

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education  
June 2005



**CHEMISTRY (SPECIFICATION B)  
FOUNDATION TIER**

**3421/F**

Thursday 16 June 2005 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.

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		23	
11			
12			
13			
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

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**

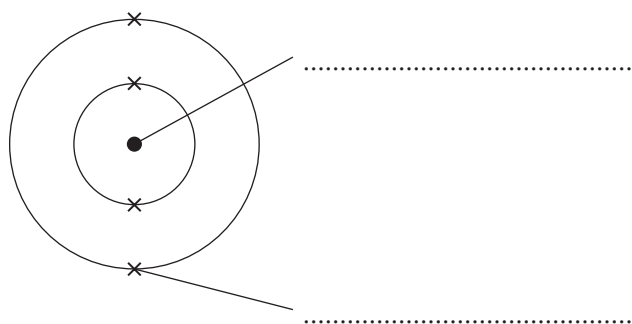
- The maximum mark for this paper is 135.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

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

- 1 (a) The diagram represents an atom of beryllium.

Use words from the box to label the diagram.

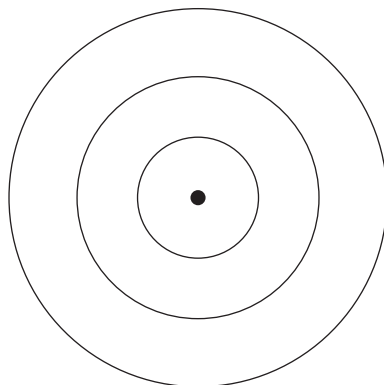
<b>electron</b>	<b>ion</b>	<b>isotope</b>	<b>molecule</b>	<b>nucleus</b>
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(2 marks)

- (b) Use crosses (×) to complete the diagram to show the electronic structure of a magnesium atom.

The atomic (proton) number of magnesium is 12.



(2 marks)

$\frac{\quad}{4}$



3 Salts can be prepared by the reaction of acids with alkalis.

(a) (i) The reactions of acids with alkalis can be represented by the equation below.

Choose a substance from the box to complete the equation.

<b>carbon dioxide</b>	<b>hydrogen</b>	<b>oxygen</b>	<b>water</b>
-----------------------	-----------------	---------------	--------------

acid + alkali  $\rightarrow$  salt + .....

(1 mark)

(ii) Draw a ring around the word which best describes the reaction.

**displacement**      **neutralisation**      **oxidation**      **reduction**

(1 mark)

(b) Sodium sulphate is an important salt.

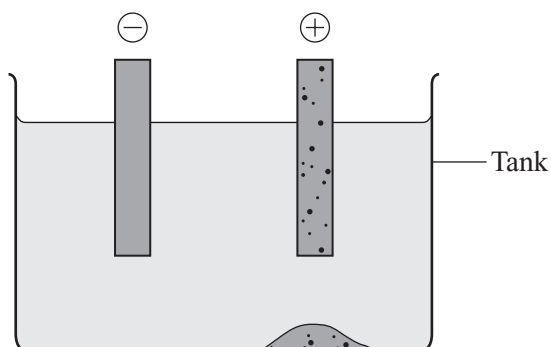
The table gives a list of some substances.

Put a tick (✓) next to the names of the acid **and** the alkali that would react to make sodium sulphate.

<b>Substances</b>	<b>(✓)</b>
Hydrochloric acid	
Nitric acid	
Potassium sulphate	
Sodium hydroxide	
Sodium nitrate	
Sulphuric acid	

(2 marks)

4 The diagram shows a method used to purify copper.



Choose words or phrases from the box to complete the sentences below.

<b>bottom of the tank</b>	<b>cracking</b>	<b>displacement</b>	<b>electrolysis</b>
<b>negative electrode</b>	<b>positive electrode</b>	<b>surface of the solution</b>	

This method of purifying copper is called .....

The impure copper is made the ..... and the pure copper collects at the .....

The impurities collect at the .....

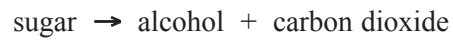
(4 marks)

4

**TURN OVER FOR THE NEXT QUESTION**

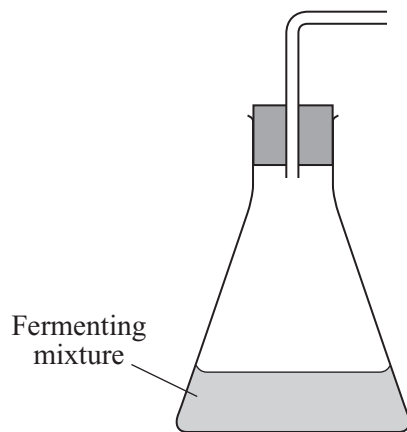
**Turn over** ►

5 Sugar can be fermented. The reaction can be represented by this equation.



(a) A student set up this apparatus to show that fermentation produces carbon dioxide. The student wanted to use limewater to test the carbon dioxide.

(i) **Complete** the diagram to show how the carbon dioxide can be bubbled through limewater.

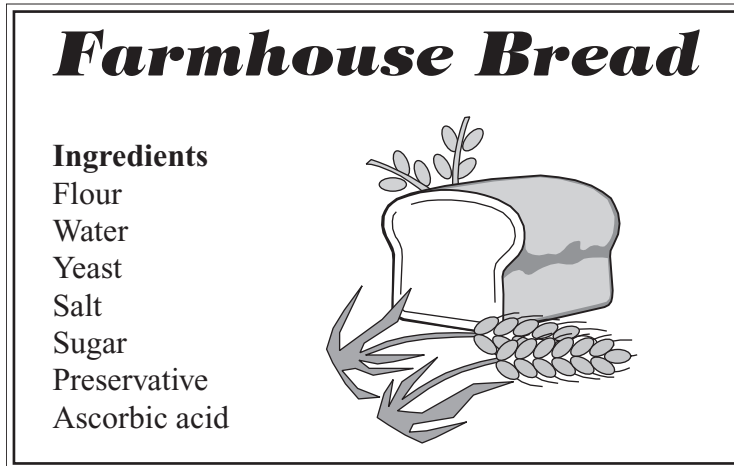


(2 marks)

(ii) What change would you see in the limewater when carbon dioxide is bubbled through it?

.....  
(1 mark)

(b) This label was on a loaf of bread.



The fermentation reaction is used when bread is made.

(i) State **two** ingredients in the bread which are essential for the fermentation reaction to occur.

..... and .....  
(2 marks)

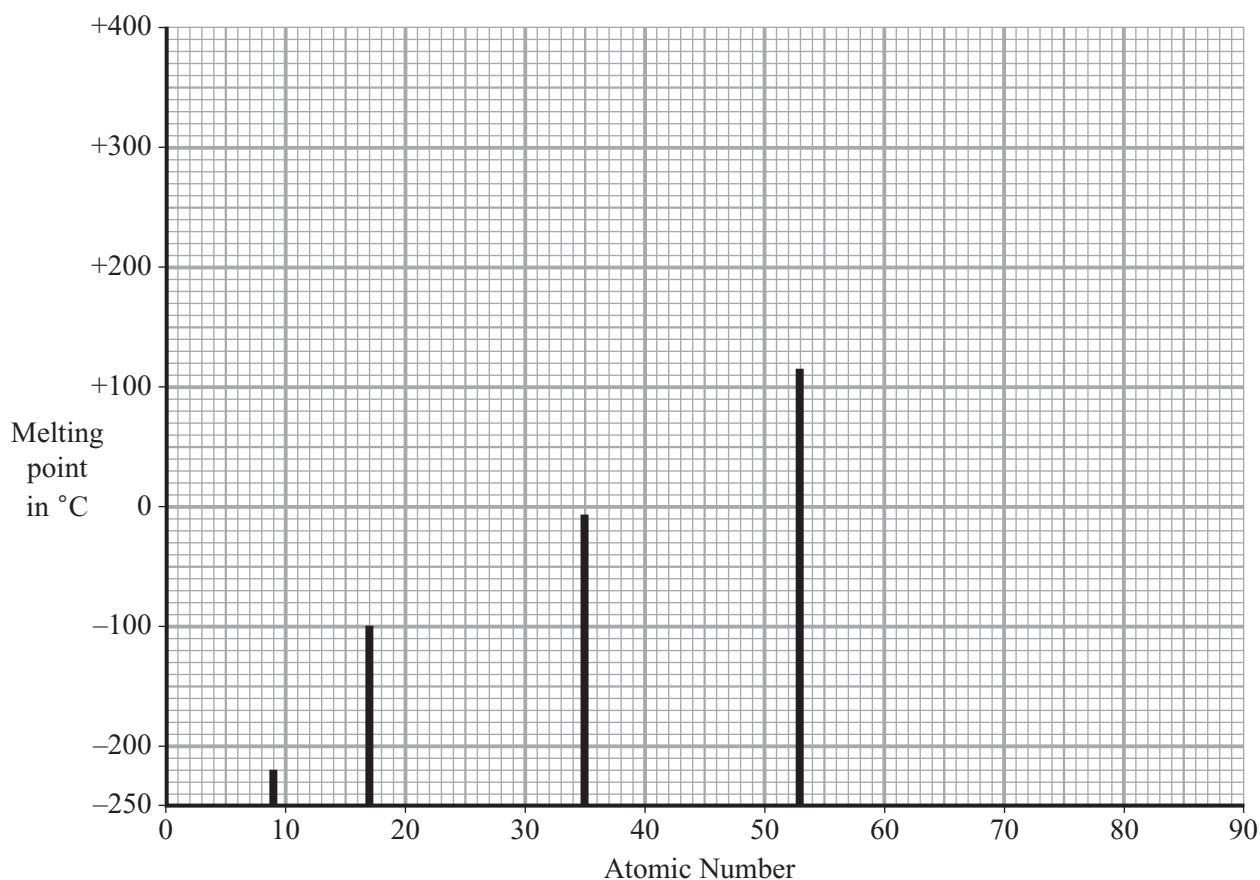
(ii) Explain why fermentation is used when bread is made.

.....  
.....  
.....  
.....  
(2 marks)

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 6 (a) The bar graph shows the melting points of the elements in Group 7 plotted against their atomic numbers.



- (i) How do the melting points of the Group 7 elements change as the atomic number increases?

.....  
 .....  
 (1 mark)

- (ii) The melting point of astatine (atomic number = 85) is not shown on the bar graph.

Estimate the melting point of astatine. .... °C  
 (1 mark)

Draw a bar for this value on the bar graph. (1 mark)



- (b) The water from wells in Japan contains bromide ions.

Bromine is extracted from this water. The bromine is displaced by adding another Group 7 element.

- (i) Place a tick (✓) next to the name of **one** Group 7 element that could be used to displace bromine from this water.

	<b>Group 7</b>	<b>(✓)</b>
	Fluorine	
	Chlorine	
	Bromine	
	Iodine	
	Astatine	

Most reactive  
 ↑  
 Least reactive

(1 mark)

- (ii) State why you have chosen this element.

.....

.....

(1 mark)

- (iii) One sample of this water contained 2 g of bromine per litre of water.

How many litres of this water would be needed to make 1 kg of bromine?  
(1 kg = 1000 g)

.....

..... litres  
(1 mark)

6

Turn over ►

7 A student investigated some instant soup.

(a) Instant soup contains a food additive which has the formula:



Give the names of all the elements in this compound.

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

.....  
.....

(2 marks)

(b) The student investigated the reaction which takes place when soup powder is added to cold water.

The student thought that the reaction might be *exothermic*.

(i) What is meant by the term *exothermic* reaction?

.....  
.....

(2 marks)

(ii) Describe an experiment that the student could do to prove that this reaction is exothermic.

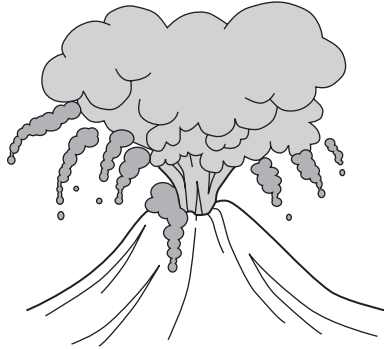
*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

(4 marks)



- 8 (a) During the first billion years of the Earth's existence, there were many active volcanoes. The volcanoes released the gases that formed the early atmosphere.



- (i) Describe how volcanoes caused the oceans to be formed.

.....  
 .....  
 .....

(2 marks)

- (ii) Most of the early atmosphere was carbon dioxide.

Give **one** way in which carbon dioxide is removed from the atmosphere.

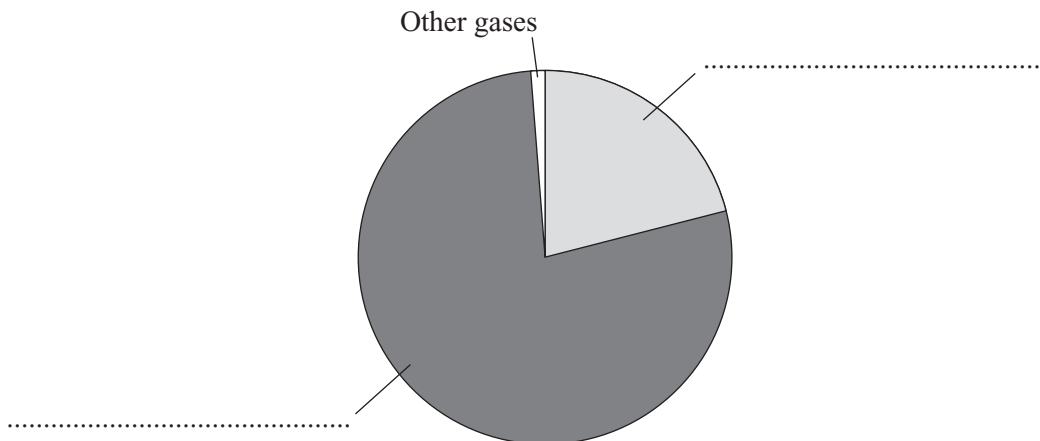
.....

(1 mark)

- (b) The atmosphere on Earth today is very different from the early atmosphere.

The pie chart shows the amounts of different gases in the air today. Choose gases from the box to label the pie chart.

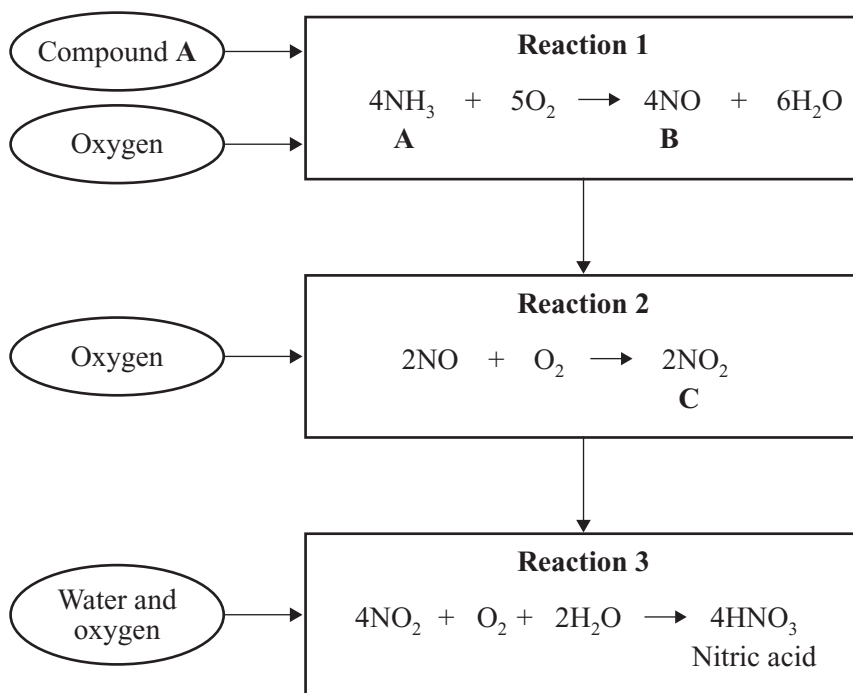
argon	carbon dioxide	hydrogen	nitrogen	oxygen
-------	----------------	----------	----------	--------



(2 marks)

Turn over ►

- 9 (a) The flow diagram shows the stages in the production of nitric acid.



Give the names of the compounds labelled as **A**, **B** and **C** on the flow diagram. Choose names from the box.

ammonia	nitrogen	nitrogen dioxide	nitrogen monoxide
---------	----------	------------------	-------------------

**A** ..... **B** .....

**C** ..... (3 marks)

- (b) Use the flow diagram to help you name **two** raw materials used to make nitric acid.

..... and ..... (2 marks)

- (c) Reaction **1** uses a catalyst.

- (i) How does a catalyst help this reaction?

..... (1 mark)

- (ii) Draw a ring around the name of the catalyst used in reaction **1**.

**copper**      **iron**      **platinum**      **vanadium**

(1 mark)

- 10 (a) List **A** gives the names of three fossil fuels. List **B** gives a physical state, at room temperature and pressure.

Draw a straight line from each fossil fuel in List **A** to its physical state in List **B**. One has been done for you.

List A Fossil fuel	List B Physical state
Coal	Gas
Crude oil	Liquid
Natural gas	Solid

(1 mark)

- (b) Fossil fuels contain organic compounds.

Which **one** of the following elements is in all organic compounds? Draw a ring around your answer.

**carbon**

**nitrogen**

**oxygen**

**sulphur**

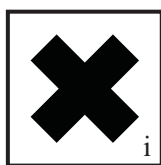
(1 mark)

- (c) Carbon monoxide is a poisonous gas which can be produced when fossil fuels burn.

- (i) Which one of the following hazard symbols, **A**, **B**, **C** or **D**, shows that carbon monoxide is poisonous? Draw a ring around the correct letter.



**A**



**B**



**C**



**D**

(1 mark)

- (ii) Complete this sentence by choosing the correct word from the box.

**carbon dioxide    nitrogen    oxygen    water**

Carbon monoxide is poisonous because it reduces the capacity of the blood to carry

.....

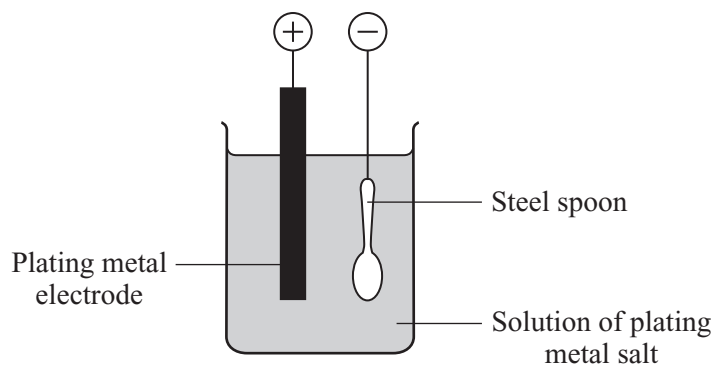
(1 mark)

Turn over ►

- 11 (a) One use of electrolysis is electroplating.

Electroplating puts a layer of one metal onto the surface of another metal.

The diagram below shows a steel spoon being electroplated.



- (i) Complete these sentences by crossing out the **two** words in each box that are wrong.

The steel spoon is made the negative electrode and is placed in a solution

containing 

atoms
ions
molecules

 of the plating metal salt.

The other electrode is made of the plating metal.

An example of a plating metal is 

magnesium
silver
sodium

.

(2 marks)

- (ii) Suggest **one** advantage of electroplating a steel spoon.

.....  
(1 mark)

(b) Aluminium is protected by a very thin layer of aluminium oxide.

For some uses of aluminium, the thickness of the protective oxide layer is increased by electrolysis. This process is called anodising.

Complete each sentence about the anodising of aluminium by choosing the correct words from the box.

Each word may be used once or not at all.

<b>hydrochloric acid</b>	<b>negative</b>	<b>oxygen</b>
<b>positive</b>	<b>sodium hydroxide</b>	<b>sulphuric acid</b>

The first stage of the process involves removing the natural oxide layer from the aluminium using dilute .....

The aluminium is then made the ..... electrode in the electrolysis of dilute .....

The gas named ..... forms on the surface of the aluminium and reacts with the metal to form a thick oxide layer. (4 marks)

7

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

12 Sulphuric acid is an important chemical.

- (a) Complete the sentences, which are about the manufacture of sulphuric acid.

Choose the correct words from the box.

Each word may be used once or not at all.

<b>calcium oxide</b>	<b>hydrogen sulphide</b>	<b>nitrogen dioxide</b>	
<b>oleum</b>	<b>sulphur dioxide</b>	<b>vanadium oxide</b>	<b>water</b>

Sulphur is burned in air to form ..... gas.

This gas is mixed with more air and passed over a hot catalyst to form sulphur trioxide.

The catalyst is a transition metal compound named .....

The sulphur trioxide is dissolved in concentrated sulphuric acid to form a fuming liquid called

.....

This fuming liquid is then reacted with ..... to produce sulphuric acid. (4 marks)

- (b) State **one** large-scale use of sulphuric acid.

..... (1 mark)

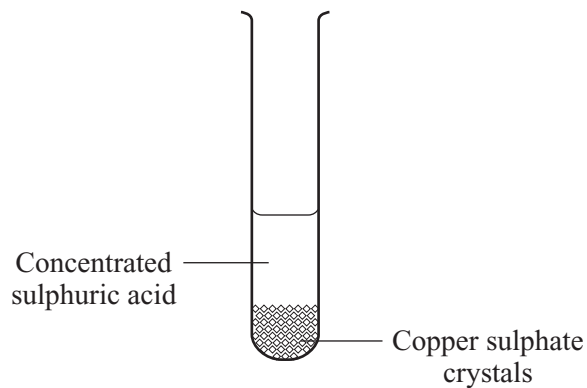
- (c) Concentrated sulphuric acid is *corrosive*.

Explain what *corrosive* means.

.....  
..... (1 mark)



- (d) Concentrated sulphuric acid was poured onto hydrated copper sulphate crystals.



The balanced symbol equation which represents this reaction is



Hydrated copper sulphate crystals are blue.

- (i) Describe what you would **see** happening.

.....  
.....  
(1 mark)

- (ii) Explain what has happened.

.....  
.....  
(1 mark)

**TURN OVER FOR THE NEXT QUESTION**

8

Turn over ►

13 Soft drinks, such as this Cream Soda, contain weak acids.



(a) Lactic acid is a weak acid.

- (i) Complete this sentence about lactic acid by crossing out the **two** words in the box that are wrong.

Solutions of weak acids contain fewer hydrogen

atoms
ions
molecules

than strong acids of the

same concentration.

(1 mark)

- (ii) Which **one** of the following could be the pH of a solution of a weak acid?

Draw a ring around your answer.

1                      5                      9                      13

(1 mark)

- (iii) Which **one** of the following shows the colour of universal indicator when it is added to a weak acid?

Draw a ring around your answer.

blue                      green                      orange                      red

(1 mark)

- (iv) You are given solutions of lactic acid and hydrochloric acid, which have the same concentrations.

Describe how you could use some magnesium ribbon to show that lactic acid is a weaker acid than the hydrochloric acid.

State how you would make it a fair test.

.....

.....

.....

.....

.....

.....

(3 marks)

- (b) This Cream Soda contains carbonated water.

Which **one** of the following substances is dissolved in water to carbonate it?

Draw a ring around your answer.

**calcium carbonate**

**carbon**

**carbon dioxide**

**carbon monoxide**

(1 mark)

- (c) Which acid-base theory states that “acids are proton donors”?

Place a tick (✓) next to the name of the theory.

Name of theory	Tick (✓)
Brønsted and Lowry	
Dalton	
Haber	
Mendeleev	

(1 mark)

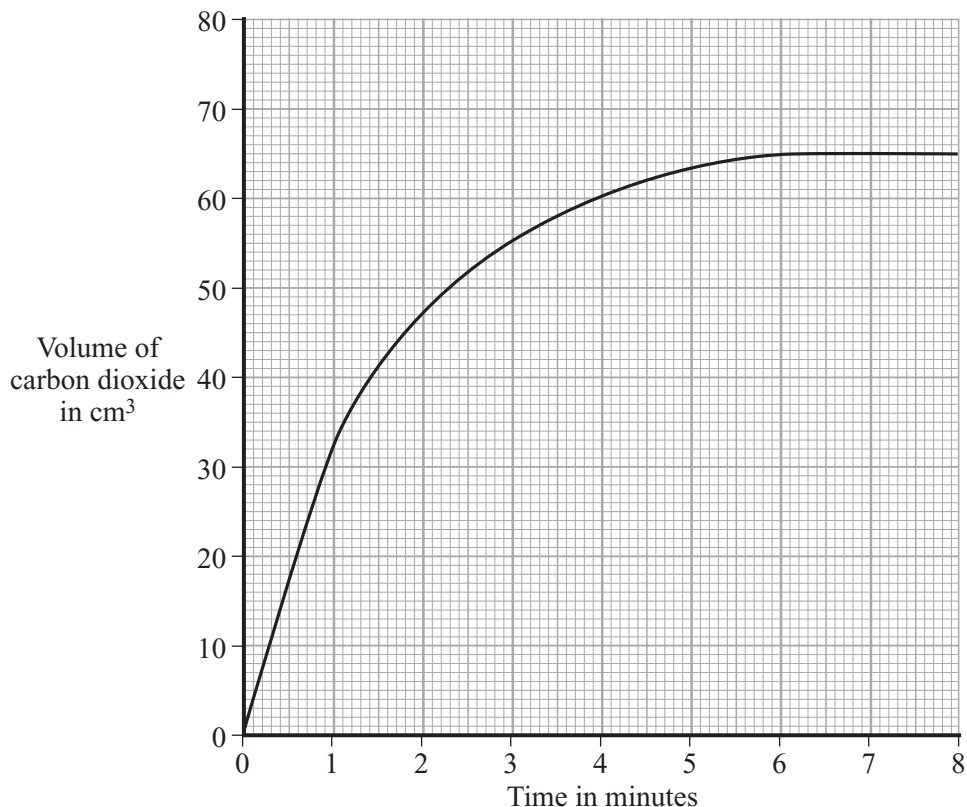
8

Turn over ►

- 14 A student studied the reaction between dilute hydrochloric acid and an **excess** of calcium carbonate.



The student measured the volume of carbon dioxide produced in the experiment. The results are shown on the graph.



- (a) After how many minutes had all the acid been used up? ..... minutes  
(1 mark)

- (b) The student wrote this conclusion for the experiment:

***‘The reaction gets slower and slower as the time increases.’***

Explain why the reaction gets slower. Your answer should be in terms of particles.

.....

.....

.....

.....

(2 marks)

- (c) A second experiment was carried out at a higher temperature. All other factors were the same.

**Draw** a line on the graph above to show the results that you would expect. (2 marks)

15 The table gives information about some metals.

Name of the metal	Cost of one tonne of the metal in December 2003 (£)	Percentage of the metal in the crust of the earth (%)
Aluminium	883	8.2
Platinum	16720000	0.0000001
Iron	216	4.1
Gold	8236800	0.0000001

(a) Use information in the table to suggest why gold and platinum are very expensive metals.

.....  
 .....  
 (1 mark)

(b) Aluminium and iron are made by *reduction* of their ores.

(i) Name the element that is removed from the ores when they are *reduced*.

.....  
 (1 mark)

(ii) Use the reactivity series on the Data Sheet to suggest a metal that would reduce aluminium ore.

.....  
 (1 mark)

(c) Aluminium is made by the reduction of molten aluminium ore, using a very large amount of electricity.

(i) How is iron ore reduced in a blast furnace to make iron?

.....  
 .....  
 .....  
 .....  
 (2 marks)

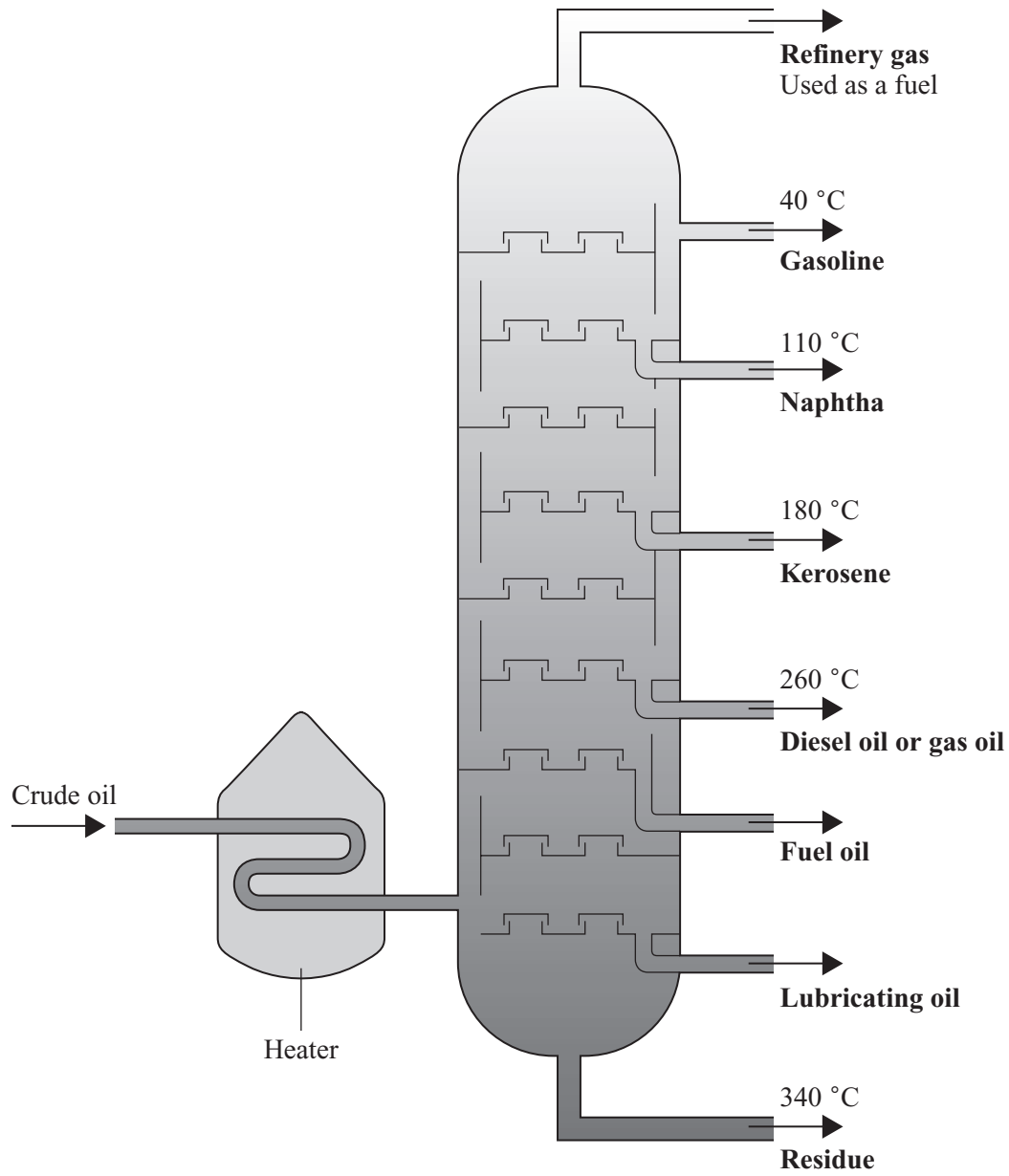
(ii) Suggest why aluminium is more expensive than iron.

.....  
 .....  
 (1 mark)

Turn over ►

6

16 Crude oil is a mixture of many hydrocarbons. The diagram shows the method used to separate crude oil.



(a) Name this method of separating crude oil.

.....  
(1 mark)

(b) Explain, as fully as you can, the way in which this method of separation works.

*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.*

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

17 Mendeleev constructed a periodic table in 1869.

In his periodic table:

- most of the elements were put in order of increasing relative atomic mass;
- elements with similar properties were put into groups;
- Mendeleev changed the order of some elements to put them with similar elements;
- spaces were left for elements that Mendeleev thought would be discovered in the future.

One space was in Group 3 between the elements aluminium and indium.

<b>Group 3</b>
<b>Boron</b>
<b>Aluminium</b>
?
<b>Indium</b>
<b>Thallium</b>

Mendeleev called this undiscovered element 'eka-aluminium'. This element is now known as gallium.

In 1871, he also predicted some of the properties of gallium.

The table shows the properties of aluminium and indium, along with some of the predictions made by Mendeleev for gallium.

	<b>Appearance</b>	<b>Metal or non-metal</b>	<b>Boiling point in °C</b>	<b>Density in g per cm<sup>3</sup></b>	<b>Relative atomic mass</b>
<b>Aluminium</b>	silvery white	metal	2467	2.7	27
<b>Predicted properties of gallium</b>	silvery white	metal	?	?	68
<b>Indium</b>	silvery white	metal	2080	7.31	115



(a) Suggest values for:

(i) the boiling point of gallium;

..... °C  
(1 mark)

(ii) the density of gallium.

..... g per cm<sup>3</sup>  
(1 mark)

(b) (i) Suggest **two** reasons why other scientists in 1871 did not accept Mendeleev's periodic table.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

(ii) Suggest why the discovery of gallium in 1875 convinced other scientists that Mendeleev's table was correct.

.....

.....

.....

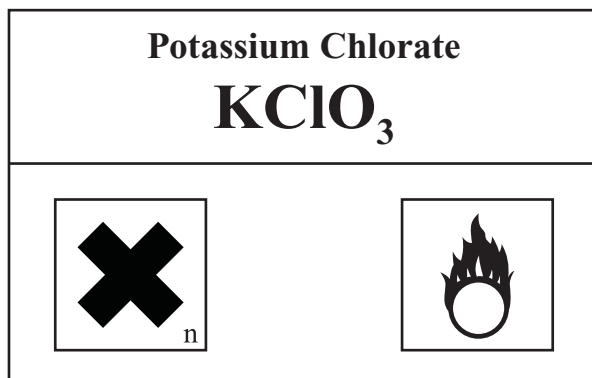
(1 mark)

5

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

18 This label was on a bottle of potassium chlorate.



(a) What does the hazard symbol on the bottom left of the label tell you about potassium chlorate?

.....  
(1 mark)

(b) A mixture of chemicals is used to make the head of a match.

The mixture contains potassium chlorate and some substances that burn easily.

Suggest why potassium chlorate is used.

.....  
.....  
.....  
(2 marks)

(c) (i) Calculate the relative formula mass ( $M_r$ ) of potassium chlorate,  $\text{KClO}_3$

(Relative atomic masses: O = 16; Cl = 35.5; K = 39)

.....  
.....  
Relative formula mass .....  
(2 marks)

(ii) Calculate the percentage of **oxygen** in potassium chlorate.

.....  
.....  
Oxygen ..... %  
(2 marks)

19 Transition elements and their compounds have many uses.

Iron oxide and cobalt oxide have been added to the glazes on pottery for hundreds of years.



- (a) State why transition metal oxides are added to pottery glazes.

.....  
(1 mark)

- (b) Use the table of ions on the Data Sheet to help you work out the formula of iron(III) oxide.

.....  
(1 mark)

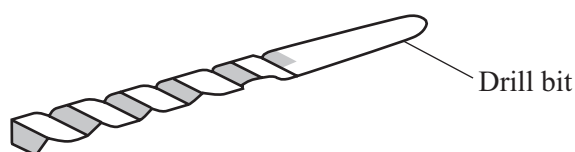
- (c) Cobalt oxide is reacted with hydrogen to form cobalt.

- (i) Balance the equation for this reaction.



- (ii) Cobalt is mixed with other transition metals to make alloys.

These alloys are used to make cutting tools which remain sharp at very high temperatures. They can cut through other metals.



Suggest **two** properties of transition metals that make them suitable for making cutting tools.

1.....

.....

2.....

.....

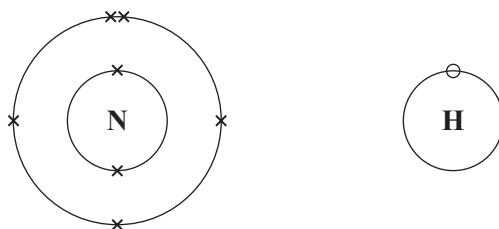
(2 marks)

Turn over ►

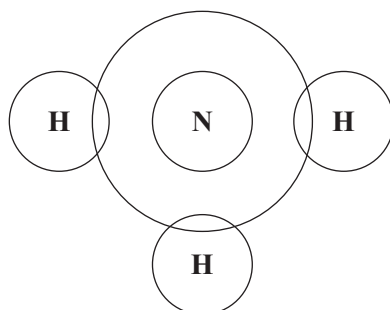
20 Ammonia ( $\text{NH}_3$ ) is an important chemical which is used to make fertilisers.

Ammonia is made from nitrogen and hydrogen.

(a) The diagrams represent the electron arrangements in atoms of nitrogen and hydrogen.



Complete the diagram showing the arrangement of electrons in a molecule of ammonia.



(1 mark)

(b) Name the type of bonding which holds the nitrogen and hydrogen atoms together in an ammonia molecule.

.....

(1 mark)

(c) This word equation represents the reaction between nitrogen and hydrogen.



What does the sign  $\square$  mean?

.....

(1 mark)

- (d) Read this article about coffee production in Costa Rica, a country in Central America. Answer the questions that follow.

Coffee is one of the most valuable crops of Costa Rica. Coffee production accounts for nearly a fifth of the country's exports.

The coffee plantations are found mainly in the Central Valley of Costa Rica. Large amounts of nitrate fertilisers are used throughout the year in the production of the coffee.

Scientists have shown that coffee plants take up about 40% of the nitrate fertiliser during the main growing season. Towards the end of the growing season the plants only take up about 6% of the nitrate fertiliser.

Underneath the Central Valley, there are natural underground reservoirs in the rock which hold large volumes of fresh water. These reservoirs supply water to more than one million people, about a quarter of the population.

Scientists have found that nitrates have contaminated the underground water. They have also shown that a large amount of this nitrate contamination has come from fertilisers used in coffee production.

- (i) Why do farmers use nitrate fertilisers?

.....  
(1 mark)

- (ii) How does the use of nitrate fertilisers help the people of Costa Rica?

.....  
.....  
(1 mark)

- (iii) Suggest how the nitrates got into the underground water.

.....  
.....  
(1 mark)

- (iv) Why are scientists concerned about pollution of the underground water?

.....  
(1 mark)

- (v) Suggest how the problem of nitrate pollution could be reduced in Costa Rica.

.....  
.....  
.....  
(2 marks)

21 Chemical tests can be used to identify compounds.

The table shows the results of some tests carried out on three solutions, **A**, **B** and **C**.

Solution	Flame Test	Hydrochloric acid is added	Sodium hydroxide solution is added	Silver nitrate solution is added
<b>A</b>	Yellow	Carbon dioxide gas produced		
<b>B</b>	Brick-red		White precipitate insoluble in excess sodium hydroxide solution	White precipitate
<b>C</b>			Dark green precipitate	

Use the information in the table to identify solutions **A**, **B** and **C**.

Give the name of:

(a) solution **A**; ..... (2 marks)

(b) solution **B**; ..... (2 marks)

(c) the metal ion in solution **C**. ..... (1 mark)



23 The information in the box is about the preparation of copper sulphate crystals.

Step 1: Add a small amount of black copper oxide to some hot dilute sulphuric acid, and stir.

Step 2: Keep adding copper oxide until it is in excess.

Step 3: Remove the excess copper oxide to leave blue copper sulphate solution.

Step 4: Evaporate the copper sulphate solution until it is saturated.

Step 5: Leave the saturated solution of copper sulphate to cool.  
Blue copper sulphate crystals form on cooling.

Step 6: Remove the crystals from the solution remaining.

Step 7: Dry the blue crystals on a piece of filter paper.

(a) (i) Suggest a reason for using excess copper oxide in Step 2.

.....  
.....  
(1 mark)

(ii) Suggest how the excess copper oxide can be removed from the solution in Step 3.

.....  
.....  
(1 mark)

(iii) What is meant by the term *saturated solution*?

.....  
.....  
.....  
(2 marks)

(iv) Why do crystals form when a hot saturated solution cools?

.....  
.....  
(1 mark)

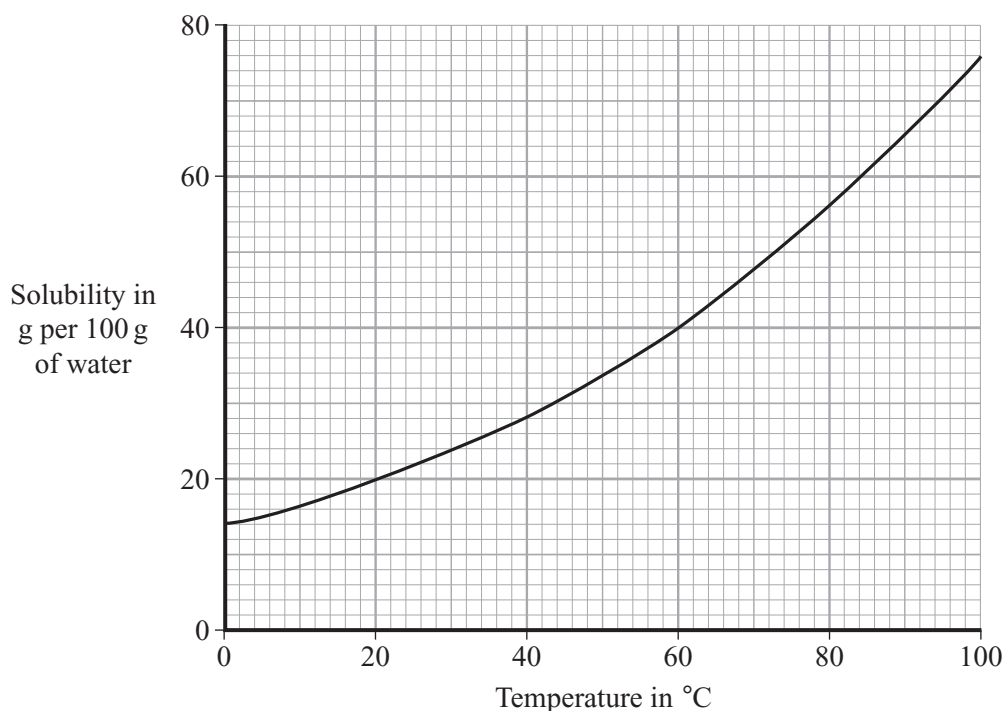


- (v) Suggest why the blue crystals are dried in Step 7 using filter paper instead of by heating.

.....  
.....

(1 mark)

- (b) The graph shows how the solubility of copper sulphate changes with temperature.



Use the graph to answer the following questions.

- (i) What is the solubility of copper sulphate at 80 °C?

Solubility = ..... g per 100 g of water  
(1 mark)

- (ii) What mass of copper sulphate would be formed if a saturated solution of copper sulphate, in 100 g of water, was cooled from 80 °C to 20 °C?

.....  
.....

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

**END OF QUESTIONS**

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