.21 g
Mass of copper oxide = 4.80 g

$2Cu(NO_3)_2(s) \longrightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$

(i) Complete the following to determine the percentage purity of the sample of copper.

The mass of one mole of CuO = 80 g

number of moles of CuO formed = ... [1]

mass of copper in copper(II) oxide = ... [1]

percentage of copper = ... [1]

(ii) Calculate the total volume of gas formed at r.t.p.

total number of moles of gas formed = ... [2]

volume of gas formed = ...dm^3 [1]

5 (a) The structure of the synthetic polymer *Terylene* is given below.

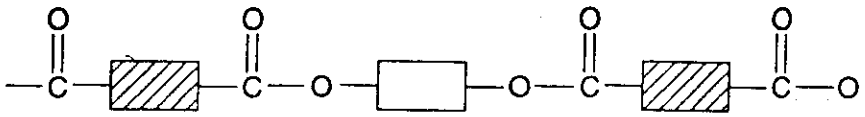


Fig. 5.1

(i) Name the type of linkage in this polymer.

.....[1]

(ii) What naturally occurring substance contains the same linkage?

.....[1]

(b) Another synthetic polymer is nylon. Draw the structure of a nylon.

[3]

(c) Complex carbohydrates such as starch are natural polymers.

(i) Name the **three** elements present in carbohydrates.

.....[1]

(ii) Draw the structure of a complex carbohydrate.

[2]

(d) Chromatography is used to identify simple carbohydrates, such as sugars, in plant material.

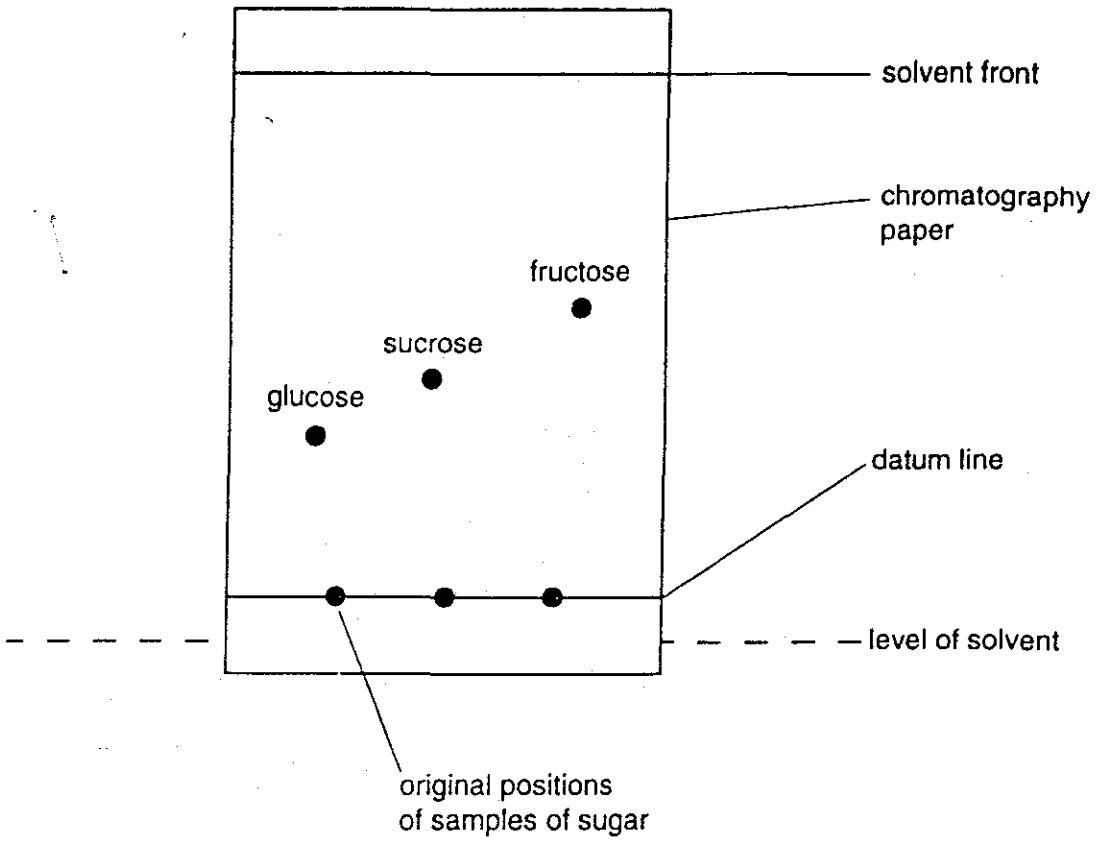


Fig. 5.2

A leaf is ground with 50% aqueous alcohol to give a colourless solution of the sugars. This solution is concentrated and a chromatogram is obtained. The paper is sprayed with resorcinol solution.

(i) A common use of ethanol is in alcoholic drinks. In this experiment it is used as a solvent. Give one other use.

.....[1]

(ii) Why is the datum line drawn in pencil?

.....[1]

(iii) Suggest a reason why it is necessary to spray the chromatogram with resorcinol.

.....

.....[2]

(iv) Describe how chromatography could be used to show that the hydrolysis of starch produces only one sugar, glucose.

.....

.....[2]

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 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 / 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.).

Candidate Name _____

Centre Number	Candidate Number

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

Thursday **9 NOVEMBER 2000** Morning 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator and/or Mathematical tables

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Mathematical tables are available.
You may use a calculator.
A copy of the Periodic Table is printed on page 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 10 printed pages and 2 blank pages.

1 The element scandium, proton (atomic) number, $Z = 21$, was discovered by L Nilson in Sweden in 1879.

(a) It forms only one ion which has the formula $^{45}_{21}Sc^{3+}$.

(i) How many electrons, protons and neutrons are there in this ion?

number of electrons .....

number of protons .....

number of neutrons .....

(ii) Predict the electron distribution of this ion.

.....

[4]

(b) The main ore of scandium is thortveitite, $Sc_2Si_2O_7$. This is converted into scandium fluoride which reacts with calcium to produce scandium metal.

(i) Balance the ionic equation for the reaction between scandium fluoride and calcium.

$$.....Ca + ...Sc^{3+} \longrightarrow ....Ca^{2+} + ...Sc \qquad [1]$$

(ii) Which change in the above reaction is oxidation? Give a reason for your choice.

.....

.....

.....[2]

(iii) An alternative method of extracting scandium is by the electrolysis of a molten mixture that contains scandium chloride. Write ionic equations for the reactions at the electrodes.

reaction at cathode .....

reaction at anode .....[2]

(c) The density of scandium is 2.99 g/cm^3 and it has only one valency of three. Scandium compounds are white solids and form colourless solutions. Titanium is a more typical transition metal, predict how its properties would be different from those of scandium.

.....

.....

.....[2]

(d) A 43 g sample of scandium ore, $Sc_2Si_2O_7$ produced 12 g of scandium. Calculate the percentage yield by completing the following calculation.

The mass of one mole of $Sc_2Si_2O_7$ is 258 g

Number of moles of $Sc_2Si_2O_7$ in 43 g of the ore = ...

One mole of $Sc_2Si_2O_7$ will give .....moles of Sc

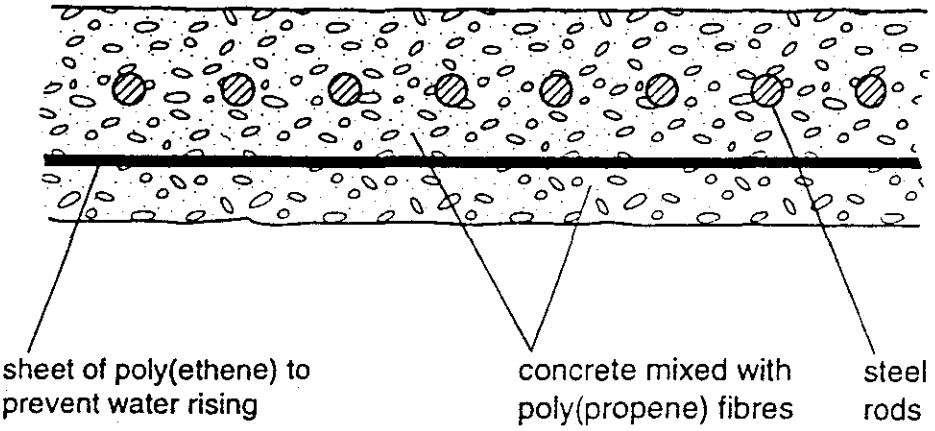
43 g of $Sc_2Si_2O_7$ will produce .....moles of Sc

43 g of $Sc_2Si_2O_7$ will produce .....g of Sc

Percentage yield of scandium = ...

= ..... [5]

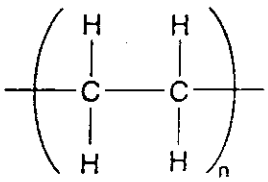
2 The diagram below shows a correctly constructed concrete floor.



(a) (i) What type of reaction is used to make both of the polymers, poly(ethene) and poly(propene)?

.....

(ii) A diagram of the structure of poly(ethene) is given below.



Draw a similar diagram to show the structure of poly(propene).

[3]

(b) (i) **Iron from the blast furnace is impure. It contains about 5% of carbon and of other impurities such as silicon and sulphur. Describe how this impure iron is converted into mild steel.**

.....

.....

.....

.....[4]

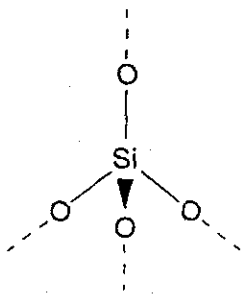
(ii) The steel reinforcing rods might be galvanised. Explain what is meant by *galvanising* and how this will decrease the rate at which the rods corrode.

.....

.....

.....[3]

(c) Two of the chemicals used to make concrete are limestone and sand. Limestone is an ionic compound, containing the ions Ca^{2+} and CO_3^{2-}. Sand is mainly an oxide of silicon which is macromolecular.



(i) What is the valency of

calcium in calcium carbonate, ...

silicon in this oxide? .....

(ii) What is the electron distribution in one atom of

calcium, ...

silicon? .....

(iii) Explain why the metal calcium forms ionic bonds but the non-metal silicon forms covalent bonds.

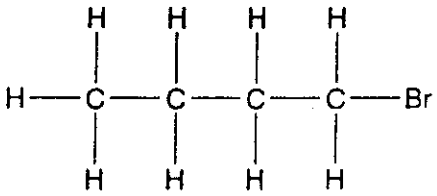
.....

.....

[6]

3 Organic compounds that contain the halogens can have chloro, bromo or iodo in their names.

(a) The following diagram shows the structure of 1-bromobutane.



(i) Draw the structure of an isomer of this compound.

(ii) Draw a possible structure of a dibromobutane.

(iii) Name two chemicals that react together to make only one product – dibromobutane.

..... and .....

[4]

(b) Draw a diagram to show the arrangement of the valency electrons in the covalent compound chloromethane.
Use o to represent an electron from carbon
Use x to represent an electron from hydrogen
Use ⊗ to represent an electron from chlorine

[3]

(c) Organic halides react with water to form an alcohol and a halide ion.
The halogen present in an organic compound can be determined by identifying the halide ion.

$$\underset{\text{bromoethane}}{CH_3CH_2Br} + \underset{\text{water}}{H_2O} \longrightarrow \underset{\text{ethanol}}{CH_3CH_2OH} + \underset{}{H^+} + \underset{\text{bromide ion}}{Br^-}$$

(i) Name the alcohol formed when 1-bromobutane reacts with water.

.....

(ii) Describe how you could test for the bromide ion.

reagent used .....

result of test .....

(iii) Suggest an explanation for the following observations.
Bromine was bubbled through a solution containing a halide ion. The solution turned dark brown.

.....

.....

[5]

(d) The rate of reaction between an organic halide and water can be studied in the following experiment.

A mixture of $10\,cm^3$ of aqueous silver nitrate and $10\,cm^3$ of ethanol are warmed to 60 °C. Drops of the organic halide are added and the time taken for a precipitate to form is measured.

The reaction produces halide ions which react with the silver nitrate to give a precipitate of a silver halide. The results are given in the table.

experiment	organic halide	number of drops	time/min
A	bromobutane	4	5
B	bromobutane	8	2
C	chlorobutane	4	100
D	iodobutane	4	0.1

(i) Write the three organic halides in order of reactivity with water.

..... most reactive

.....

.....

..... least reactive

(ii) Explain why it takes longer to produce the precipitate in experiment A than in B.

.....

.....

[3]

4 The two non-metals, sulphur and selenium, are in Group VI.

(a) Sulphuric acid is made from sulphur. This acid is used to make detergents called sulphonates. A hydrocarbon is made to react with oleum (fuming sulphuric acid) to form sulphonic acids. These form salts called sulphonates.

(i) Complete the word equations for some reactions of a sulphonic acid.

magnesium + sulphonic acid ⟶ magnesium sulphonate + ...

sodium carbonate + sulphonic acid ⟶ ..... + ... + water.

....

(ii) Sulphonate ions are of the type RSO_3^-, where R is an organic group. What is the formula of magnesium sulphonate?

.....

(iii) How is oleum made in the Contact Process?

.....

.....

(iv) How is oleum changed into concentrated sulphuric acid?

.....

[7]

(b) Insoluble and soluble sulphates can each be made from dilute sulphuric acid. Describe how a pure sample of the insoluble salt, lead(II) sulphate, can be made.

.....

.....

.....

.....[4]

(c) Predict two **chemical** properties of the non-metal selenium.

.....

.....[2]

(d) Selenium is used to make a device that can change light energy into electrical energy.

(i) Name the process used in green plants to change light energy into chemical energy.

.....

(ii) Explain how a liquid fuel can be obtained from plant material.

.....

.....

[3]

5 Chemistry is concerned with problem-solving and answering questions. For each of the following, describe any experiments that are needed and, when necessary, indicate how the results should be used to solve the problem.

(a) Nickel sulphate-7-water exists as bright green crystals and anhydrous nickel sulphate as a yellow powder. How could you show that the action of heat on the hydrated salt is a reversible reaction?

.....

.....

.....[3]

(b) How could you prove that the percentage of water in an aqueous solution of sodium chloride is 74%?

.....

.....

.....[4]

(c) A small piece of cement from a wall is dissolved in nitric acid. The resulting mixture is filtered to give a solution.

(i) What observation shows that the cement contains carbonate ions and what test is needed to confirm this?

observation .....

test .....

result .....

(ii) How could you show that the solution contains calcium ions?

reagent .....

result .....

reagent .....

result .....

[6]

(d) The formula of an acid is either of the type HY or H_2Y. How could you find out which one is correct by using aqueous solutions of the acid and of sodium hydroxide. Assume that both solutions have the same concentration, 0.1mol/dm^3.

.....

.....

.....

.....[4]

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 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: $^{a}_{b}X$ — 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.).

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

MAY/JUNE SESSION 2001 1 hour 15 minutes

Candidates answer on the question paper.
No additional materials are required.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

1 Fertilisers contain nitrogen. They are usually ammonium salts or nitrates.

(a) Describe a test for the nitrate ion.

test .....

.....

result .....

.....[4]

(b) Urea, $CO(NH_2)_2$, is a fertiliser. It reacts with water to form a solution of ammonium carbonate. This reaction is catalysed by the enzyme, urease.

(i) Describe how you could show that this solution contained carbonate ions.

.....

.....

(ii) The fermentation of glucose is also catalysed by enzymes. Write a word equation for this reaction.

.....[4]

(c) Nitrogen-containing fertilisers used to be made by the following reaction.

$N_2 + O_2 \rightleftharpoons 2NO$ forward reaction is endothermic

3000 °C and no catalyst

They are now made using the reaction below.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ forward reaction is exothermic

450 °C and iron as a catalyst

(i) Suggest why a high temperature is needed for the first reaction but a lower temperature for the other.

.....

.....

.....

(ii) Explain why a catalyst is not needed for the first reaction.

.....

.....[3]

(d) Plants need nitrogen to make proteins, which are natural polymers.

(i) Name the linkage present in proteins.

.....

(ii) Nylons are synthetic polymers which have the same linkage as proteins. Draw the structure of the nylon that could be made from the monomers:

$H_2N(CH_2)_6NH_2$ and $HOOC(CH_2)_8CO_2H$

[3]

2 (a) The Group I metals show trends in both their physical and chemical properties.

(i) How does the melting point of lithium compare with that of caesium?

.....

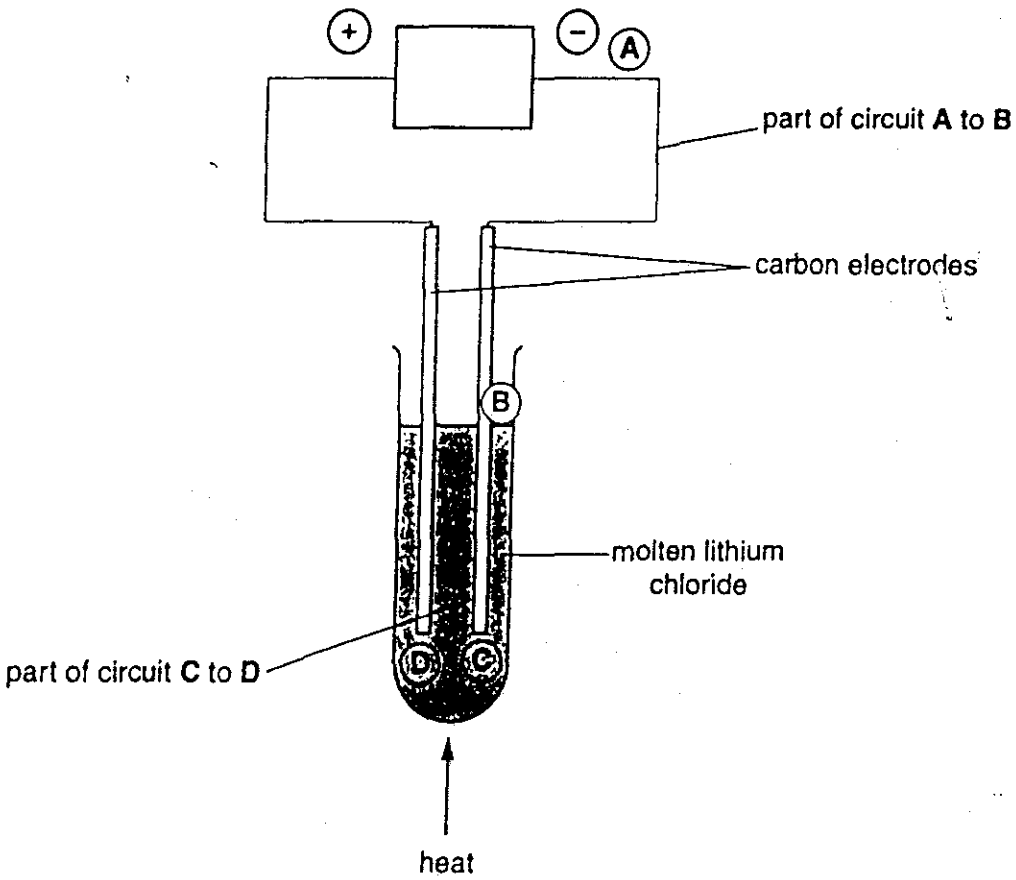
(ii) All Group I metals react with cold water to form the metal hydroxide and hydrogen. What is the trend in their reactivity with water?

.....

(iii) Write an equation for the reaction between water and lithium.

.....[4]

(b) Lithium is extracted by the electrolysis of its molten chloride.



(i) Lithium chloride is an ionic compound. Explain why it is conducts electricity in the molten state but not in the solid state.

.....[2]

(ii) How is electricity conducted in the part of the circuit labelled

A to B? .....

C to D? .....[2]

(iii) What would be the products of the electrolysis of concentrated aqueous lithium chloride?

.....

.....[3]

(c) The following is part of the description of the preparation of the soluble salt lithium chloride.

25.0 cm^3 of a solution of lithium hydroxide, concentration 1.00 mol/dm^3 was placed in a beaker. A few drops of the indicator, methyl orange, were added and the mixture turned yellow. Hydrochloric acid was added from a burette until the mixture just turned red. 20.0 cm^3 of the acid was needed to neutralise the alkali.

(i) Describe how the experiment should be completed to obtain pure crystals of the salt.

.....

.....

.....

.....[3]

(ii) Calculate the concentration of the hydrochloric acid.

$$LiOH + HCl \longrightarrow LiCl + H_2O$$

Number of moles of LiOH in 25 cm^3 of a 1.00 mol/dm^3 solution

= .....

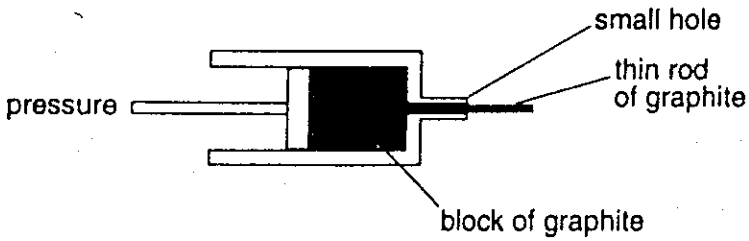
Therefore number of moles of HCl in 20 cm^3 = ...

Concentration of HCl = ...

= ..... mol/dm^3 [4]

3 (a) Diamond and graphite are macromolecular forms of carbon. Their physical properties are different, because they have different structures.

(I) By discussing its structure explain how graphite can change its shape without breaking.



.....

.....

(II) If the experiment is repeated using a diamond, it cuts into the metal rather than change shape. Explain by discussing its structure why diamond is so hard.

.....

.....[4]

(b) Both solids burn to form carbon dioxide. Draw a diagram to show the arrangement of the valency electrons in one molecule of this covalent compound.

Use o to represent an electron from carbon.
Use x to represent an electron from oxygen. [3]

(c) When carbon dioxide is cooled it can change directly from a gas to a molecular solid, dry ice. Complete the table by describing the arrangement and movement of the molecules in both the solid and gaseous states.

	solid	gas
arrangement of molecules		
movement of molecules		

[6]

(d) Scientists in the USA have changed the molecular solid, dry ice, into a macromolecular structure which is similar to that of silicon(IV) oxide. Draw this structure. Your diagram need not contain more than one carbon atom

[2]

4 (a) (i) One of the isomeric butenes is but-1-ene which has the formula $CH_3-CH_2-CH=CH_2$. Give the name and structural formula of another butene.

name .....

formula

(ii) But-1-ene can be oxidised to two acids whose formulae are given below.

Name these acids.

$CH_3-CH_2-CO_2H$ .....

HCO_2H .....[4]

(b) But-1-ene can behave as a monomer and undergo addition polymerisation.

(i) Give the name and the structural formula of the polymer formed from but-1-ene.

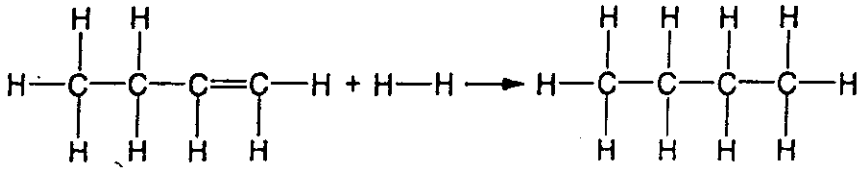
name .....

structure

(ii) Suggest a use for this type of polymer.

.....[3]

(c) The equation, given below, represents the formation of one mole of butane from butene.



(i) What is the mass of one mole of butane molecules?

.....

(ii) Complete the table that shows the bonds broken and formed in this reaction.

bond	energy change in kJ/mol	exothermic or endothermic
1 mole of C=C bonds broken	+610	endothermic
1 mole of H—H bonds broken	+436	.....
1 mole of C—C bonds formed	–346	.....
2 moles of ..... bonds formed	–826	.....

(iii) Use the data in the table to determine if the reaction is exothermic or endothermic. Give a reason for your choice.

.....

.....[6]

(d) The gases butene and ethene could be separated by liquefaction followed by fractional distillation because they have different boiling points.

alkene	boiling point/K	molecular mass
ethene	170	28
butene	226	56

(i) Using the data in the table suggest another technique that would separate these gases.

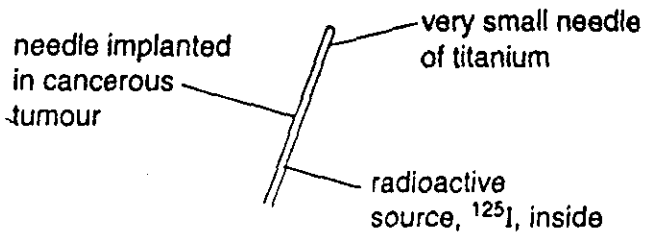
.....

(ii) Explain why the technique you have given in (i) would separate the gases.

.....

.....[3]

5 Titanium and radioactive iodine are used in a treatment for cancer.



(a) (i) Give the symbol and nucleon number of a radioactive isotope that is used as a source of power.

.....

(ii) Another radioactive isotope is ^{131}I. How do the atoms of these two iodine isotopes differ?

.....

(iii) During radioactive decay, ^{131}I changes to another element with the proton number of 54. Identify this element and explain why it is less reactive than iodine.

.....

.....[5]

(b) All the isotopes of iodine have the same chemistry.

(i) Name a reagent that can change iodine molecules into iodide ions.

.....

(ii) Name a reagent that can change iodide ions into iodine molecules.

.....

(iii) Write an equation for **either** of the two reactions above.

.....

(iv) Predict the formula of titanium iodide by completing the following.

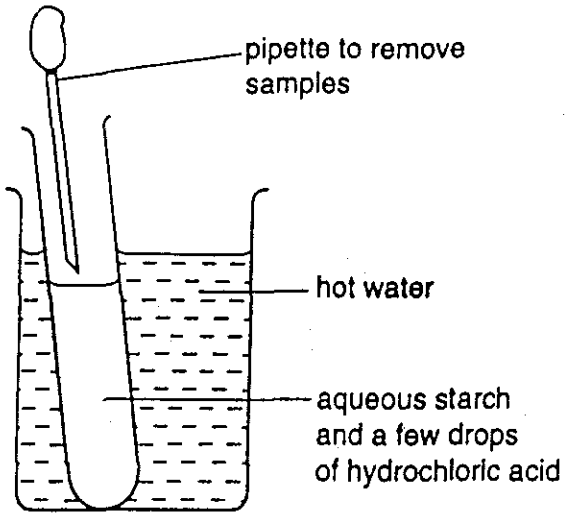
How many more electrons has a titanium atom than an atom of the nearest noble gas? .....

How many fewer electrons has an iodine atom than an atom of the nearest noble gas? .....

Formula of titanium iodide is ..... [5]

(c) Starch is a complex carbohydrate. Its formula is shown below. Starch reacts with iodine to form a deep blue colour.

In the experiment illustrated below, samples are removed at intervals and tested with iodine.



Typical results of this experiment are given in the table.

time/min	colour of tested sample
0	deep blue
5	pale blue
20	colourless

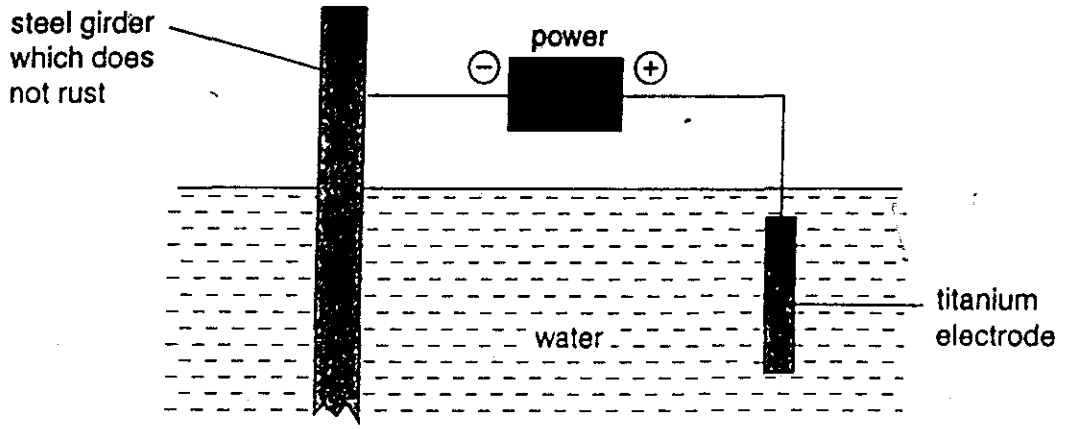
By referring to the chemistry involved, explain these results.

.....

.....

.....[4]

(d) Titanium is chosen to make the needles because it does not corrode. Another use which depends on the same property is shown in the diagram.



(i) Define oxidation in terms of electron transfer.

.....

(ii) Explain why the steel girder does not rust.

.....

.....[3]

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.).

Candidate Name _____

Centre Number	Candidate Number

International General Certificate of Secondary Education
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CHEMISTRY 0620/3

PAPER 3

OCTOBER/NOVEMBER SESSION 2001 1 hour 15 minutes

Candidates answer on the question paper.
No additional materials are required.

TIME - 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

200

[Turn over

1 **(a)** The poisonous gas, carbon monoxide, is emitted by vehicle exhausts.

(i) How is this gas formed?

.....[2]

(ii) Explain how a catalytic converter reduces the emission of this gas.

.....

.....[2]

(iii) The following reaction is used to detect carbon monoxide.

$$CO + \underset{\text{orange}}{Pd^{2+}} + H_2O \rightarrow CO_2 + \underset{\text{black}}{Pd} + 2H^+$$

What type of chemical reaction is the change Pd^{2+} to Pd? Give a reason for your answer.

.....[2]

(iv) Ethene will also give the above reaction. Describe another chemical test for this gas.

.....

.....[2]

(b) Carbon monoxide is used to purify nickel. Nickel reacts with carbon monoxide to form a gaseous compound.

$$Ni(s) + 4CO(g) \rightleftharpoons Ni(CO)_4(g)$$ forward reaction is exothermic

(i) What reaction condition will favour the back reaction and reform nickel metal? Explain your choice.

.....

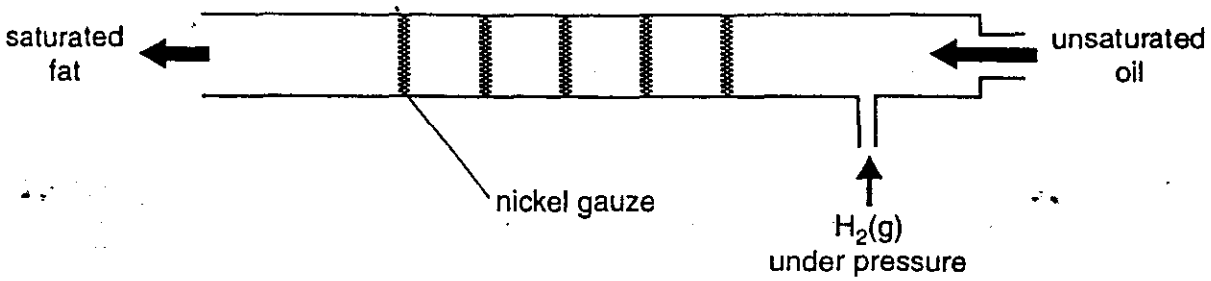
.....[2]

(ii) The main impurity in the nickel is copper. What technique is used to purify copper after it has been separated from the nickel?

.....[1]

201

(c) Pure nickel is used to catalyse the reduction of unsaturated oils to saturated fats.



(i) What is meant by the terms *saturated* and *unsaturated*?

.....

.....[2]

(ii) Name the functional group in fats.

.....[1]

(iii) How can a soap be made from a fat?

.....[2]

2 (a) (i) Describe how oxygen is separated from air.

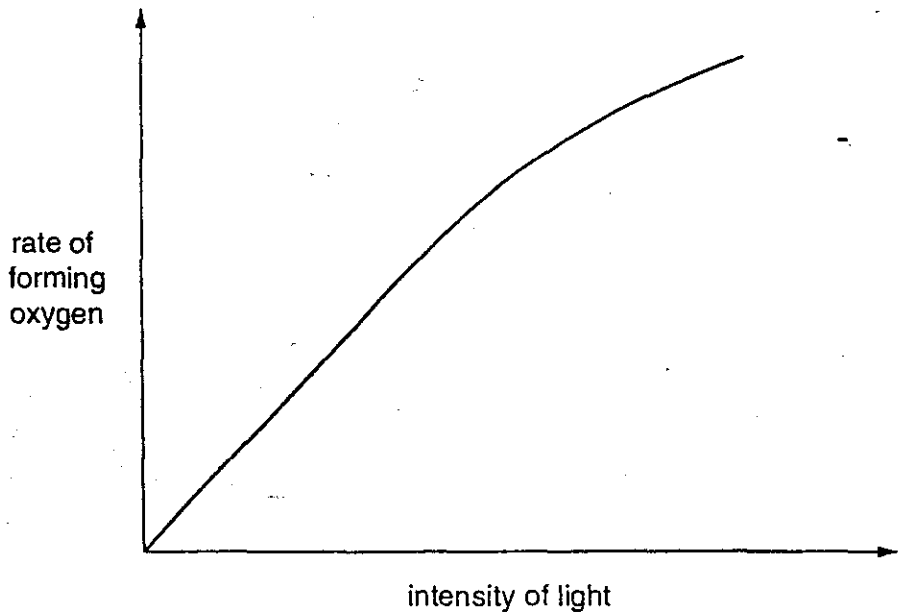
.....

.....[2]

(ii) Give **one** use of oxygen.

.....[1]

(b) When a green plant is exposed to bright light it photosynthesises and forms oxygen. The rate at which oxygen is formed was measured at 25 °C. The intensity of the light is changed and the new rate measured. The results of experiments of this type are shown on the graph below.



(i) Write a word equation for the reaction that produces oxygen.

.....[1]

(ii) Name the catalyst for photosynthesis.

.....[1]

(iii) What can be deduced from this experiment about the relationship between photosynthesis and light?

.....

.....[2]

(iv) The experiment was repeated at 30 °C. Predict the effect this would have on the rate of reaction and sketch the new graph on the same axes. [2]

(v) Give another example of a reaction that is influenced by light. Describe **one** important application of this reaction.

reaction .....

application .....[3]

(c) Potassium chlorate, which has a formula of the type, $KClO_n$, decomposes to form oxygen. 2.45 g of the chlorate produced 1.49 g of potassium chloride and 0.72 dm^3 of oxygen at r.t.p. Find the value of n.

$$KClO_n \longrightarrow KCl + \frac{n}{2}O_2$$

Mass of one mole of KCl = 74.5 g

Number of moles of KCl formed = ...

Number of moles of oxygen molecules formed = ...

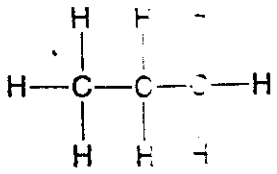
Number of moles of oxygen atoms = ...

Mole ratio KCl: O is .....

n = ...

[4]

3 Propane is an alkane. It has the structural formula



(a) The equation for the complete combustion of propane is given below. Insert the two missing volumes.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

volume of gas/cm^3 .... 15 [2]

(b) Propane reacts with chlorine to form two chloropropanes with the formula C_3H_7Cl.

(i) Write an equation for this reaction.

.....[1]

(ii) What type of reaction is this?

.....[1]

(c) The two chloropropanes react with sodium hydroxide to form two different alcohols.

(i) These alcohols are isomers. Using the propanols as an example explain the term *isomer*.

.....

.....

.....[3]

(ii) Fractional distillation can separate the two propanols. Suggest a reason why this method is effective.

.....[1]

(iii) Oxygen can oxidise propanol to propanoic acid. Name another reagent that will bring about this reaction.

.....[1]

(iv) Propanol and propanoic acid react to form an ester. Give the name and structural formula of an ester.

name .....

structural formula

[3]

(d) Propene can be made by heating propane and sulphur.

(i) Outline another method of making alkenes from alkanes.

.....

.....[2]

(ii) Outline how propanol could be made from propene.

.....

.....[2]

For Examiner's Use

4 **(a)** Zinc is made by reducing zinc oxide. In 1695 Homberg obtained zinc from calamine, zinc carbonate. At present zinc is extracted from the ore, zinc blende.

(i) Suggest a way of changing calamine into zinc oxide.

.....[1]

(ii) Describe how zinc is extracted from zinc blende.

.....

.....

.....[3]

(b) Zinc oxide is used to make aqueous zinc chloride. This can be used to preserve wood. Describe how this solution could be made.

.....

.....

.....[3]

(c) Zinc is used to make alloys.

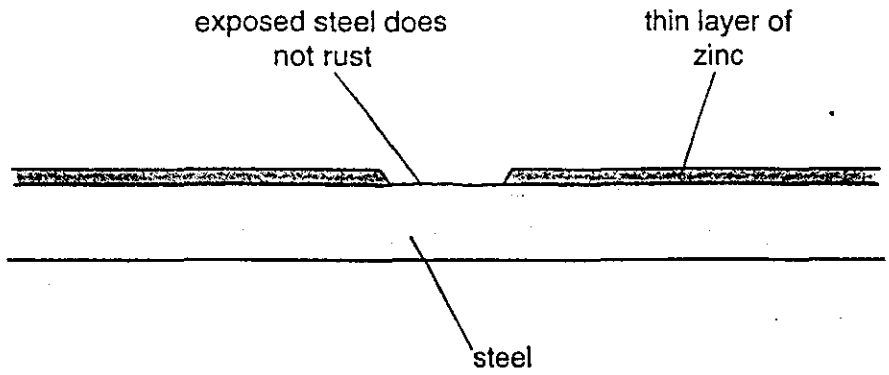
(i) Name an alloy that contains zinc.

.....[1]

(ii) What is the other metal in this alloy?

.....[1]

(d) Another use of zinc is galvanising. When the zinc layer is broken, the steel is exposed.



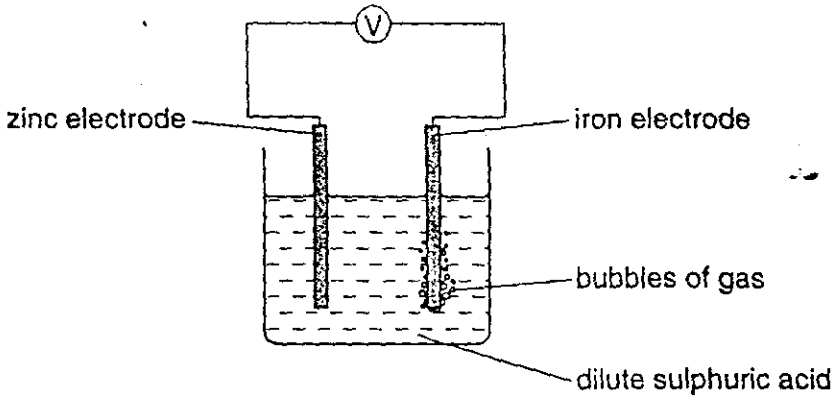
Explain why the **exposed** steel does **not** rust.

.....

.....

.....[3]

(e) The diagram below represents a simple cell.



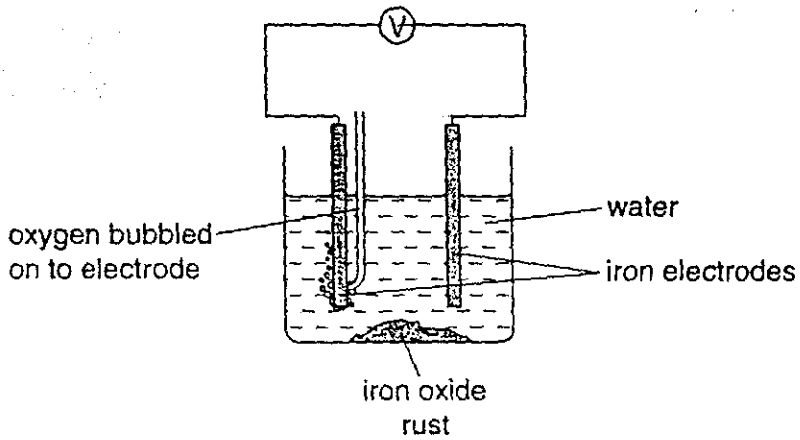
(i) Write an ionic equation for the reaction that occurs at the zinc electrode.

.....[1]

(ii) How could the voltage of the cell be increased?

.....[1]

(f) A different type of cell is drawn below.



(i) The pH of the solution increases. Give the name of the ion formed.

.....[1]

(ii) Complete the equation that represents the formation of this ion.

O_2 + ... H_2O + ... → ..... [2]

5 (a) In the USA, sulphur is obtained from underground deposits. It burns to form sulphur dioxide. This is used in paper making, to preserve food and in the manufacture of sulphuric acid.

(i) Why is sulphur dioxide needed in paper making?

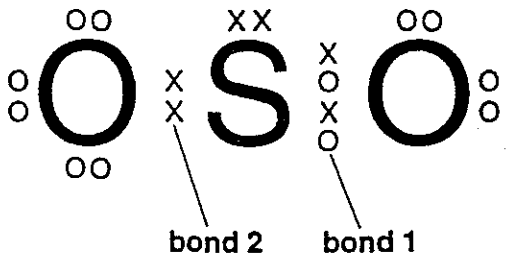
.....[1]

(ii) How does sulphur dioxide preserve food?

.....[1]

(b) The diagram shows a possible arrangement of the valency electrons in a molecule of sulphur dioxide.

O represents an electron from an oxygen atom
X represents an electron from a sulphur atom



(i) What type of covalent bond is labelled **bond 1**?

.....[1]

(ii) What is unusual about the covalent bond labelled **bond 2**?

.....[1]

(c) Sulphur reacts violently with magnesium to form the ionic compound magnesium sulphide. Draw a diagram that shows the arrangement of the valency electrons in this compound.

Use O to represent an electron from a magnesium atom.
Use X to represent an electron from a sulphur atom. [3]

(d) Sulphuric acid is a typical strong acid.

(i) Explain the term *strong acid.*

.....[2

(ii) Write a word equation for the reaction between zinc carbonate and sulphuric acid.

.....[2

(iii) Write an equation for the reaction between sodium hydroxide and sulphuric acid.

.....[2

(iv) Write an ionic equation for the reaction between magnesium and sulphuric acid.

.....[2

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
CAMBRIDGE INTERNATIONAL EXAMINATIONS

CHEMISTRY 0620/3

PAPER 3

MAY/JUNE SESSION 2002

1 hour 15 minutes

Candidates answer on the question paper.
No additional materials are required.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 12 printed pages.

University of Cambridge
Local Examinations Syndicate

1 In 1886, the modern electrolytic process for the extraction of aluminium was discovered in the USA by C. Hall.

(a) Before this discovery, the only method of extracting the metal was by displacement.

(i) Name a metal that can displace aluminium from aluminium chloride.

.....[1]

(ii) Write a word equation for this displacement reaction.

.....[1]

(iii) Complete the equation for the reaction.

$AlCl_3$ + ... ⟶ ..... + ...[2]

(b) Aluminium is produced by the electrolysis of an electrolyte that contains aluminium oxide.

(i) Write an ionic equation for the reduction of the aluminium ion at the cathode.

.....[2]

(ii) Name the main ore of aluminium.

.....[1]

(iii) Complete the following description of the electrolyte by filling the spaces.

The electrolyte is a ..... mixture of aluminium oxide and ..... which is maintained at 900 °C. [2]

(iv) Explain why the gas given off at the anode is a mixture of oxygen and carbon dioxide.

.....

.....[2]

(c) One property of aluminium is that it resists corrosion because it is covered with a layer of its oxide.

(i) Give **one** use of the metal that depends on this property.

.....[1]

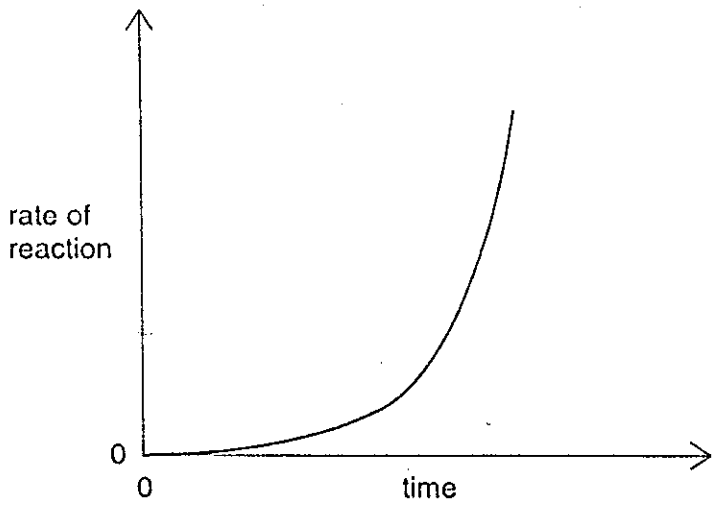
(ii) Give another use of the metal that depends on a different property.

use .....

property.....[2]

212

(d) The graph shows how the rate of the exothermic reaction between aluminium and hydrochloric acid varies with time.



(i) Suggest a reason why the reaction goes slowly at first.

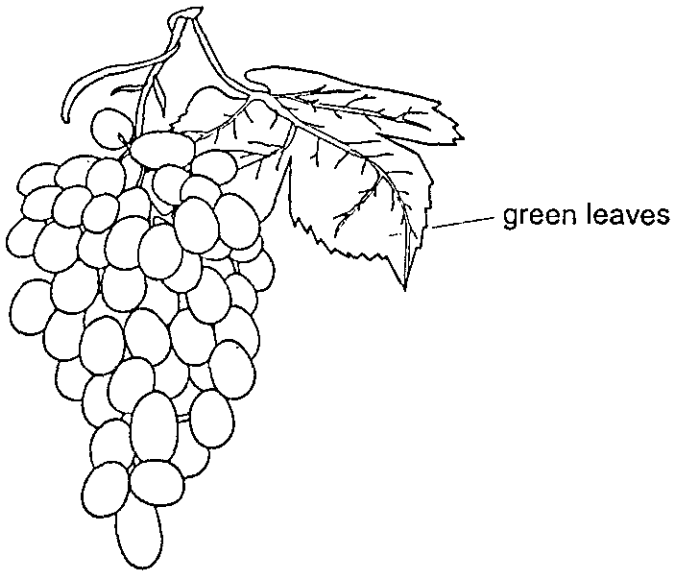
.....[1]

(ii) Suggest **two** reasons for the increase in rate.

.....

.....[2]

2 Fermentation of sugars is one method of making ethanol. Vines produce glucose by photosynthesis. The glucose collects in the grapes which grow in clusters on the vine.



(a) Vines are attacked by a fungus that ruins the grapes. In 1882 it was discovered that spraying the vines with Bordeaux mixture killed the fungus.

The fungicide, Bordeaux mixture, contains water, calcium hydroxide and copper(II) sulphate.

(i) Name the raw material from which calcium hydroxide is made.

.....[1]

(ii) The mixture contains four ions. Complete the list of ions.

Cu^{2+}, OH^-, ... and ..... [2]

(iii) A different fungicide can be made by the reaction between an excess of aqueous ammonia and a copper(II) salt. Describe the **observations** for this reaction.

addition of aqueous ammonia .....

.....

then excess aqueous ammonia .....

.....[3]

(b) Explain how the vine produces glucose by photosynthesis.

.....

.....

.....

.....[4]

(c) The grapes are crushed to extract an aqueous solution of glucose. This solution is fermented to make ethanol. Explain why each of the following is necessary.

(i) yeast

.....[1]

(ii) an absence of oxygen

.....

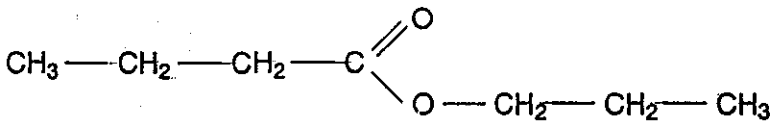
.....[2]

(iii) an optimum temperature of about 35 °C

.....

.....[2]

(d) Plants can make esters as well as sugars. The formula of a typical ester is drawn below. Deduce the names of the organic acid and of the alcohol from which the ester could have been made.

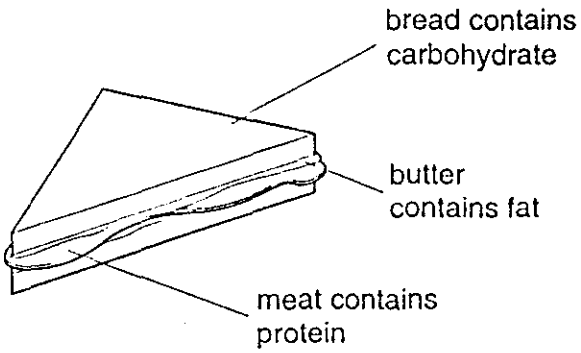


organic acid .....

alcohol.....[2]

3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.

(a) A sandwich contains three of the main constituents of food.



These constituents of food can all be hydrolysed by boiling with acid or alkali.

constituent of food	linkage	product of hydrolysis
protein		
fat		
complex carbohydrate		

(i) Complete the table. [5]

(ii) What type of synthetic polymer contains the same linkage as

proteins, ...

fats? .....[2]

(iii) Fats can be unsaturated or saturated. A small amount of a fat was dissolved in an organic solvent. Describe how you could find out if this fat was saturated or unsaturated.

reagent .....

result if saturated .....

result if unsaturated .....

.....[3]

(b) One of the reasons for using hydrogen as a fuel is to reduce air pollution. Petroleum-powered vehicles are a major cause of air pollution. This pollution can be decreased by reactions of the type shown below.

$$2CO + 2NO \longrightarrow N_2 + 2CO_2$$

(i) Where in a vehicle does this type of reaction occur?

.....[1]

(ii) Explain how carbon monoxide is formed in the engine.

.....

.....[2]

(iii) Give a reason why the hydrogen-powered vehicle produces less pollution.

.....[1]

(c) Outline how hydrogen is manufactured from water.

.....

.....[2]

4 Bromine is one of the halogens in Group VII.

(a) (i) Predict which halogen has the lightest colour.

.....[1]

(ii) Predict which halogens are solids at room temperature.

.....[1]

(b) Bromine is obtained from the bromide ions in sea water. Sea water is concentrated by evaporation. Chlorine gas is bubbled through the solution. Chlorine oxidises the bromide ion to bromine.

(i) Complete the following equation.

Cl_2 + ...Br^- ⟶ ..... + ... [2]

(ii) Explain using the idea of electron transfer why the bromide ion is oxidised by chlorine.

The bromide ion is oxidised because .....

.....

Chlorine is the oxidising agent because.....

.....[2]

(iii) Name a reagent that can be oxidised by bromine molecules.

.....[1]

(c) Bromine reacts with phosphorus to form phosphorus tribromide.
Draw a diagram showing the arrangement of the **valency** electrons in one molecule of this covalent compound. The electron distribution of bromine is:

2 + 8 + 18 + 7.

Use x to represent an electron from phosphorus.
Use o to represent an electron from bromine. [3]

(d) Phosphorus tribromide reacts with water to form two acids.

(i) Balance the equation for this reaction.

$$PBr_3 + ...H_2O \longrightarrow .....HBr + H_3PO_3$$

[1]

(ii) Describe by giving essential details how you could show that phosphorous acid, H_3PO_3, is a weaker acid than hydrogen bromide.

.....

.....

.....[2]

(e) Hydrogen bromide is an acid. When it is dissolved in water the following reaction occurs.

$$HBr + H_2O \longrightarrow H_3O^+ + Br^-$$

(i) Name the particle lost by the hydrogen bromide molecule.

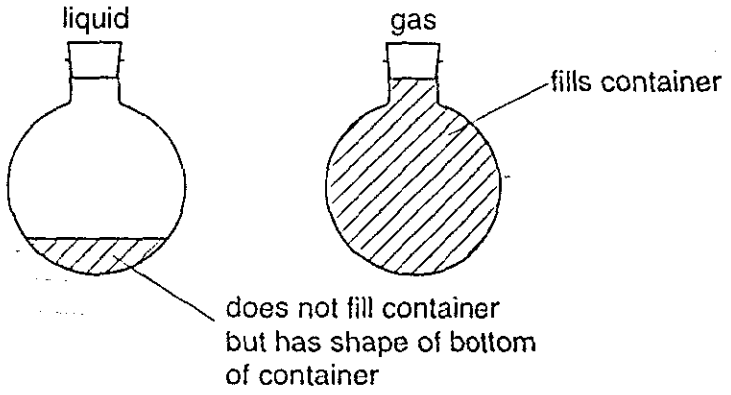
.....[1]

(ii) What type of reagent is the water molecule in this reaction?

.....[1]

5 (a) The Kinetic Theory explains the properties of solids, liquids and gases in terms of the movement of particles.

Liquids and gases both take up the shape of the container but a gas always fills the container. Explain this, using the ideas of the Kinetic Theory.



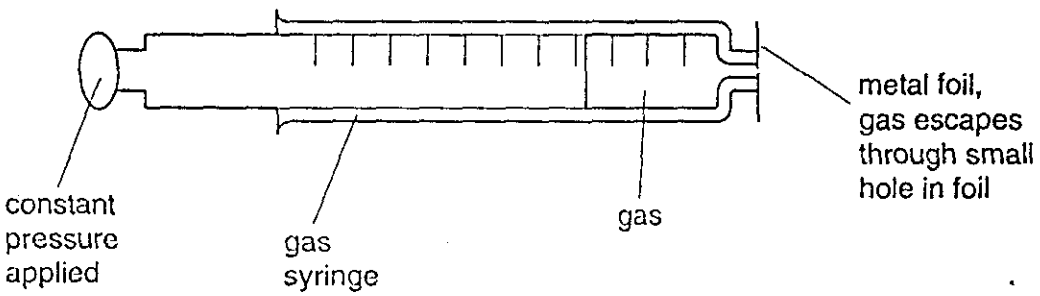
.....

.....

.....

.....[4]

(b) The following apparatus can be used to measure the rate of diffusion of a gas.



(i) What measurements would need to be taken to calculate the rate of diffusion of a gas?

.....[2]

(ii) Which gas, carbon dioxide or sulphur dioxide, would diffuse faster?
Explain your choice.

.....

.....

.....[3]

220

(c) A 20 cm^3 sample of butyne, C_4H_6, is burnt in 150 cm^3 of oxygen. This is an excess of oxygen.

$$2C_4H_6(g) + 11O_2(g) \longrightarrow 8CO_2(g) + 6H_2O(l)$$

(i) What volume of oxygen reacts?

.....[1]

(ii) What volume of carbon dioxide is produced?

.....[1]

(iii) What is the total volume of gases left at the end of the reaction?

.....[1]

(d) Calculate the mass of water formed when 9.0 g of butyne is burnt. The mass of one mole of butyne is 54 g.

from the above equation, 1 mole of butyne forms 3 moles of water

number of moles of butyne reacted .....

number of moles of water formed .....

mass of water formed ..... g [3]

Centre Number	Candidate Number

Candidate Name _____

International General Certificate of Secondary Education
CAMBRIDGE INTERNATIONAL EXAMINATIONS

CHEMISTRY 0620/3

PAPER 3

OCTOBER/NOVEMBER SESSION 2002

1 hour 15 minutes

Candidates answer on the question paper.
No additional materials are required.

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

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 12.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This question paper consists of 10 printed pages and 2 blank pages.

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

[Turn over

1 **(a)** Sulphuric acid is made by the Contact Process.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \text{forward reaction is exothermic}$$

(i) What are the reaction conditions for the Contact Process?

.....

.....[3]

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

.....

.....

.....[2]

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

.....

.....[2]

(b) There are three ways of making salts from sulphuric acid.
titration using a burette and indicator
precipitation by mixing the solutions and filtering
neutralisation of sulphuric acid using an excess of an insoluble base

Complete the following table of salt preparations.

method	reactant 1	reactant 2	salt
titration	sulphuric acid		sodium sulphate
neutralisation	sulphuric acid		zinc sulphate
precipitation	sulphuric acid		barium sulphate
	sulphuric acid	copper(II) oxide	copper(II) sulphate

[4]

(c) The results of an investigation into the action of heat on copper(II) sulphate-5-water, a blue crystalline solid, are given below.

The formula is $CuSO_4.5H_2O$ and the mass of one mole is 250 g

A 5.0 g sample of the blue crystals is heated to form 3.2 g of a white powder. With further heating this decomposes into a black powder and sulphur trioxide.

(i) Name the white powder.

.....[1]

(ii) What is observed when water is added to the white powder?

.....[1]

(iii) Name the black powder.

.....[1]

(iv) Calculate the mass of the black powder. Show your working.

.....

.....

.....[3]

2 **Manganese is a transition element. It has more than one valency and the metal and its compounds are catalysts.**

(a) **(i)** Predict **three** other properties of manganese that are typical of transition elements.

.....

.....[3]

(ii) Complete the electron distribution of manganese by inserting one number.

2 + 8 + ... + 2 [1]

(b) **It has several oxides, three of which are shown below.**
Manganese(II) oxide, which is basic.
Manganese(III) oxide, which is amphoteric.
Manganese(IV) oxide, which is acidic.

(i) Complete the word equation.

manganese(II) oxide + hydrochloric acid → ..... + ... + ...

[2]

(ii) **Which, if any, of these oxides will react with sodium hydroxide?**

.....[1]

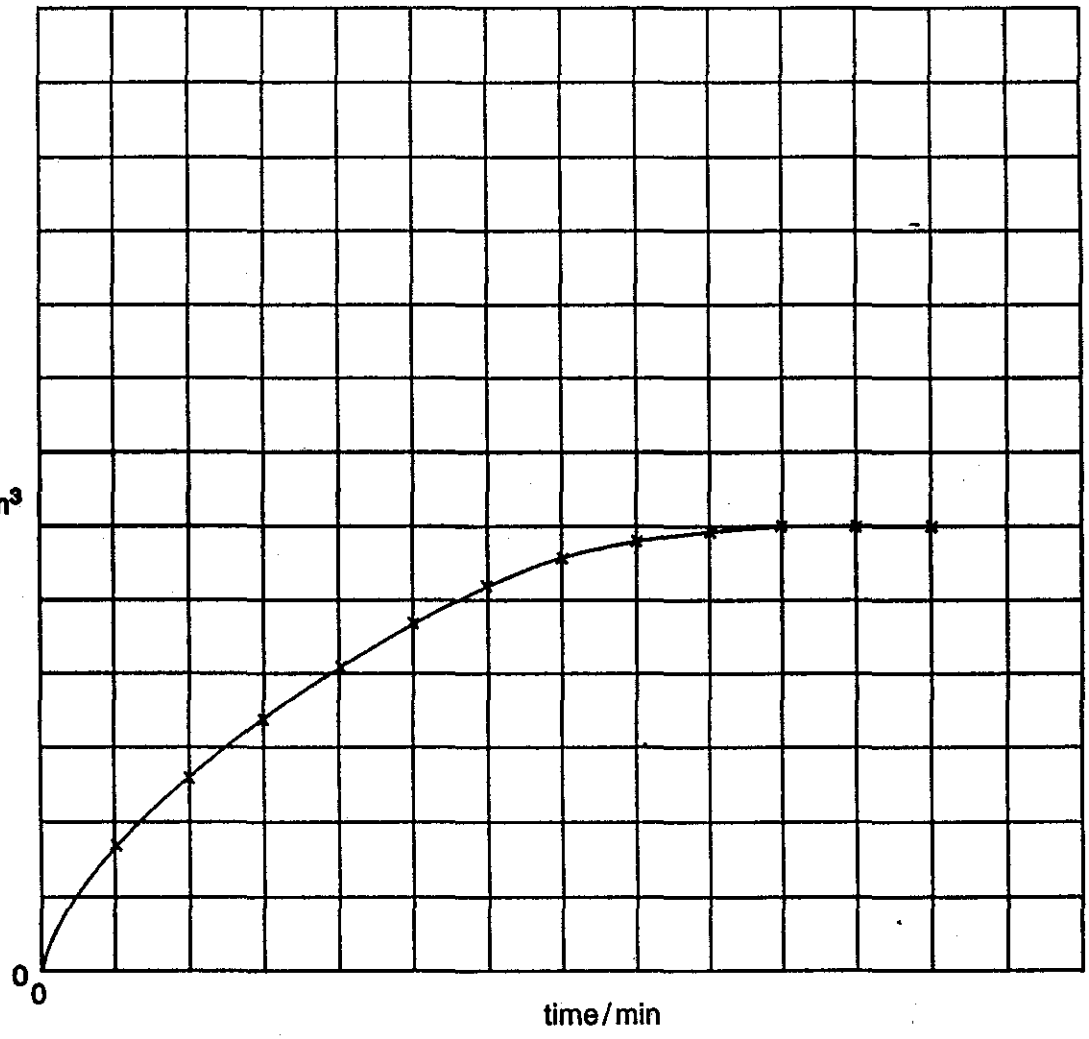
(c) Aqueous hydrogen peroxide decomposes to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

This reaction is catalysed by manganese(IV) oxide

The following experiments were carried out to investigate the rate of this reaction.

A 0.1 g sample of manganese(IV) oxide was added to 20 cm^3 of 0.2 M hydrogen peroxide solution. The volume of oxygen produced was measured every minute. The results of this experiment are shown on the graph.



(i) How does the rate of reaction vary with time? Explain why the rate varies.

.....

.....[3]

(ii) The following experiment was carried out at the same temperature.

0.1 g of manganese(IV) oxide and 20 cm^3 of 0.4 M hydrogen peroxide

Sketch the curve for this experiment on the same grid. [2]

(iii) How would the shape of the graph differ if only half the mass of catalyst had been used in these experiments?

.....

.....

.....[2]

3 The elements in Period 3 and some of their common oxidation states are shown below.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Oxidation State	+1	+2	+3	+4	−3	−2	−1	0

(a) (i) Why do the oxidation states increase from sodium to silicon?

.....[1]

(ii) After Group(IV) the oxidation states are negative and decrease across the period. Explain why.

.....

.....[2]

(b) The following compounds contain two elements. Predict their formulae.

aluminium sulphide .....

silicon phosphide ..... [2]

(c) Choose a different element from Period 3 that matches each description.

(i) It has a similar structure to diamond.

.....[1]

(ii) It reacts violently with cold water to form a solution pH = 14.

.....[1]

(iii) It has a gaseous oxide of the type XO_2, which is acidic.

.....[1]

(d) The only oxidation state of argon is zero. Why it is used to fill light bulbs?

.....

.....[1]

(e) Draw a diagram that shows the arrangement of the valency electrons in the ionic compound sodium phosphide.

Use o to represent an electron from sodium.
Use x to represent an electron from phosphorus. [3]

(f) Sodium reacts with sulphur to form sodium sulphide.

$$2Na + S \rightarrow Na_2S$$

An 11.5 g sample of sodium is reacted with 10 g of sulphur. All of the sodium reacted but there was an excess of sulphur.
Calculate the mass of sulphur left unreacted.

(i) Number of moles of sodium atoms reacted = ...
[2 moles of Na react with 1 mole of S]

(ii) Number of moles of sulphur atoms that reacted = ...

(iii) Mass of sulphur reacted = ...g

(iv) Mass of sulphur left unreacted = ...g [4]

4 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

(a) Copper is used to make alloys.

(i) Give **two** other uses of copper.

.....[2]

(ii) Alloys have similar structures to pure metals. Give a labelled diagram that shows the structure of a typical alloy, such as brass.

[3]

227

(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper) .....

.....[1]

(ii) anode (impure copper) .....

.....[1]

(iii) Write an ionic equation for the reaction at the cathode.

.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is ..... .

The solution changes into ..... . [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

.....

.....[2]

(d) Copper is an unreactive metal. Its compounds are easily reduced to the metal or decomposed to simpler compounds. Complete the following equations.

(i) ...CuO + ... → ...Cu + ...

(ii) Copper(II) hydroxide $\xrightarrow[\text{(heat)}]{}$ ..... + ...

.....

(iii) $Cu(NO_3)_2 \xrightarrow[\text{(heat)}]{}$ ..... + ... + ...

[4]

For Examiner's Use

5 Alkenes are unsaturated hydrocarbons. They show structural isomerism. Alkenes take part in addition reactions and form polymers.

(a) Structural isomers have the same molecular formula but different structural formulae. Give an example of structural isomerism.

molecular formula .....

two structural formulae

[3]

(b) Ethene reacts with each of the following. Give the name and structural formula of each product.

(i) steam

name of product .....

structure of product

[2]

(ii) hydrogen

name of product .....

structure of product

[2]

229

(c) Alkenes polymerise by addition.

(i) Explain the term *polymerise*.

.....

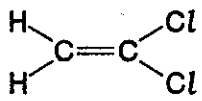
.....[2]

(ii) What is the difference between addition polymerisation and condensation polymerisation?

.....

.....[2]

(iii) Poly(dichloroethene) is used extensively to package food. Draw its structure. The structural formula of dichloroethene is drawn below.



[2]

(d) **Steel may be coated with another metal, eg zinc or chromium, or with a polymer, eg poly(chloroethene), to prevent rusting.**

(i) **Suggest a property of poly(chloroethene) that makes it suitable for this purpose.**

.....[1]

(ii) Explain why the steel will rust when the protective coating of chromium or polymer is broken.

.....[1]

(iii) When the protective layer of zinc is broken, the steel still does not rust. Suggest an explanation.

.....

.....

.....[2]

230

Centre Number	Candidate Number	Name

CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CHEMISTRY 0620/03

Paper 3

May/June 2003

1 hour 15 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces provided at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is provided on page 12.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
4	
5	
TOTAL	

SP (NF/JG) S33032/4

University of Cambridge Local Examinations Syndicate

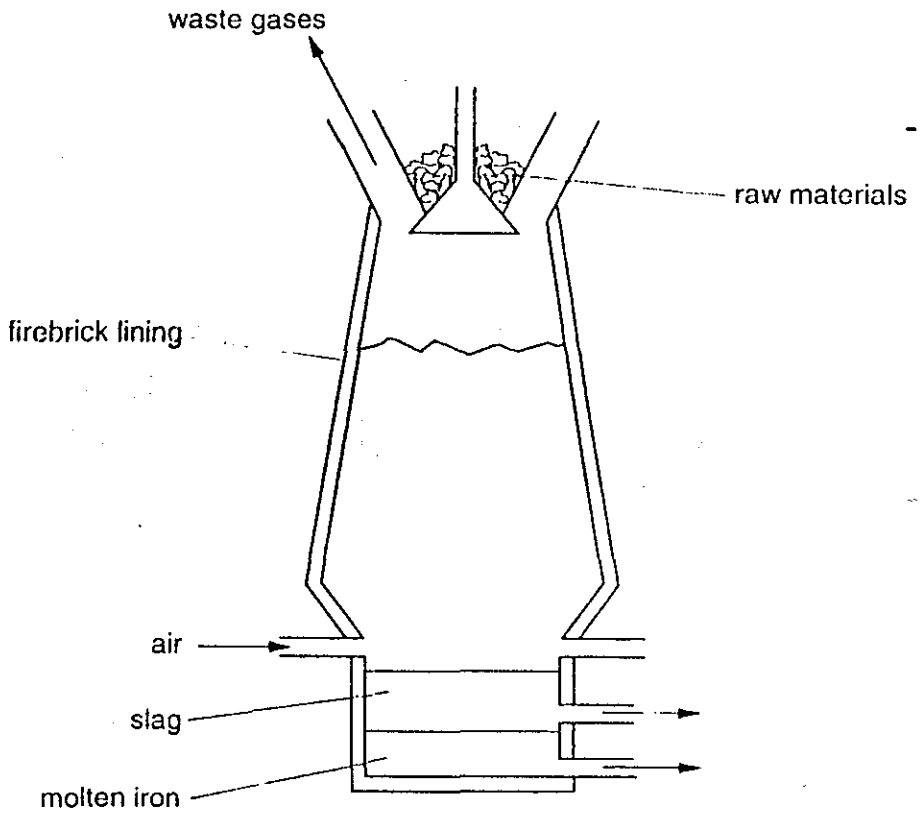
1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(a) Complete the following equation.

$$\underset{\text{iron ore}}{Fe_2O_3} + \underset{\text{charcoal}}{C} \rightarrow \text{.....} + \text{.....}$$

[2]

(b) In 1705 Abraham Darby showed that iron ore could be reduced using coke in a blast furnace.



(i) The temperature in the furnace rises to 2000 °C. Write an equation for the exothermic reaction that causes this high temperature.

.....

(ii) In the furnace, the ore is reduced by carbon monoxide. Explain how this is formed.

.....

.....[3]

(c) The formation of slag removes an impurity in the ore. Write a word equation for the formation of the slag.

.....[2]

(d) Stainless steel is an alloy of iron. It contains iron, other metals and about 0.5% of carbon.

(i) State a use of stainless steel.

.....

(ii) Name a metal, other than iron, in stainless steel.

.....

(iii) The iron from the blast furnace is impure. It contains about 5% of carbon and other impurities, such as silicon and phosphorus. Describe how the percentage of carbon is reduced and the other impurities are removed.

.....

.....

.....[6]

(e) One of the methods used to prevent iron or steel from rusting is to electroplate it with another metal, such as tin. Complete the following.

The anode is made of ..... .

The cathode is made of ..... .

The electrolyte is a solution of ..... .

[3]

2 Calcium and other minerals are essential for healthy teeth and bones. Tablets can be taken to provide these minerals.

Healthy Bones

Each tablet contains

calcium
magnesium
zinc
copper
boron

(a) Boron is a non-metal with a macromolecular structure.

(i) What is the valency of boron?

.....

(ii) Predict **two** physical properties of boron.

.....

.....

(iii) Name another element and a compound that have macromolecular structures.

element .....

compound .....

(iv) Sketch the structure of one of the above macromolecular substances.

[7]

(b) Describe the reactions, if any, of zinc and copper(II) ions with an excess of aqueous sodium hydroxide.

(i) zinc ions

addition of aqueous sodium hydroxide .....

.....

excess sodium hydroxide .....

.....

(ii) copper(II) ions

addition of aqueous sodium hydroxide .....

.....

excess sodium hydroxide .....

.....[4]

(c) Each tablet contains the same number of moles of $CaCO_3$ and $MgCO_3$. One tablet reacted with excess hydrochloric acid to produce 0.24 dm^3 of carbon dioxide at r.t.p.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$
$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$$

(i) Calculate how many moles of $CaCO_3$ there are in one tablet.

number of moles CO_2 = ...

number of moles of $CaCO_3$ and $MgCO_3$ = ...

number of moles of $CaCC_3$ = ...

[3]

(ii) Calculate the volume of hydrochloric acid, 1.0 mol / dm^3, needed to react with one tablet.

number of moles of $CaCO_3$ and $MgCO_3$ in one tablet = ...
Use your answer to **(c)(i)**.

number of moles of HCl needed to react with one tablet = ...

volume of hydrochloric acid, 1.0 mol / dm^3, needed to react with one tablet = ...

[2]

3 Alkenes are unsaturated hydrocarbons. They undergo addition reactions.

(a) Two of the methods of making alkenes are cracking and the thermal decomposition of chloroalkanes.

(i) Complete an equation for the cracking of the alkane, decane.

$C_{10}H_{22}$ → ..... + ...
decane

(ii) Propene can be made by the thermal decomposition of chloropropane. Describe how chloropropane can be made from propane.

reagents propane and .....

conditions ..... [4]

(b) The following alkenes are isomers.

$CH_3–CH_2–CH=CH_2$ $CH_3–C(CH_3)=CH_2$

(i) Explain why they are isomers.

.....

.....

(ii) Give the name and structural formula of another hydrocarbon that is isomeric with the above.

name .....

structural formula

[4]

(c) Give the name of the product when but-1-ene reacts with each of the following.

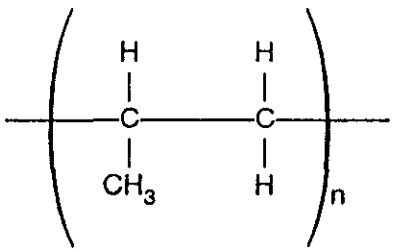
steam .....

hydrogen .....

bromine ..... [3]

(d) Alkenes can polymerise.

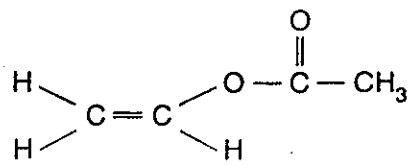
(i) Deduce the name and structural formula of the monomer from the structure of the polymer.



name of monomer .....

structural formula

(ii) Draw the structure of the polymer formed from the following monomer.



(iii) Describe the pollution problems caused by the disposal of polymers in landfill sites and by burning.

landfill sites .....

.....[2]

burning .....

.....[1]

4 Nitrogen dioxide, NO_2, is a dark brown gas.

(a) Most metal nitrates decompose when heated to form the metal oxide, nitrogen dioxide and oxygen.

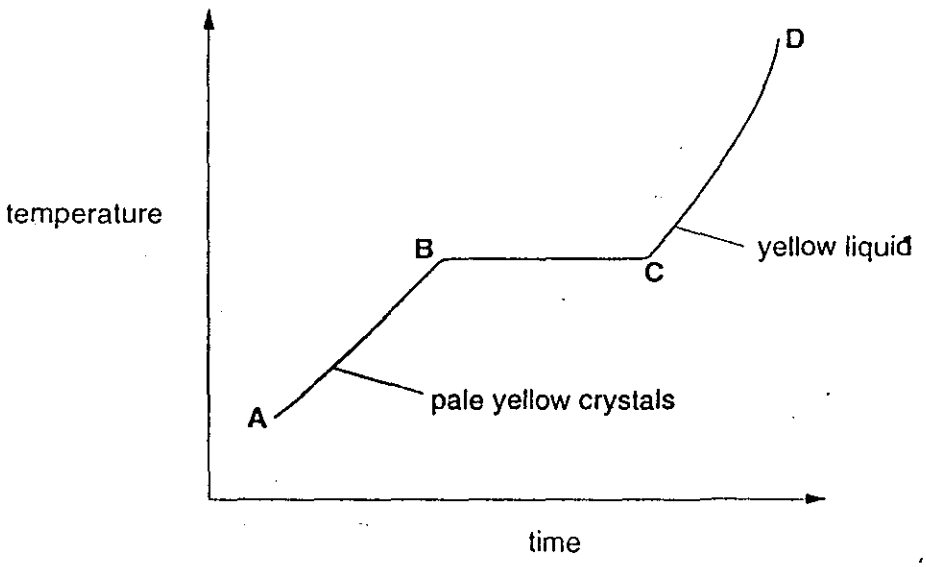
(i) Write a symbol equation for the decomposition of lead(II) nitrate.

$Pb(NO_3)_2 \rightarrow$ ..... + ... + ... [2]

(ii) Potassium nitrate does not form nitrogen dioxide on heating. Write the word equation for its decomposition.

.....[1]

(b) When nitrogen dioxide is cooled, it forms a yellow liquid and then pale yellow crystals. These crystals are heated and the temperature is measured every minute. The following graph can be drawn.



(i) Describe the arrangement and movement of the molecules in the region **A–B**.

.....

.....

(ii) Name the change that occurs in the region B–C

.....[4]

(c) Nitrogen dioxide and other oxides of nitrogen are formed in car engines.

(i) Explain how these oxides are formed.

.....

.....

(ii) How are they removed from the exhaust gases?

.....

.....[4]

(d) Nitrogen dioxide, oxygen and water react to form dilute nitric acid.
Describe how lead(II) nitrate crystals could be prepared from dilute nitric acid and lead(II) oxide.

.....

.....

.....[3]

5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

(a) How many **more** protons, electrons and neutrons are there in one atom of lanthanum than in one atom of caesium. Use your copy of the Periodic Table of the Elements to help you.

number of protons .....

number of electrons .....

number of neutrons ..... [3]

(b) All three metals can be obtained by the electrolysis of a molten halide. The electrolysis of the aqueous halides does not produce the metal.

(i) Complete the equation for the reduction of lanthanum ions at the negative electrode (cathode).

La^{3+} + ... → .....

(ii) Name the **three** products formed by the electrolysis of aqueous caesium bromide.

.....

.....[4]

(c) All three metals react with cold water. Complete the word equation for these reactions.

metal + water → ..... + ... [2]

(d) Barium chloride is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and gives the arrangement of the valency electrons around the negative ion.
The electron distribution of a barium atom is 2.8.18.18.8.2

Use x to represent an electron from a barium atom.
Use o to represent an electron from a chlorine atom.

[2]

(e) Describe, by means of a simple diagram, the lattice structure of an ionic compound, such as caesium chloride.

[2]

(f) The reactions of these metals with oxygen are exothermic.

$$2Ba(s) + O_2(g) \rightarrow 2BaO(s)$$

(i) Give an example of bond forming in this reaction.

.....

(ii) Explain using the idea of bond breaking and forming why this reaction is exothermic.

.....

.....[3]

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															

*58-71 Lanthanoid 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
†90-103 Actinoid series	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 = 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.).

Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CHEMISTRY **0620/03**

Paper 3

October/November 2003

1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials 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 in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs or rough working.
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.

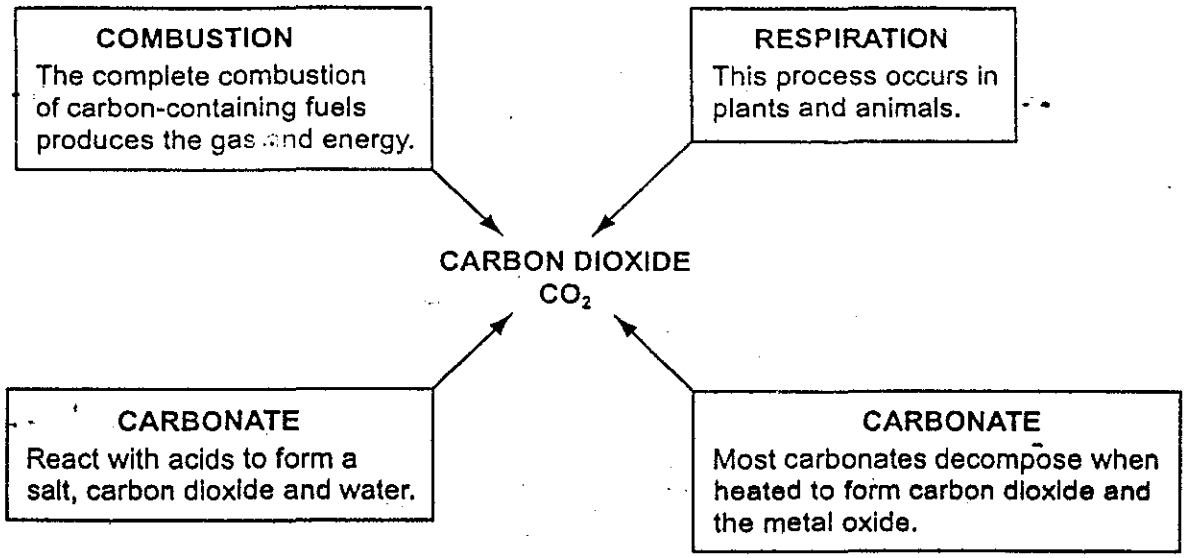
If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

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

This document consists of 15 printed pages and 1 blank page.

1 Four of the reactions that form carbon dioxide are shown below.



(a) (i) Name **two** liquid fuels that are obtained from petroleum.

..... [2]

(ii) Give the name of the different gas formed by the incomplete combustion of a carbon-containing fuel.

..... [1]

(iii) Explain the term *respiration*.

.....

..... [2]

(b) Magnesium carbonate reacts with hydrochloric acid to form a salt.

(i) Name this salt.

..... [1]

(ii) Name another chemical which will react with hydrochloric acid to form the same salt.

..... [1]

(c) Calcium oxide (lime) is made by heating calcium carbonate.

(i) Give another use of calcium carbonate.

..... [1]

(ii) Explain why lime is used by farmers.

..... [1]

2 Oxygen is the reactive gas in the atmosphere and a lot of Chemistry is centred around oxygen and its reactions. The major gases in the atmosphere are oxygen (O_2), nitrogen (N_2) and argon (Ar).

(a) (i) What is the approximate percentage of oxygen in the air?

..... [1]

(ii) Give two uses of oxygen.

.....

..... [2]

(iii) A technique used to separate mixtures of gases is diffusion. Which one of the above gases would diffuse the fastest? Give a reason for your choice.

.....

..... [2]

(iv) Give a use of argon.

..... [1]

(v) About three billion years ago, the Earth's atmosphere contained a high percentage of carbon dioxide and very little oxygen. Explain why the presence of chlorophyll-containing bacteria caused the composition of the atmosphere to change.

.....

.....

..... [3]

(b) The major source of the pollutant, nitrogen oxide, is motor vehicles.

(i) Under what condition is this oxide formed?

..... [1]

(ii) Name the device that reduces the amount of this pollutant emitted by vehicle exhausts.

..... [1]

(c) Potassium and oxygen react to form the ionic compound, potassium oxide. Draw a diagram that shows the arrangement of the valency electrons around the negative ion and the charges on both ions.

Use o to represent an electron from a potassium atom.
Use x to represent an electron from an oxygen atom.

[3]

(d) Oxygen in the presence of water causes iron and steel to rust. Describe **two** methods of reducing the rate of rusting.

.....

..... [2]

For Examiner Use

3 Redox reactions involve the transfer of electrons. Oxidation is the loss of electrons and reduction is the gain.

(a) (i) Describe the colour change observed when acidified potassium manganate(VII) is reduced.

.....

..... [2]

(ii) Suggest a suitable reducing agent for this reaction.

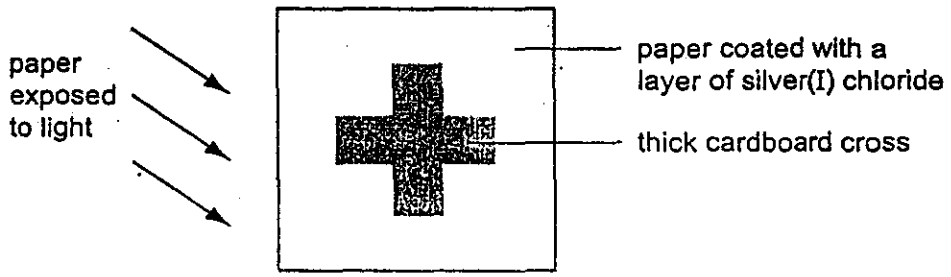
..... [1]

(b) Chromium(III) chloride is changed into potassium chromate(VI). Is this change oxidation or reduction? Give a reason for your choice.

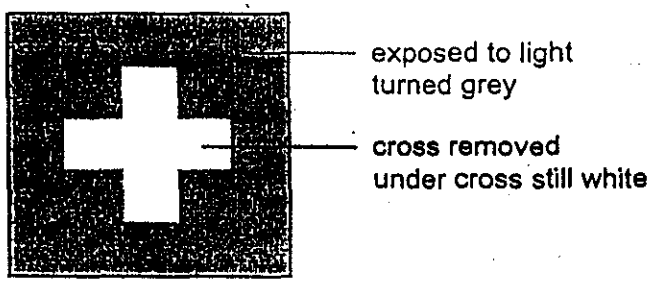
.....

..... [2]

(c) A piece of paper is coated with a layer of silver(I) chloride. It is used in the following experiment.



The cross is removed.



(i) Explain why the silver(I) chloride that was not exposed to the light remained white but that which was exposed turned grey.

.....

..... [2]

(ii) Write an equation for the reduction of the silver(I) ion.

..... [1]

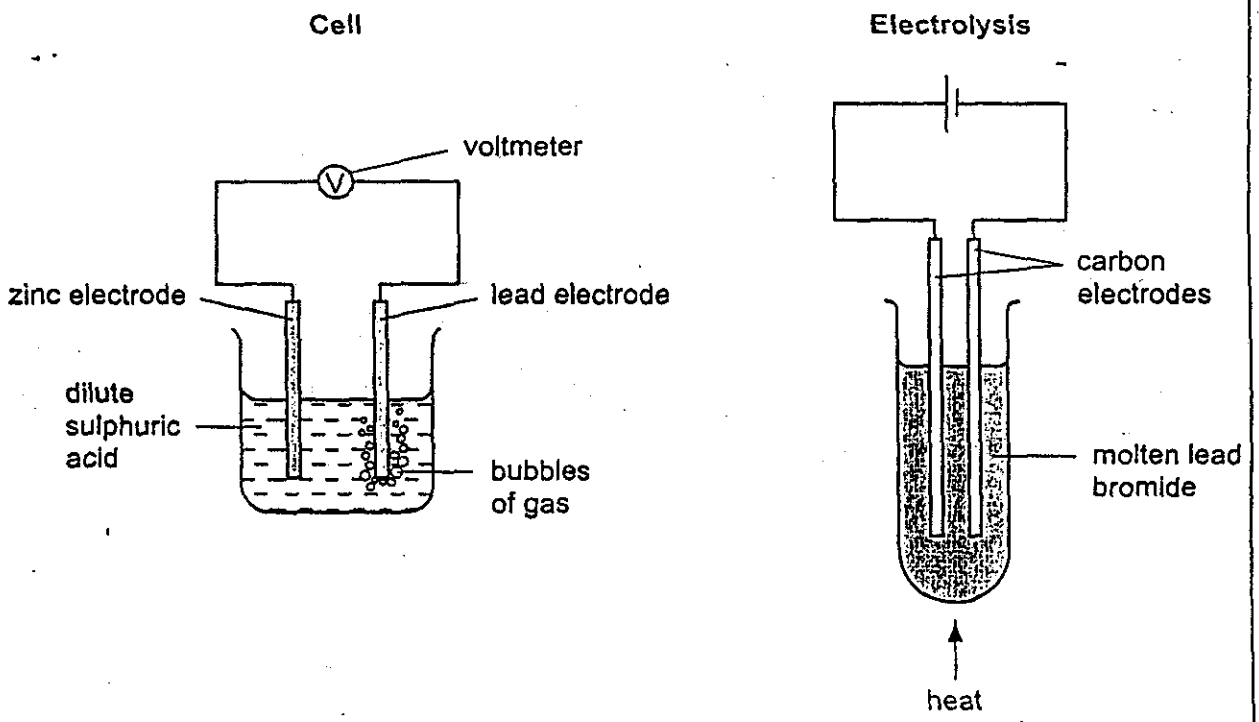
(iii) What difference would using a brighter light make?

..... [1]

(iv) What is an important application of this reaction?

..... [1]

(d) The diagrams show an example of electrolysis and of a cell.



(i) One of the above reactions is exothermic. State, giving a reason, which reaction is exothermic.

.....

..... [1]

(ii) How could you tell from the cell experiment which is the more reactive, zinc or lead?

..... [1]

(iii) Name the products of the electrolysis of molten lead bromide.

product at negative electrode ..... [1]

product at positive electrode ..... [1]

For Examiner's Use

(e) To compare the reactivity of lead, manganese, silver and iron, each metal was added to a solution containing the positive ion of a different metal. The results of this experiment are given in the table below.

	Pb^{2+}	Mn^{2+}	Ag^{+}	Fe^{2+}
Pb		no reaction	reaction	no reaction
Mn	reaction		reaction	reaction
Ag	no reaction	no reaction		no reaction
Fe	reaction	no reaction	reaction	

(i) Write the four metals in order of reactivity.

..... most reactive

.....

.....

..... least reactive [2]

(ii) Which metal most readily forms positive ions?

..... [1]

(iii) Which ion is the best oxidising agent?

..... [1]

250

4 One use of the polymer, polyacrylonitrile, is to make carbon fibres. The monomer, acrylonitrile, is made by the following reaction.

$$2CH_3—CH=CH_2 + 2NH_3 + 3O_2 \rightarrow 2CH_2=CH—CN + 6H_2O$$

(a) Propene is made by the thermal cracking of the naphtha fraction of petroleum. This is a mixture of alkanes, C_4 to C_{10}.

(i) Name the technique used to obtain naphtha from petroleum.

..... [1]

(ii) Predict the formula for the C_{10} alkane.

C_{10} ..... [1]

(iii) Write a symbol equation for the cracking of hexane (C_6H_{14}) to form propene.

..... [1]

(b) Ammonia is manufactured by the Haber Process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$ forward reaction is exothermic.

450 °C

200 atmospheres pressure

(i) Explain why a high pressure increases the percentage of ammonia in the equilibrium mixture.

.....

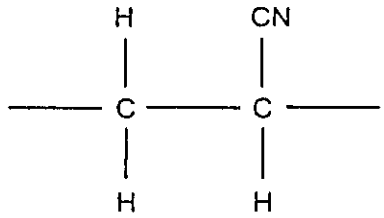
..... [2]

(ii) At 300 °C, the yield of ammonia would be greater. Why is this lower temperature not used?

..... [1]

For Examiner's Use

(c) The repeat unit of the polymer, polyacrylonitrile, is drawn below. Add two more units to this diagram.



[2]

(d) Carbon fibres have a similar structure to graphite. Describe the bonding in this macromolecule. A labelled sketch is acceptable.

[2]

5 Heating a compound so that it splits up to form two or more simpler substances is called thermal decomposition.

(a) Complete the equations for the thermal decomposition of the following compounds.

(i) Magnesium hydroxide → ..... + ...

..... [1]

(ii) potassium nitrate → ..... + ...

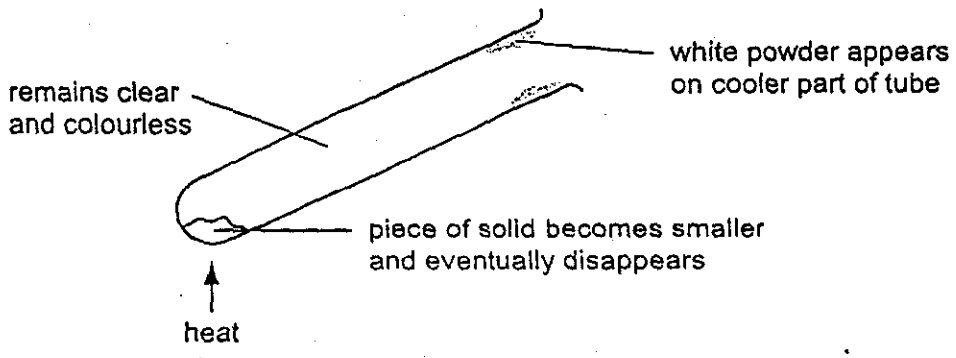
..... [2]

(iii) ..... $Cu(NO_3)_2$ → ..... + ... + ... [2]

(b) The equation and a diagram for the reversible decomposition of ammonium chloride are given below.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

white both gases colourless



Suggest an explanation for the above observations.

.....

.....

..... [2]

(c) In an experiment, 6.08g of iron(II) sulphate was heated until the decomposition was complete.

Calculate the mass of iron(III) oxide formed and the total volume of gas produced, measured at r.t.p.

$$2FeSO_4\,(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

The mass of one mole of $FeSO_4$ is 152g.

The mass of one mole of Fe_2O_3 is 160g.

(i) Calculate the number of moles of $FeSO_4$ used.

.....

(ii) Use your answer to **(i)** to predict the number of moles of Fe_2O_3 formed.

.....

(iii) Calculate the mass of iron(III) oxide formed.

..... g

(iv) Use your answer to **(i)** to predict the number of moles of SO_2 formed.

.....

(v) What is the **total** volume of gas produced.

..... dm^3 [6]

6 The following three compounds are alcohols

CH_3-CH_2-CH_2-CH_2-OH
butan-1-ol

HO-CH_2-CH_2-OH
ethane-1,2-diol

HO-CH_2-CH(OH)-CH_2-OH
glycerol

(a) (i) Alcohols can be broken down into alkenes and water. Give the name and structural formula of an alkene that could be made from butan-1-ol.

name .....

structural formula

[2]

(ii) Give the structural formula of an alcohol that is isomeric with butan-1-ol.

[1]

(iii) Butan-1-ol can be oxidised to an organic acid. Give its name and structural formula.

name .....

structural formula

[2]

(iv) Name an oxidising agent that can change an alcohol into an organic acid.

..... [1]

(b) Glycerol is formed by the hydrolysis of naturally occurring esters.

(i) Give an example of a natural ester that can be hydrolysed to glycerol.

..... [1]

(ii) Name the reagent used to hydrolyse this type of ester.

..... [1]

(iii) What other useful product is formed by this hydrolysis?

..... [1]

(c) Ethane-1,2-diol is used to make condensation polymers, such as polyesters.

(i) Draw the structure of a typical polyester.

[3]

(ii) Suggest an explanation why butan-1-ol cannot form long polymer molecules but ethane-1,2-diol can.

.....

..... [2]

BLANK PAGE

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: $^{a}_{b}X$ — 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.).