Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature							

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General Certificate of Secondary Education
June 2004

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY FOUNDATION TIER

3421/F

Monday 14 June 2004 9.00 am to 11.15 am

F

In addition to this paper you will require:
- a ruler;
- the Data Sheet (enclosed).

You may use a calculator.

Time allowed: 2 hours 15 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 135.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		14	
2		15	
3		16	
4		17	
5		18	
6		19	
7		20	
8		21	
9		22	
10			
11			
12			
13			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

LEAVE MARGIN BLANK

Answer **all** questions in the spaces provided.

1 Choose elements from the box to complete the table.

The periodic table on the Data Sheet may help you to answer this question.

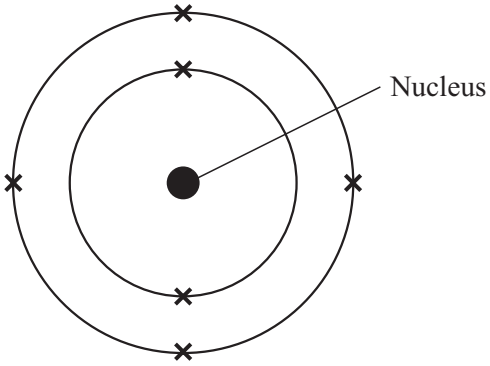
astatine	**bromine**	**chlorine**	**hydrogen**
lithium	**magnesium**	**nickel**	**oxygen**

Description of element	Name of element
A gas which gives a squeaky pop when tested with a burning splint	
A transition element	
The least reactive element in Group 7	
A red-brown liquid which is in Group 7	
A metal which moves around on the surface of cold water and produces bubbles of gas	

(5 marks)

5

2 The diagram represents the electronic structure of an atom of an element.



The periodic table on the Data Sheet may help you with this question.

(a) Name this element.

.....

(1 mark)

(b) Complete this sentence.

The nucleus of an atom contains neutrons and .....

(1 mark)

2

TURN OVER FOR THE NEXT QUESTION

3 This label was on a bottle of stain remover.

(a) What do the hazard symbols on the label mean?

Put a tick (✓) next to the best **two** descriptions.

It can attack and destroy living tissue	
It can provide oxygen which can make other substances burn more fiercely	
It can cause reddening or blistering of the skin	
It can catch fire very easily	
It is highly toxic	
It is a harmful substance	

(2 marks)

(b) Suggest **one** item of safety clothing that might be worn when mixing 'Simply Amazing' with water. Explain why it should be worn.

.....

.....

.....

(2 marks)

(c) When 'Simply Amazing' is mixed with water a reaction takes place which produces bubbles of oxygen gas.

(i) Suggest a method that you could use to measure how quickly this reaction takes place.

.....

.....

.....

.....

.....

.....

(2 marks)

(ii) Read the instructions on the label and then suggest how increasing the temperature of the water affects the rate of this reaction.

.....

.....

(1 mark)

(iii) Suggest **one** other way in which the rate of a reaction can be changed.

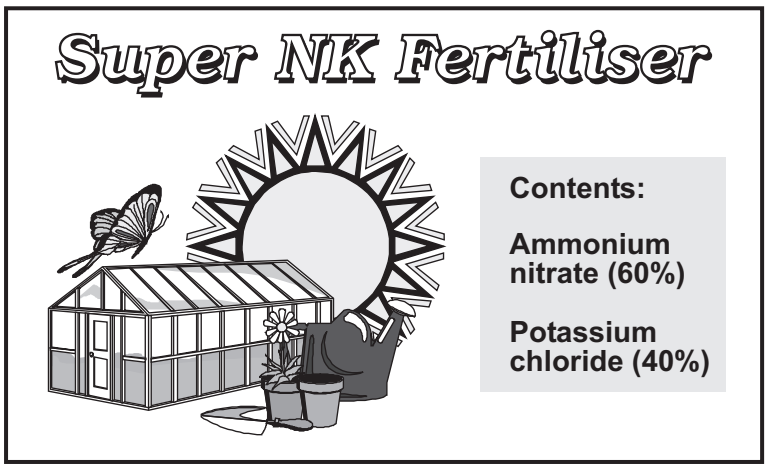
.....

.....

(1 mark)

8

4 The label gives information about one type of fertiliser.



(a) This fertiliser is an NK fertiliser. Use the Data Sheet to help you to suggest which elements all NK fertilisers contain.

.....

(1 mark)

(b) Calculate the mass of ammonium nitrate in 1000 g of this fertiliser.

.....

.....

Mass =..... g

(2 marks)

(c) Ammonium nitrate and potassium chloride are both salts. They can be made by neutralisation reactions.

Choose substances from the box to complete the word equations for the formation of these two salts.

ammonia	**hydrochloric acid**	**nitric acid**
potassium nitrate	**water**	**potassium hydroxide**

ammonia + ... → ammonium nitrate + water

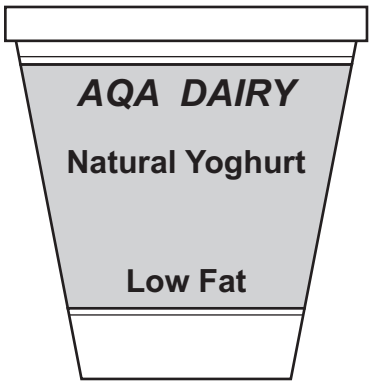
..... + hydrochloric acid → potassium chloride + ...

(3 marks)

6

LEAVE MARGIN BLANK

5 Yoghurt is made from milk by the action of microorganisms. The sugar in the milk is converted into an acid.



(a) Draw a ring around the name of the type of microorganism which changes milk into yoghurt.

bacteria **fungus** **virus** **yeast**

(1 mark)

(b) Draw a ring around the name of the acid formed in the yoghurt.

ethanoic **hydrochloric** **lactic** **nitric**

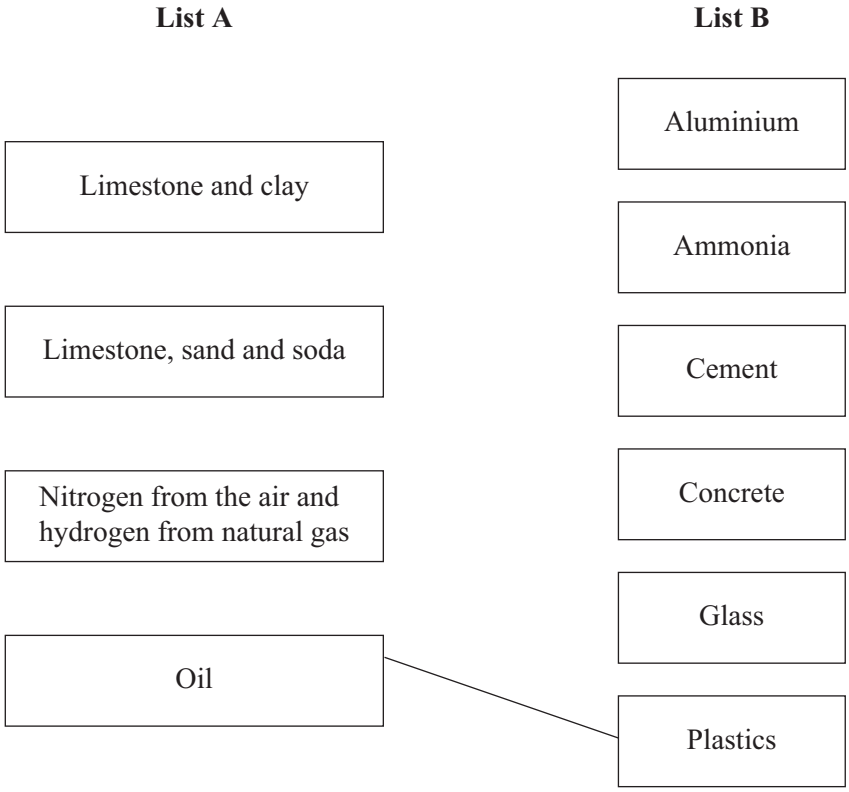
(1 mark)

2

TURN OVER FOR THE NEXT QUESTION

6 List **A** gives the names of some raw materials used by the chemical industry. List **B** gives useful products made from these raw materials.

Draw **one** line from each box of raw materials in list **A** to the useful product made from them in list **B**. One line has been drawn for you.



(3 marks)

3

7 Niobium is a typical transition metal.

(a) Put a tick (✓) next to each of the **four** properties in the table that you would expect for Niobium.

Property	
brittle	
conducts heat	
dull	
forms coloured compounds	
high melting point	
low boiling point	
strong	
very reactive	

(4 marks)

(b) Niobium is extracted from pyrochlorite. This has the formula:

$$CaNaNb_2O_6F$$

Pyrochlorite contains two other metals. Name these **two** metals.

The periodic table on the Data Sheet may help you to answer this question.

..... and .....

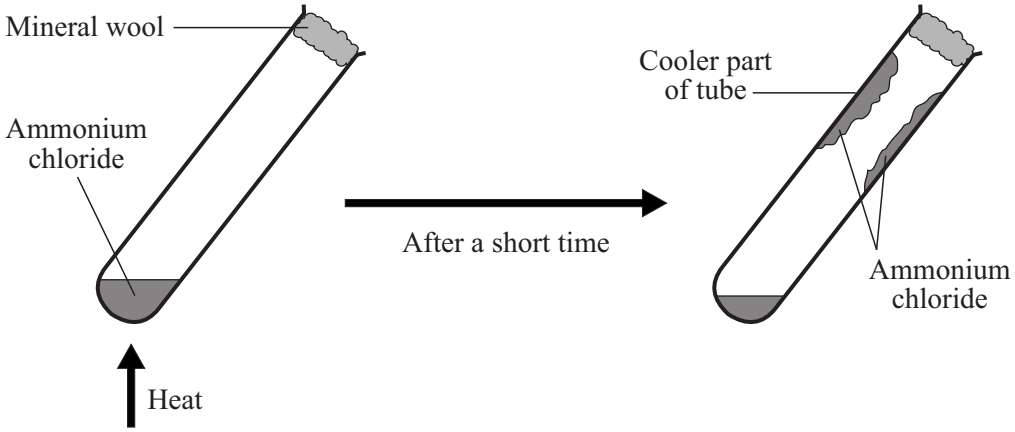
(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

8 A student did two experiments using ammonium chloride.

(a) In the first experiment the student heated a small amount of ammonium chloride in a test tube.



Two reactions take place in the test tube.

Reaction **1**	ammonium chloride → ammonia + hydrogen chloride (colourless gases)
Reaction **2**	ammonia + hydrogen chloride → ammonium chloride

(i) Complete the sentences by crossing out the **incorrect** word in each box.

Reaction **1** takes place at a [high / low] temperature.

Reaction **2** takes place at a [high / low] temperature.

(1 mark)

(ii) Draw a ring around the word which best describes reactions **1** and **2**.

combustion **displacement** **oxidation** **reduction** **reversible**

(1 mark)

(iii) Suggest a reason for the mineral wool at the top of the test tube.

.....

.....

(1 mark)

(b) In the second experiment the student mixed a small amount of ammonium chloride with some water in a beaker.

The temperature of the water was measured before and after adding the ammonium chloride.

Temperature before adding the ammonium chloride	20ºC
Temperature after adding the ammonium chloride	16ºC

Draw a ring around the word which best describes the process which takes place.

combustion **displacement** **endothermic** **exothermic** **freezing**

(1 mark)

4

TURN OVER FOR THE NEXT QUESTION

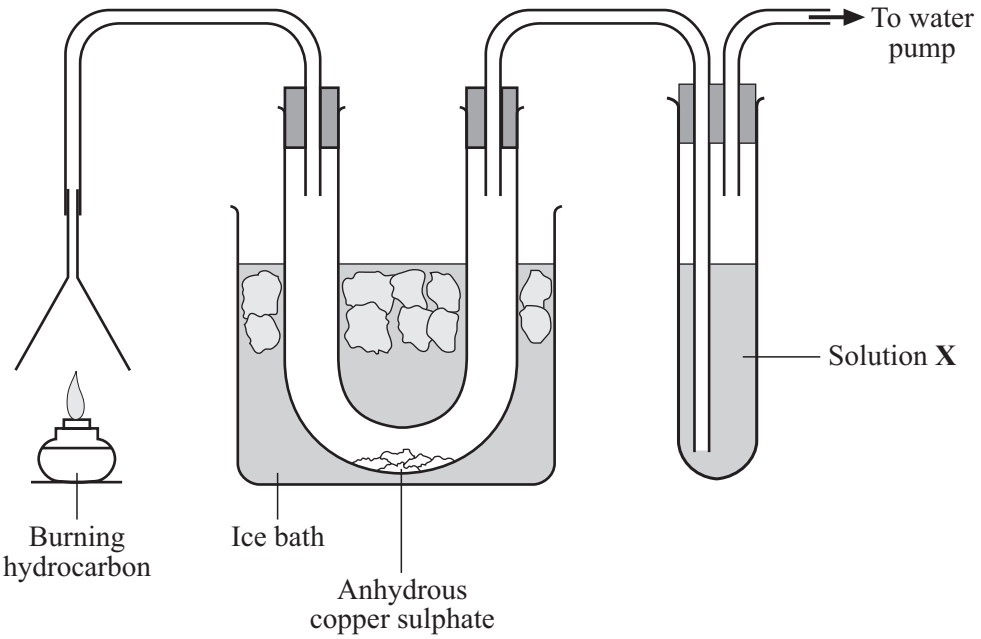
9 Petrol is a hydrocarbon fuel.

(a) Complete this sentence.

Hydrocarbons are compounds which are made from the elements ..... and

..... only. *(2 marks)*

(b) This apparatus was used to study the combustion of a hydrocarbon fuel.



(i) Name the substance which changed the anhydrous copper sulphate from white to blue.

.....

(1 mark)

(ii) Carbon dioxide is also produced when the hydrocarbon fuel is burned.

Name the solution, labelled **X** on the diagram, which tests for carbon dioxide.

.....

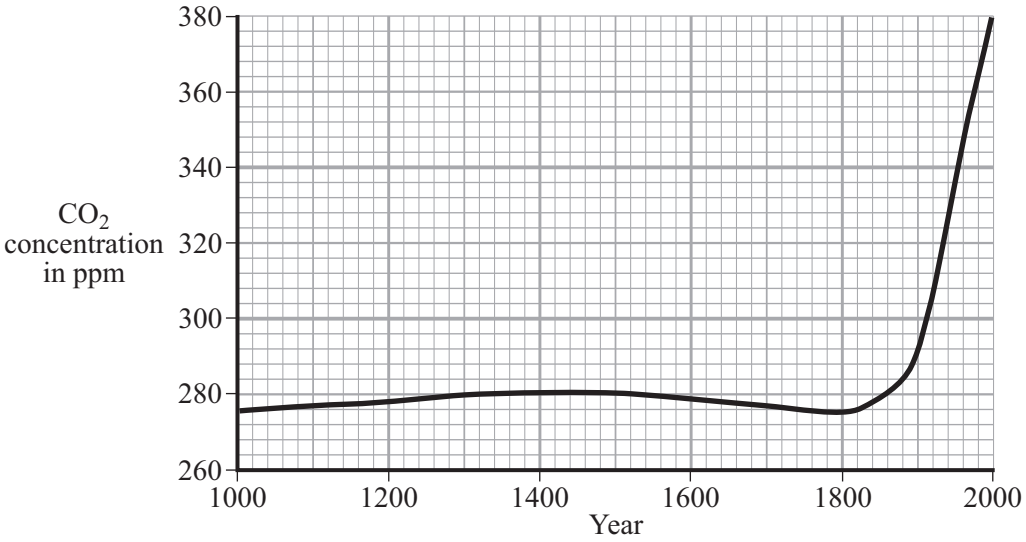
(1 mark)

(iii) Complete this sentence.

Carbon dioxide turns solution **X**.....

(1 mark)

(c) The graph shows how the concentration of carbon dioxide in the air has varied since the year 1000.



(i) Describe the changes in the concentration of carbon dioxide in the air since the year 1000.

.....

.....

.....

.....

.....

.....

(3 marks)

(ii) Suggest why the concentration of carbon dioxide in the air has changed since the year 1800.

.....

.....

(1 mark)

9

10 Steel is an alloy of iron.

(a) Complete these sentences about the manufacture of steel by crossing out the **two** words in each box that are wrong.

Molten iron from the blast furnace is mixed with recycled scrap

aluminium
copper
iron

.

The non-metal impurities are converted into acidic oxides.

This is done by passing pure

air
nitrogen
oxygen

into the mixture.

The acidic oxides are removed by adding

argon
calcium carbonate
sodium chloride

.

These reactions produce pure iron.

Calculated quantities of

carbon
phosphorus
sulphur

are added to the pure iron to make steel.

(4 marks)

(b) Different types of steel have different properties.

Some properties of steels are given in the table below.

Which **two** of these are properties of low carbon steels?

Place a tick (✓) next to these **two** properties.

Property	Tick (✓)
Brittle	
Easily shaped	
Soft	
Strong	

(2 marks)

6

11 This label has been taken from a bottle of alcoholic drink.

The alcohol in this drink is ethanol.

(a) Complete each sentence about the manufacture of ethanol from sugar by choosing the correct words from the box.

Each word may be used once or not at all.

acids	**air**	**alkalis**	**carbon dioxide**	**chlorine**
enzymes		**fermentation**	**oxidation**	**water**

Ethanol can be produced by the ..... of sugar.

In the reaction vessel sugar is mixed with warm ..... and yeast is added.

The yeast contains ..... which are biological catalysts.

The sugar reacts to form ethanol and ..... gas.

This gas is allowed to escape but ..... is prevented from entering the reaction vessel. *(5 marks)*

(b) Ethanol is in alcoholic drinks. State **one** other use of ethanol.

.....

(1 mark)

6

12 (a) Complete each sentence about water by choosing the correct words from the box.

Each word may be used once or not at all.

calcium	**chloride**	**chlorine**	**hydroxide**	**nitrate**	**oxygen**

(i) Hardness in water is caused by dissolved ..... ions.

(1 mark)

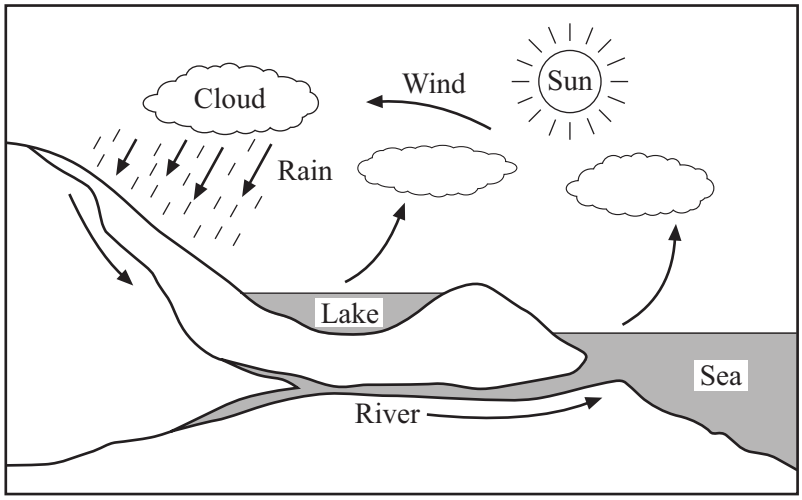
(ii) Some ..... dissolved in water is essential for aquatic life.

(1 mark)

(iii) The use of artificial fertilisers can result in many natural waters being contaminated with dissolved ..... ions, which can have harmful effects on babies.

(1 mark)

(b) The diagram shows part of the water cycle.



Describe what is happening in the water cycle.

To gain full marks you should write down your ideas in good English. Put them into a sensible order and use correct scientific words.

.....

.....

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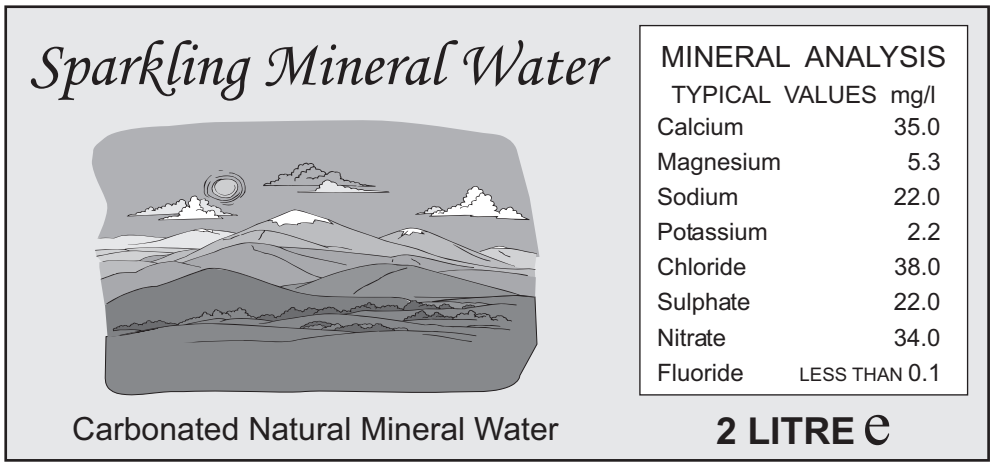
.....

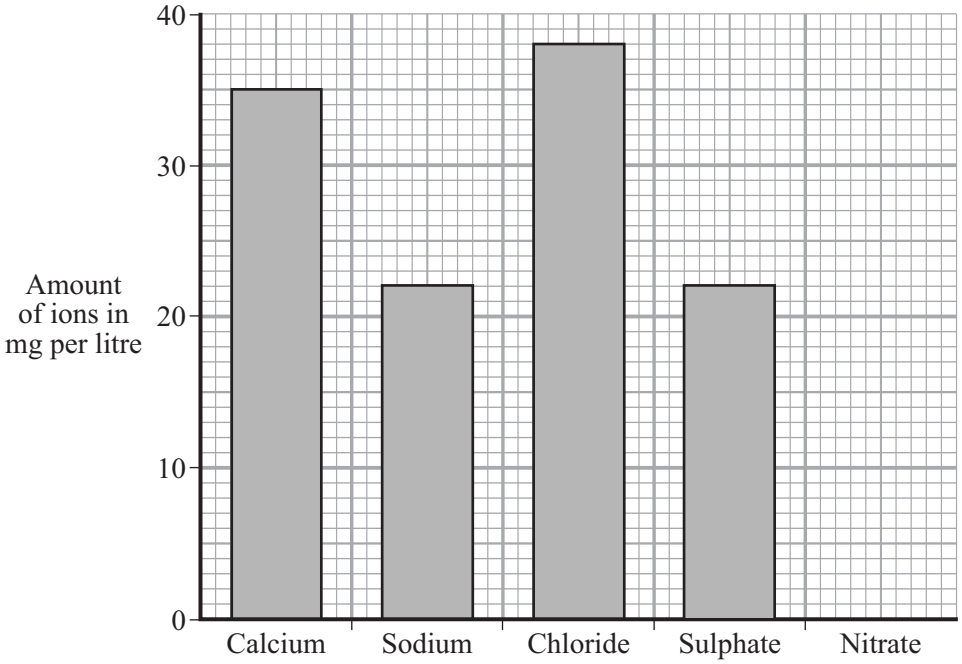
.....

(3 marks)

(c) This label has been taken from a bottle of carbonated mineral water.



(i) The bar chart shows the amounts of some of the ions in this mineral water.



Complete the bar chart to show the amount of nitrate ions given on the label.

(1 mark)

(ii) Describe how water is carbonated.

.....

.....

.....

(2 marks)

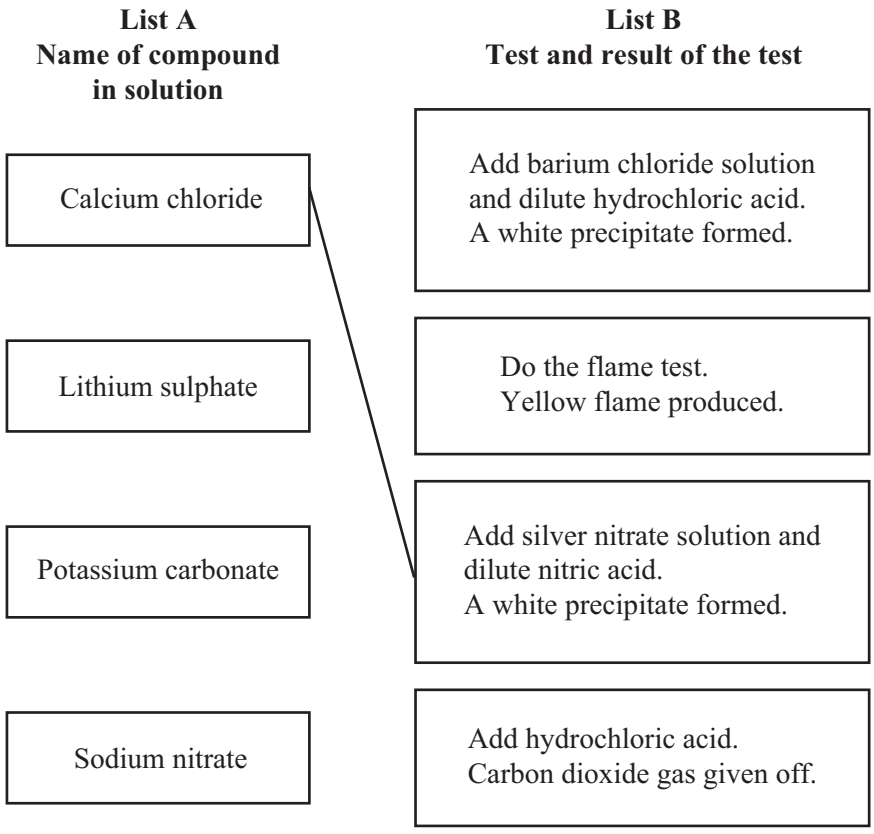
9

Turn over ▶

13 Chemical tests can be used to identify compounds.

(a) List **A** gives the names of four compounds in solution. List **B** gives tests and the result of the tests.

Draw a straight line from each compound in List **A** to its test and test result in List **B**. The first one has been done for you.



(2 marks)

(b) State what you would **see** when sodium hydroxide solution reacts with copper sulphate solution.

.....

.....

(2 marks)

(c) (i) Name **one** instrumental method which can be used to help in the identification of substances.

.....

(1 mark)

(ii) Suggest **one** advantage of the instrumental method you have named.

.....

(1 mark)

6

14 The periodic table on the Data Sheet may help you to answer this question.

(a) Newlands and Mendeleev both designed periodic tables in which the elements were put in the order of their relative atomic masses.

When the elements are put in this order a few of them are placed incorrectly when compared with a modern periodic table.

(i) Give **one** example of a pair of elements that would be placed incorrectly if they were in the order of their relative atomic masses.

..... and .....

(1 mark)

(ii) Explain why placing these two elements in the order of their relative atomic masses would **not** be correct.

.....

.....

(1 mark)

(b) In the modern periodic table the elements are put in order of their atomic (proton) numbers.

Explain how the positions of the elements in the periodic table are linked to the electronic structure of their atoms.

.....

.....

.....

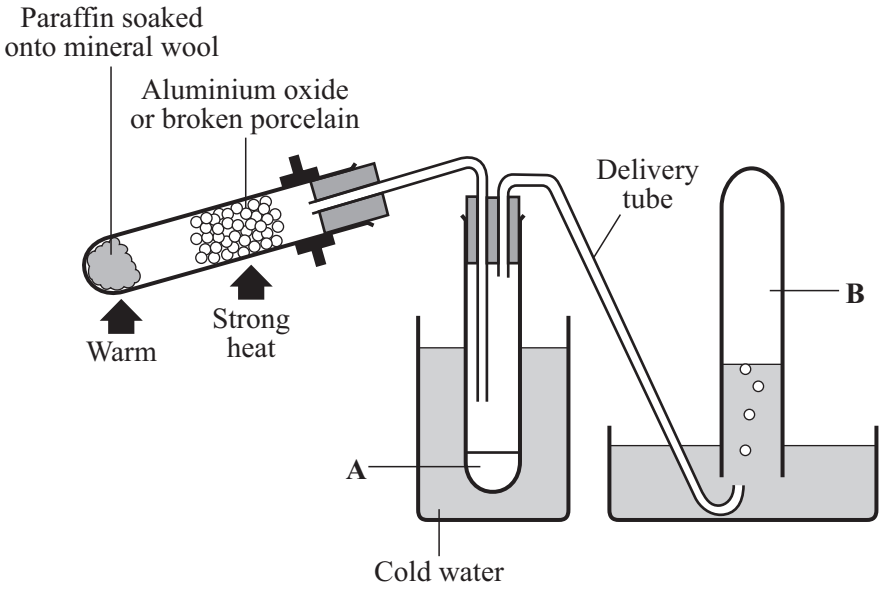
.....

(2 marks)

4

TURN OVER FOR THE NEXT QUESTION

15 The diagram shows an apparatus that can be used to carry out cracking reactions in a laboratory.



(a) Why is aluminium oxide or broken porcelain used?

.....

(1 mark)

(b) Paraffin contains decane. The cracking of decane can be represented by the equation below. A decane molecule is split into two smaller molecules.

Complete the equation by adding the formula of the other product.

$C_{10}H_{22}$ (l) → ..... (l) + C_2H_4 (g)
decane

(1 mark)

(c) Would you expect C_2H_4 molecules to collect at position **A** or **B** shown on the diagram?

Position.....

Explain your answer.

.....

.....

(1 mark)

(d) Cracking reactions involve *thermal decomposition*.

What is meant by *thermal decomposition*?

.....

.....

.....

.....

(2 marks)

(e) Explain, as fully as you can, why cracking is used in the oil industry.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(f) The cracking reaction produces a mixture of products. The mixture contains hydrocarbons with different boiling points.

Suggest a method of separating this mixture.

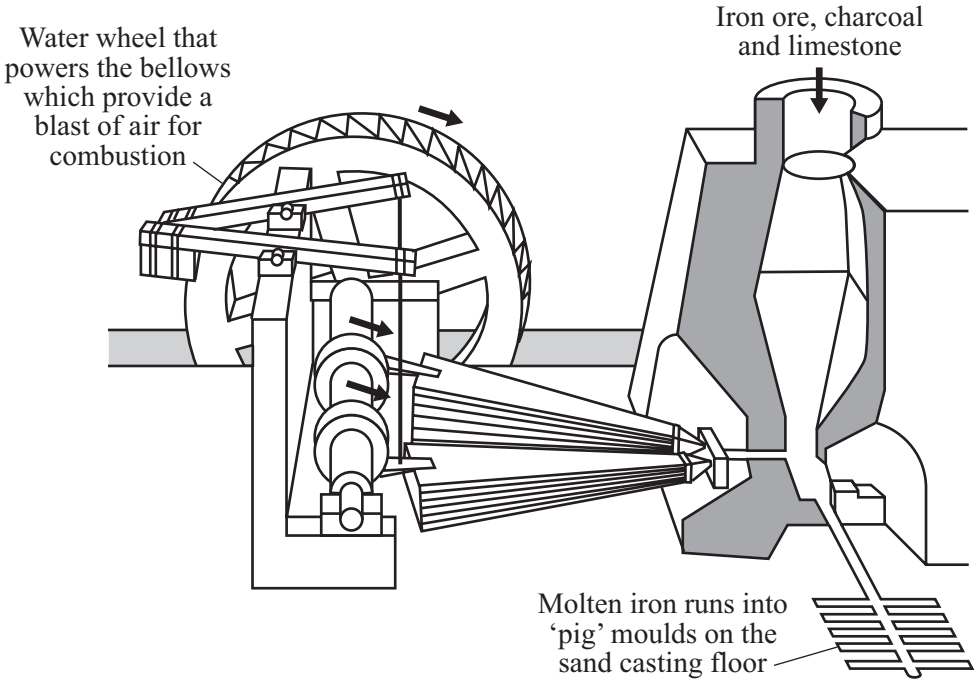
.....

.....

(1 mark)

9

16 The diagram shows an early type of blast furnace used in Wales about 300 years ago.



(a) (i) This early type of furnace uses charcoal. Name the raw material that has replaced charcoal in modern furnaces.

.....

(1 mark)

(ii) State **one** other way in which this early type of furnace differs from a modern furnace.

.....

.....

(1 mark)

(b) The charcoal provides carbon. This reacts with oxygen to form carbon monoxide. The iron oxide in the iron ore is *reduced* by the carbon monoxide.

(i) State what the word *reduced* means.

.....

(1 mark)

(ii) Name the **two** substances formed when iron oxide reacts with carbon monoxide.

..... and .....

(1 mark)

(c) Why is limestone added to the blast furnace?

.....

.....

(1 mark)

(d) Explain why sodium cannot be extracted from its ore by this method.

The Data Sheet may help you to answer this question.

.....

.....

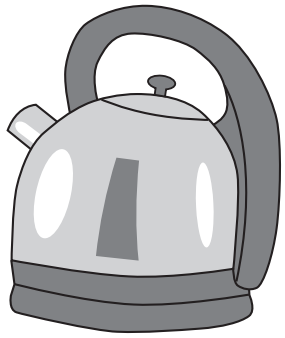
.....

.....

(2 marks)

(e) Stainless steel is an alloy which contains iron and other metals.

This kettle is made from stainless steel.



(i) Name a metal which is added to iron to make stainless steel.

.....

(1 mark)

(ii) Why is stainless steel a good material for making kettles?

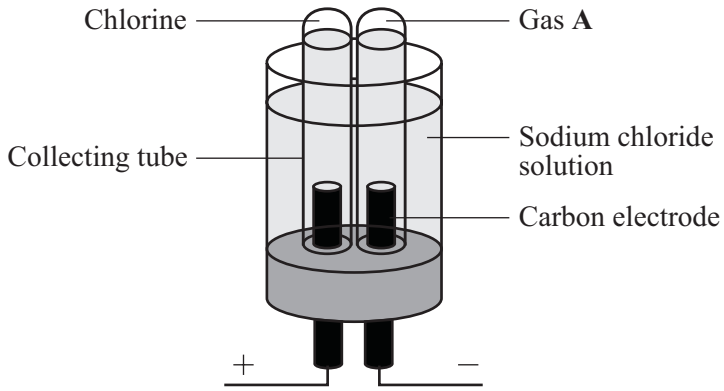
.....

.....

(1 mark)

9

17 The electrolysis of sodium chloride solution is an important industrial process. The apparatus shown below can be used to show this electrolysis in the laboratory.



(a) Name gas **A**. .....

(1 mark)

(b) Chlorine is produced at the positive electrode. Describe and give the result of a chemical test to prove that the gas is chlorine.

.....

.....

.....

.....

(2 marks)

(c) Chloride ions move to the positive electrode. Explain why.

.....

.....

(1 mark)

(d) A small quantity of chlorine is added to drinking water. Explain why.

.....

.....

(1 mark)

(e) The solution around the negative electrode becomes alkaline. Name the ion which makes the solution alkaline.

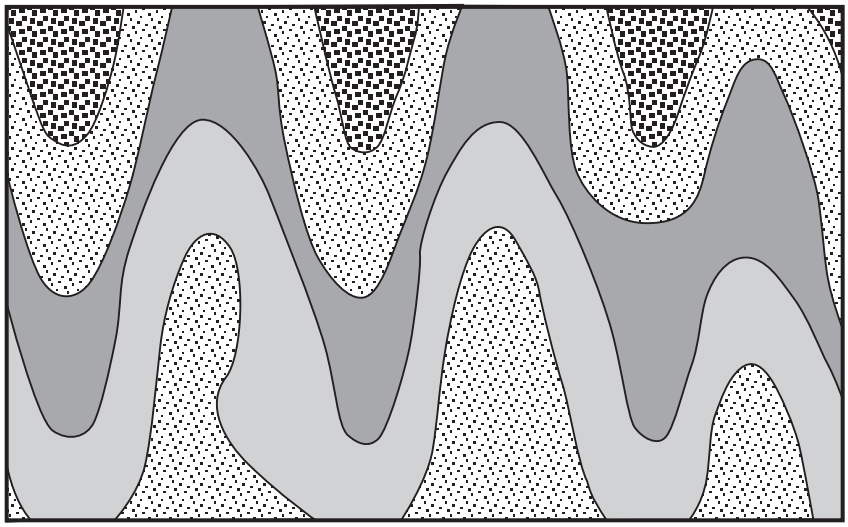
.....

.....

(1 mark)

6

18 The diagram shows a cross section through some metamorphic rocks.



These rocks were once horizontal layers of sedimentary rocks.

Describe how the sedimentary rock was changed into metamorphic rock.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

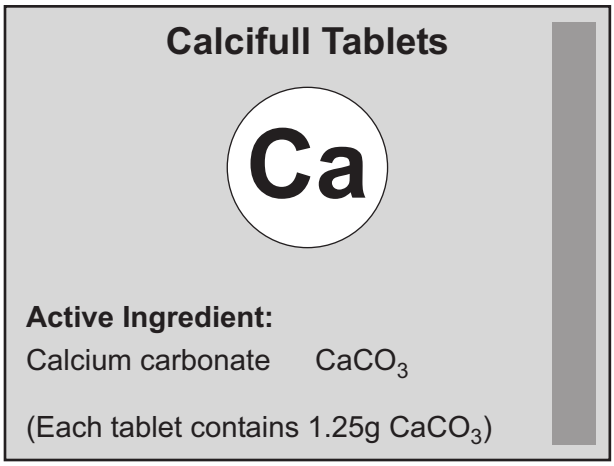
.....

(3 marks)

3

TURN OVER FOR THE NEXT QUESTION

19 Calcium carbonate tablets are used to treat people with calcium deficiency.



(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

.....

.....

Relative formula mass = ...
(2 marks)

(b) Calculate the percentage of calcium in calcium carbonate, $CaCO_3$.

.....

.....

Percentage of calcium = ... %
(2 marks)

(c) Calculate the mass of calcium in each tablet.

.....

.....

Mass of calcium = ... g
(2 marks)

(d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).

$$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2O\ (1) + CO_2\ (g)$$

Suggest why the patient may suffer from 'wind'.

.....

.....

(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

20 Many foods contain chemical additives.

(a) A tin of creamed rice contains sodium carbonate as an acidity regulator.

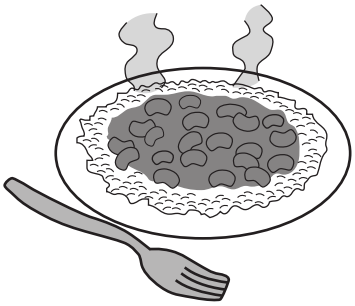
Use the table of ions on the Data Sheet to help you to work out the formula of sodium carbonate.

.....

.....

(1 mark)

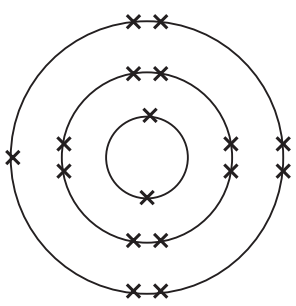
(b) A tin of red kidney beans contains calcium chloride as a firming agent.

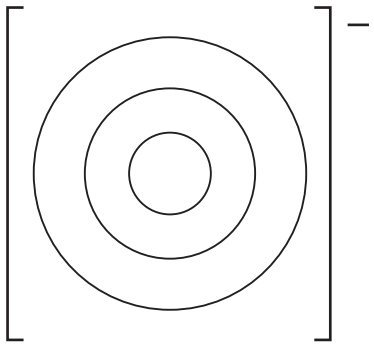


Calcium chloride is an ionic compound which contains calcium ions (Ca^{2+}) and chloride ions (Cl^{-}).

(i) The diagram on the left represents the electronic structure of a chlorine atom.

Complete a similar diagram on the right to represent a chloride ion.





(2 marks)

(ii) Explain how a calcium **atom** changes into a calcium **ion** which has a 2+ charge.

.....

.....

.....

.....

(2 marks)

(c) Cola drinks contain phosphoric acid, H_3PO_4. The two equations show how phosphoric acid can be made from phosphorus.

Balance these two equations.

(i) P_4 + ... O_2 → P_4O_{10} *(1 mark)*

(ii) P_4O_{10} + ... H_2O → $4H_3PO_4$

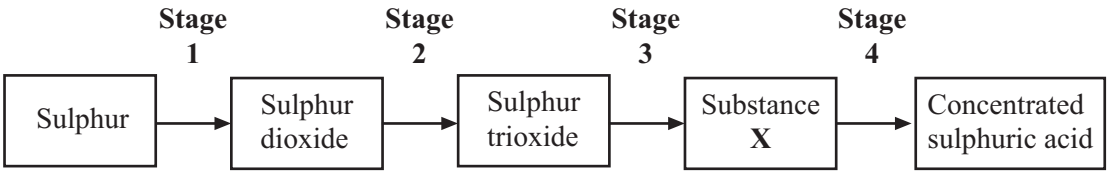
(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

21 Sulphuric acid can be made by the Contact Process.

(a) There are four main stages in the Contact Process.



Give the name of:

(i) the catalyst used in **Stage 2**;

.....

(1 mark)

(ii) the substance which dissolves sulphur trioxide in **Stage 3**;

.....

(1 mark)

(iii) substance **X**, formed in **Stage 3**.

.....

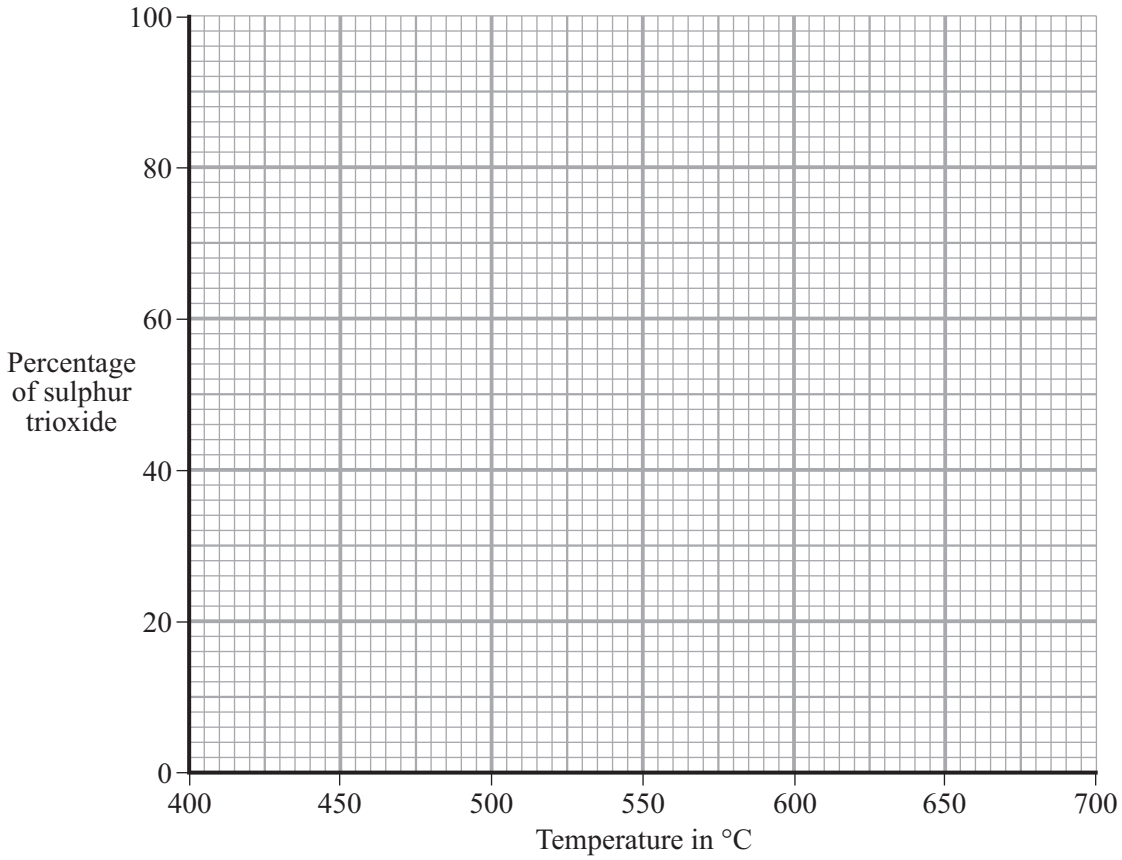
(1 mark)

(b) The percentage of sulphur trioxide formed in **Stage 2** depends upon the temperature.

The table gives information about the percentage of sulphur trioxide formed at different temperatures.

Percentage of sulphur trioxide	98	96	90	80	66	50	32
Temperature in ºC	400	450	500	550	600	650	700

(i) Plot the data on the grid opposite. Draw a smooth curve to show how temperature affects the percentage of sulphur trioxide formed.



(2 marks)

(ii) Use your graph to find the temperature which gives 70% of sulphur trioxide.

.....ºC
(1 mark)

(c) A balanced symbol equation which represents the overall process is

$$S + H_2O + 1\tfrac{1}{2}O_2 \rightarrow H_2SO_4$$

This equation means that the formula mass of sulphuric acid can be made starting from the formula mass of sulphur.

The formula mass of sulphur is 32 g.

(i) Show that the formula mass of sulphuric acid is 98 g.

Relative atomic masses: H = 1; O = 16; S = 32.

.....

.....
(2 marks)

QUESTION 21 CONTINUES ON THE NEXT PAGE

(ii) In practice, the actual amount of sulphuric acid made from 32 g of sulphur is less than 98 g. **Stage 2** of the Contact Process is reversible.

Suggest why this lowers the amount of sulphuric acid made.

.....

.....

(1 mark)

(d) The balanced symbol equation which represents the reaction between sulphuric acid and sodium hydroxide solution is

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Use the ideas of Arrhenius and Bronsted-Lowry to explain why sodium hydroxide is a base when it reacts with sulphuric acid.

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(3 marks)

12

22 The following passage is about the preparation of lead iodide, an insoluble salt.

> An excess of potassium iodide in solution was shaken with some lead nitrate solution in a test tube.
>
> The lead iodide precipitate was separated from the mixture and then washed several times with water.
>
> The lead iodide was dried and then placed in a bottle.

(a) Suggest a reason why excess potassium iodide was used.

.....

.....

(1 mark)

(b) What word used in the passage shows that lead iodide is insoluble?

.....

(1 mark)

(c) Suggest how lead iodide can be separated from the mixture.

.....

.....

(1 mark)

(d) Why was the lead iodide washed with water?

.....

.....

(1 mark)

(e) Suggest a method which could be used to dry this lead iodide.

.....

.....

(1 mark)

(f) Lead compounds are toxic.

Suggest a suitable safety precaution that should be taken when using toxic substances in laboratories.

.....

(1 mark)

6

END OF QUESTIONS

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