

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education
June 2005



**CHEMISTRY (SPECIFICATION B)
HIGHER TIER**

3421/H

Thursday 16 June 2005 9.00 am to 11.15 am

H

<p>In addition to this paper you will require:</p> <ul style="list-style-type: none"> • a ruler; • the Data Sheet (enclosed). <p>You may use a calculator.</p>

For Examiner's Use			
Number	Mark	Number	Mark
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	
		21	
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.

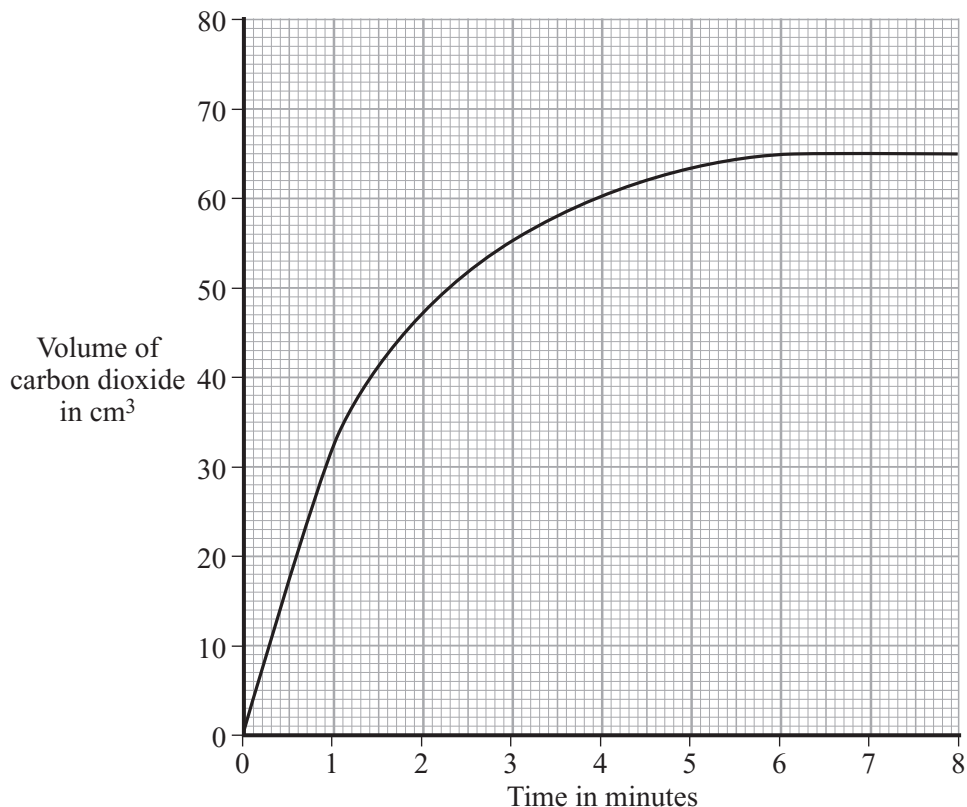
Information

- 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.

- 1 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.

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(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)

2 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.

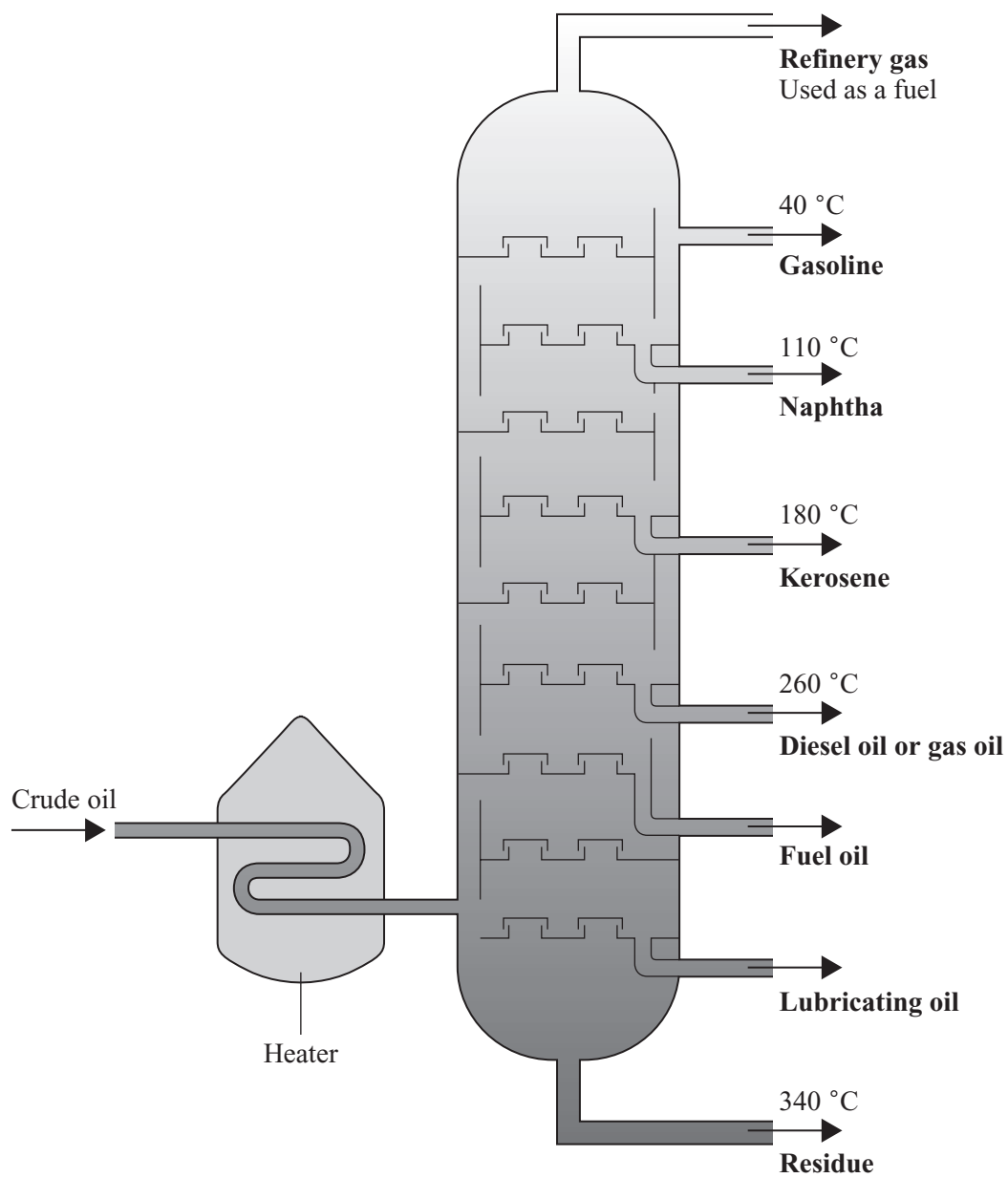
.....

 (1 mark)

Turn over ►

6

3 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.

.....

.....

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(4 marks)



TURN OVER FOR THE NEXT QUESTION

Turn over ►

4 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.

Group 3
Boron
Aluminium
?
Indium
Thallium

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.

	Appearance	Metal or non-metal	Boiling point in °C	Density in g per cm³	Relative atomic mass
Aluminium	silvery white	metal	2467	2.7	27
Predicted properties of gallium	silvery white	metal	?	?	68
Indium	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 cm³
(1 mark)

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

Reason 1

.....

Reason 2

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(2 marks)

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

.....

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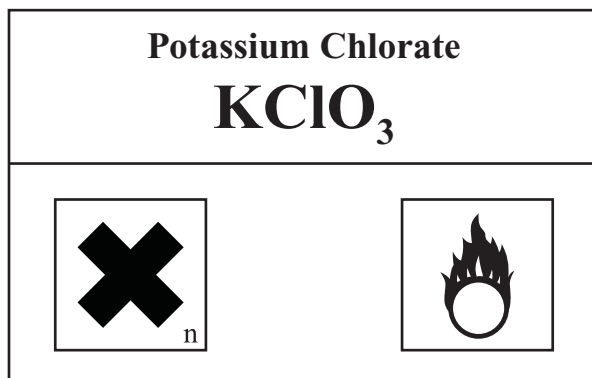
(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

Turn over ►

5 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, 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)

6 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)

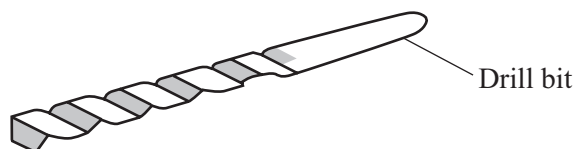
- (c) Cobalt oxide is reacted with hydrogen to form cobalt.

- (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.....

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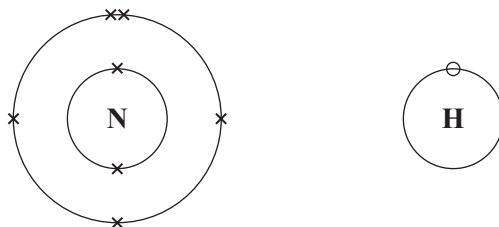
(2 marks)

Turn over ►

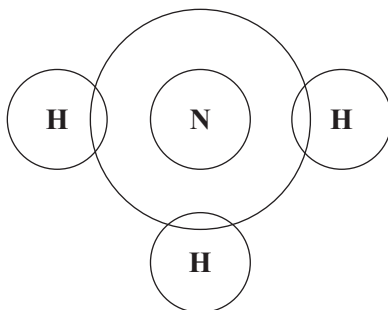
7 Ammonia (NH_3) is an important chemical which is used to make fertilisers.

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)

8 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
A	Yellow	Carbon dioxide gas produced		
B	Brick-red		White precipitate insoluble in excess sodium hydroxide solution	White precipitate
C			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)

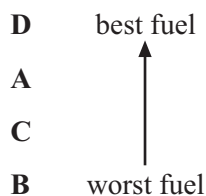
(c) the metal ion in solution **C**. (1 mark)

9 The table gives some data about four fuels, A, B, C and D.

Fuel	Cost in pence per 100 g	Energy in kJ per 100 g	Energy per penny in kJ	Gas (✓) formed on burning		
				Carbon dioxide	Sulphur dioxide	Water vapour
A	6.0	4800	800	✓		✓
B	4.0	1200	300	✓		✓
C	3.5	2800	800	✓	✓	✓
D	18.0	14400	800			✓

A student was asked to use the data in the table to compare these four fuels, and then place the fuels in an order.

The order that the student chose was:



Use the information in the table to suggest reasons why the student chose this order.

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

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(4 marks)



Turn over ▶

10 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*?

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

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

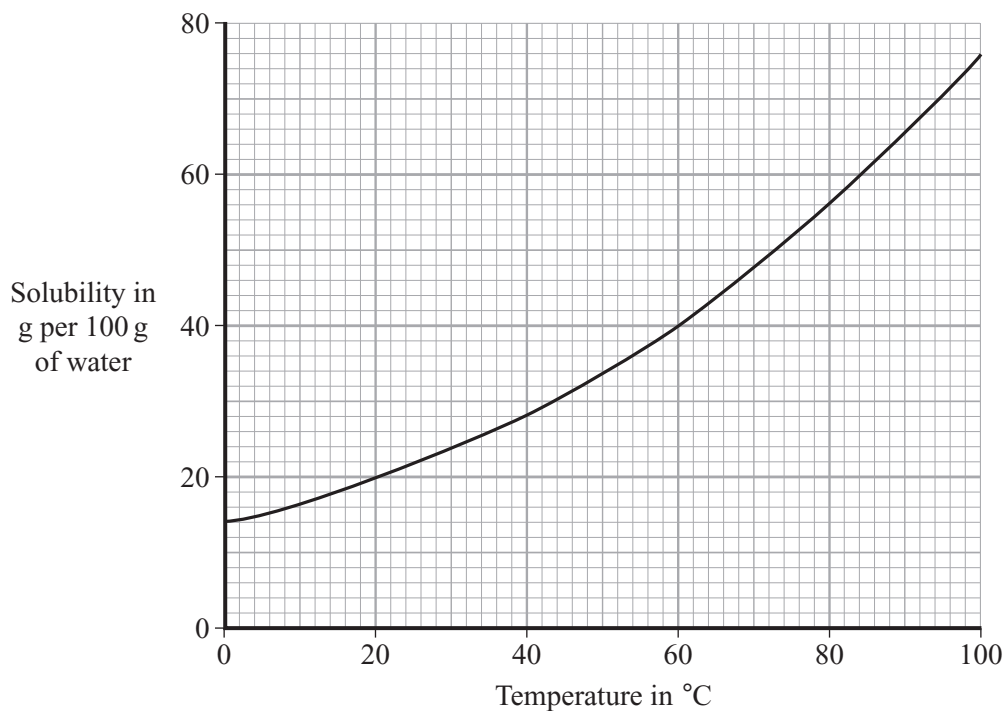
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(1 mark)

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

.....
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(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?

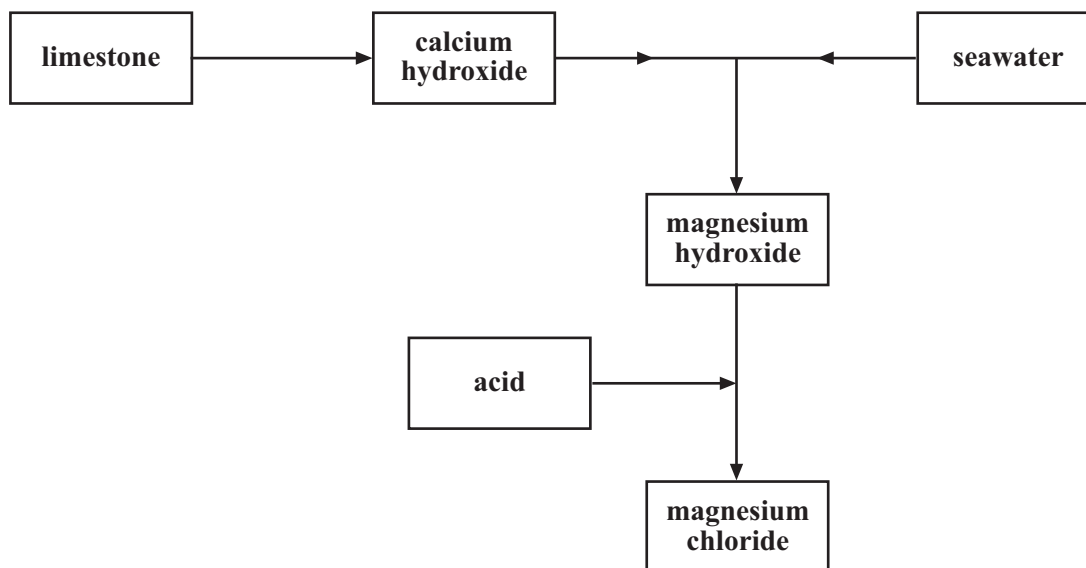
Solubility = g per 100 g of water
(1 mark)

(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)

- 11 Magnesium chloride is a useful salt.
The flow diagram shows how it can be made.



- (a) (i) Describe how calcium hydroxide can be made from limestone.

.....

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(2 marks)

- (ii) Write a word equation for the neutralisation of magnesium hydroxide with a suitable acid to form magnesium chloride.

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(2 marks)

- (b) Explain, in terms of ions and molecules, what happens when any acid reacts with any alkali.

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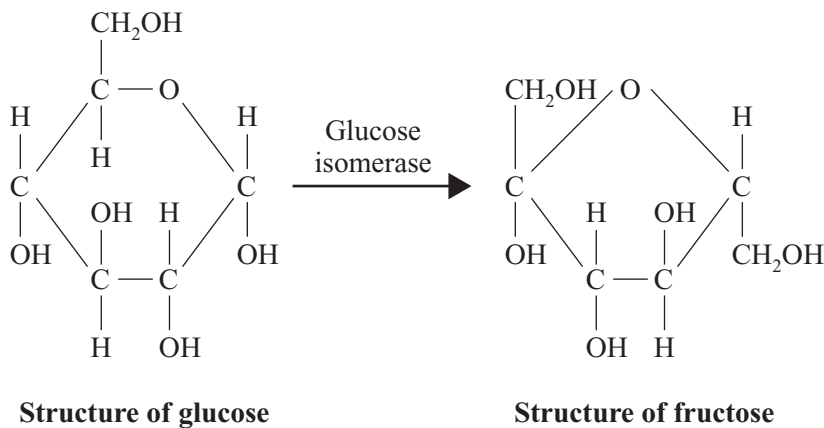
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(3 marks)

12 Glucose can be converted by glucose isomerase into fructose.

Fructose is used as a sweetener in slimming foods and soft drinks.



(a) The formula of glucose is $C_6H_{12}O_6$.

What is the formula of fructose?
(1 mark)

(b) What is the advantage of using fructose, instead of glucose, in slimming foods and soft drinks?

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

(c) What type of substance is glucose isomerase?

.....
(1 mark)

(d) The glucose isomerase is immobilised for use in this process.

State how it can be immobilised.

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(2 marks)

(e) Suggest why glucose isomerase must be immobilised to allow a continuous process.

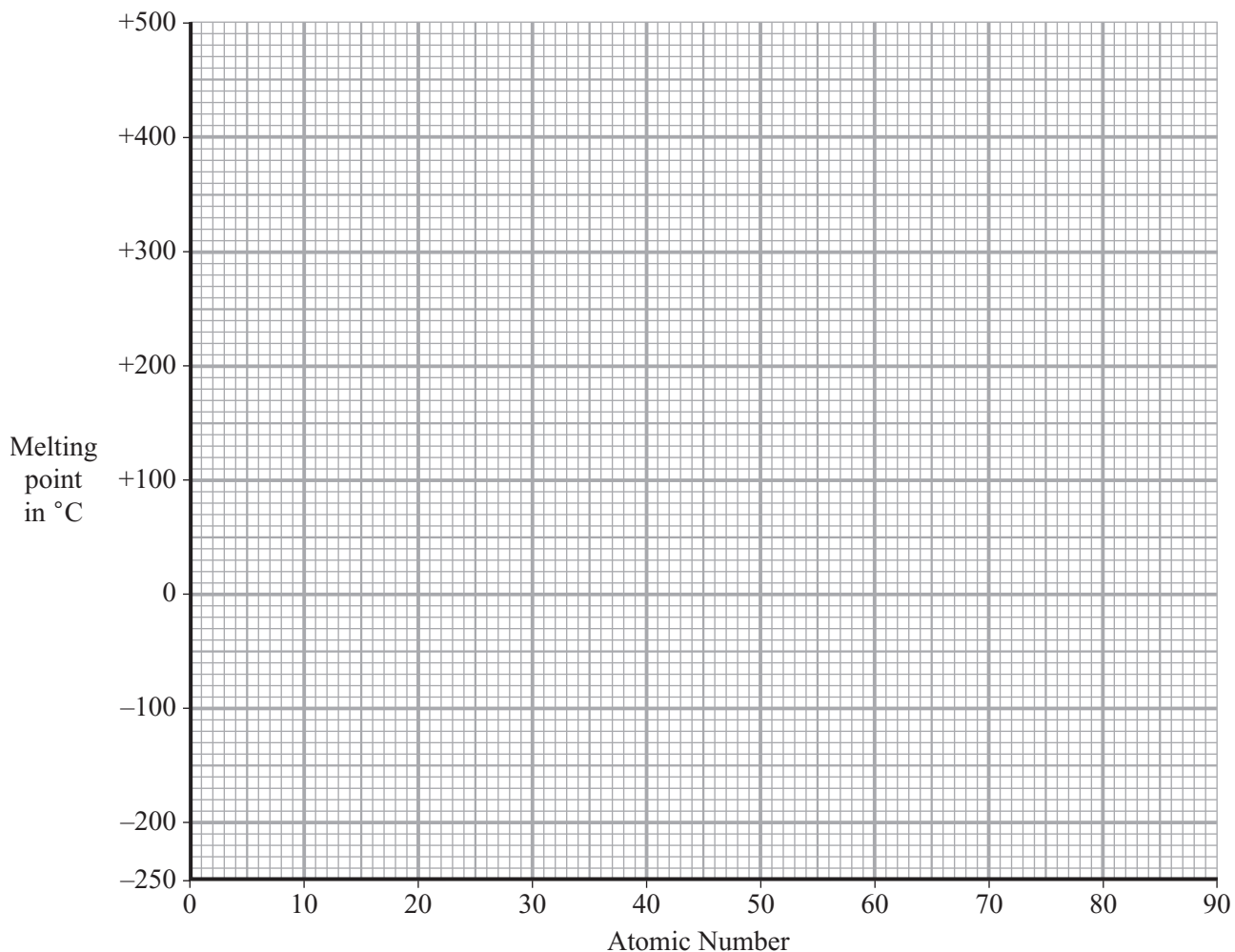
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(1 mark)

Turn over ▶

- 13 (a) The table gives the melting points of some of the elements of Group 7.

Element	Atomic number	Melting point in °C
Fluorine	9	- 220
Chlorine	17	- 101
Bromine	35	- 7
Iodine	53	114
Astatine	85	?

- (i) Plot a graph of the melting point against atomic number.



Draw a line of best fit.

Extend your line to estimate a value for the melting point of astatine.

(2 marks)

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

(iii) Which of the Group 7 elements are solids at 20°C?

.....
(1 mark)

(b) (i) Draw a diagram to show the arrangement of electrons in an atom of fluorine.

(1 mark)

(ii) The elements of Group 7 have similar chemical properties.

Explain, in terms of electrons, why they have similar chemical properties.

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

(c) Xenon is a very unreactive element.

(i) Explain, in terms of electrons, why xenon is so unreactive.

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(2 marks)

(ii) Fluorine reacts with xenon but iodine does not.

Explain, in terms of atomic structure, why fluorine is more reactive than iodine.

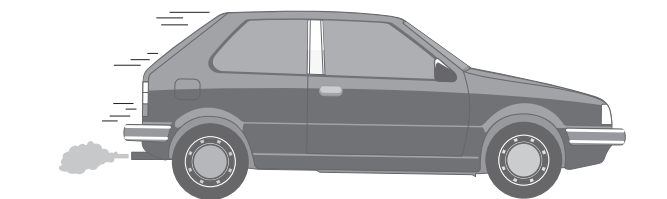
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(3 marks)

Turn over ►

11

- 14 (a) Petrol is a mixture of hydrocarbons such as octane, C_8H_{18}

When petrol is burned in a car engine, a large amount of carbon dioxide is produced.



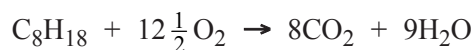
This car uses 114 g of petrol to travel one mile.

Calculate the mass of carbon dioxide produced when this car travels one mile.

Assume that petrol is octane and that combustion is complete.

(Relative atomic masses: H = 1 ; C = 12 ; O = 16)

The combustion of octane can be represented by this equation.



.....

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Mass of carbon dioxide = g
(3 marks)

- (b) For the last 200 million years the amount of carbon dioxide in the atmosphere has remained almost the same.

Describe the natural processes which remove carbon dioxide from the atmosphere.

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.

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(4 marks)

- (c) The amount of carbon dioxide in the atmosphere has increased over the last one hundred years. Suggest **two** reasons why this has happened.

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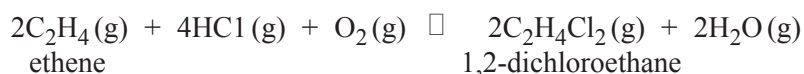
(2 marks)



Turn over ►

15 The monomer chloroethene is made from ethene in a two-stage process.

(a) The first stage is to convert ethene to 1,2-dichloroethane.



State and explain the effect of increasing the pressure on:

(i) the yield of 1,2-dichloroethane;

.....

 (2 marks)

(ii) the rate of reaction.

.....

 (2 marks)

(b) In the second stage 1,2-dichloroethane is converted into chloroethene.



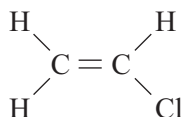
This reaction is a thermal decomposition.

Suggest what would need to be done to decompose 1,2-dichloroethane.

.....

 (1 mark)

(c) The diagram shows the structure of a chloroethene molecule.



Describe a laboratory test to show that chloroethene is unsaturated.

Test

Result of the test.....

(2 marks)

(d) A useful polymer is made from chloroethene. Name this polymer.

.....
 (1 mark)

16 This question is about two compounds of silver.

- (a) Silver tarnishes because it reacts with hydrogen sulphide in the air to form silver sulphide.

A sample of silver sulphide contains 10.8 g of silver and 1.6 g of sulphur.

Calculate the formula of silver sulphide.

You must show all your working to gain full marks.

(Relative atomic masses: S = 32 ; Ag = 108)

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(4 marks)

- (b) A photographic film contains silver bromide.

When the film is exposed to light, it darkens as silver is formed.

The reaction which takes place can be represented by two half equations.

- (i) Balance this half equation.



Explain why this is an oxidation reaction.

.....

.....

(2 marks)

- (ii) Complete this half equation.



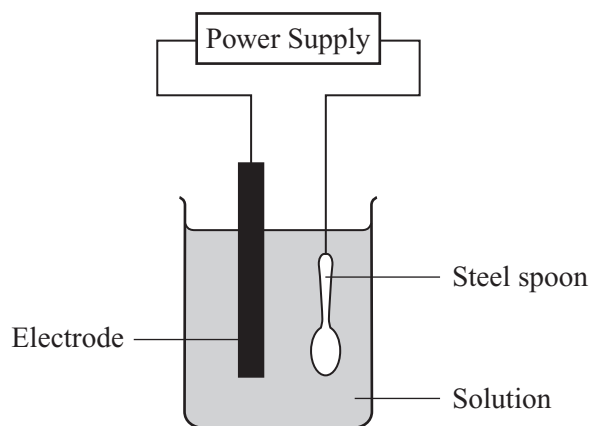
(1 mark)

($\frac{\quad}{7}$)

Turn over ►

17 One use of electrolysis is electroplating.

The diagram shows how a steel spoon can be electroplated with silver.



Describe how to electroplate a steel spoon with silver, naming the substances you would use.

.....

.....

.....

.....

(2 marks)

2

18 There are two main types of plastics (polymers).

- Thermosoftening plastics
- Thermosetting plastics

(a) Name **one** thermosetting plastic.

.....
(1 mark)

(b) Describe how a plastic can be tested to find out if it is thermosoftening or thermosetting.

Test:

Result if thermosoftening:

.....

Result if thermosetting:

.....
(3 marks)

(c) Explain the difference between thermosoftening plastics and thermosetting plastics in terms of their structure and bonding.

You may draw labelled diagrams to help you answer this question.

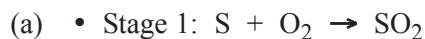
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(3 marks)



Turn over ►

19 In the United Kingdom sulphuric acid is made by the Contact Process in four stages.



What type of reaction takes place in Stage 1?

.....
(1 mark)

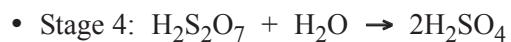
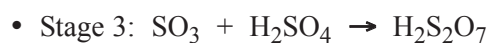


The forward reaction is exothermic.

Explain, in terms of rate of reaction and yield at equilibrium, why a temperature of about 450 °C is used for Stage 2.

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(4 marks)

(c) The final two stages are:

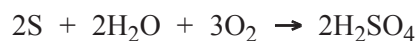


In Stage 3 of the Contact Process sulphur trioxide is **not** added to water.

Explain why.

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

(d) The equation which represents the overall process is



Calculate the number of moles of sulphuric acid that could be made from 1 tonne of sulphur (1 tonne = 1×10^6 g).

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

.....

.....

.....

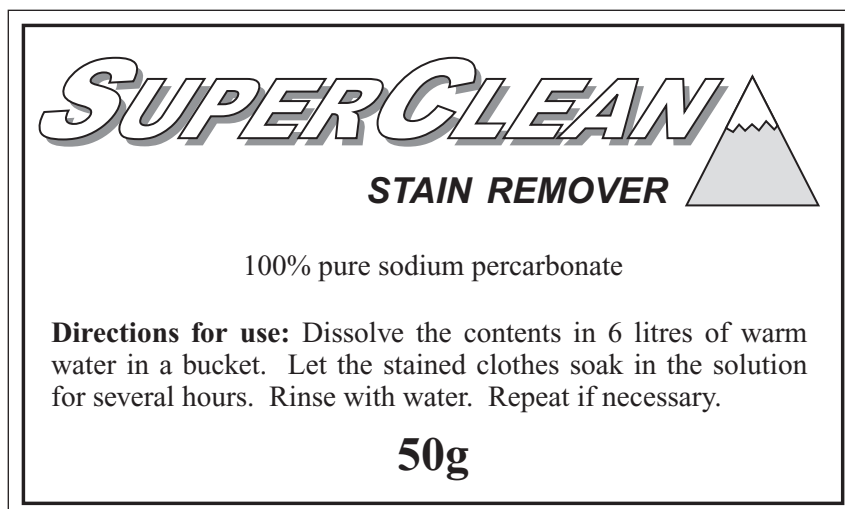
Number of moles =
(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

Turn over ►

20 This label has been taken from a packet of SuperClean.



Sodium percarbonate is a powerful stain removing chemical.

The formula of sodium percarbonate can be represented as $\text{Na}_2\text{C}_2\text{O}_6$

- (a) (i) Calculate the number of moles of sodium percarbonate in the 50 g packet.

Relative atomic masses: C = 12; O = 16; Na = 23.

.....

Number of moles =
 (2 marks)

- (ii) Calculate the concentration of the sodium percarbonate solution, in moles per cubic decimetre, when 50 g of sodium percarbonate is dissolved in 6 litres (dm^3) of water.

.....

Concentration =moles per cubic decimetre
 (1 mark)

- (b) When sodium percarbonate acts as a stain removing chemical, it decomposes to produce oxygen.

The equation which represents the decomposition of sodium percarbonate is



- (i) Calculate the number of moles of oxygen produced from 50 g of sodium percarbonate.

.....
.....

Number of moles =

(1 mark)

- (ii) Calculate the volume of oxygen, at room temperature and pressure, produced from 50 g of sodium percarbonate.

1 mole of any gas at room temperature and pressure has a volume of 24 dm³.

.....
.....

Volume of oxygen = dm³

(2 marks)

6

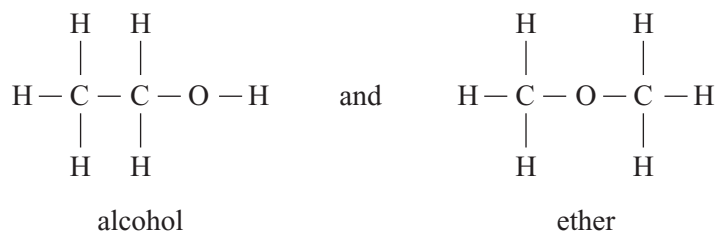
TURN OVER FOR THE NEXT QUESTION

Turn over ►

21 Two substances (**A** and **B**) have the same molecular formula, C_2H_6O .

One substance is an alcohol (CH_3CH_2OH) and the other is an ether (CH_3OCH_3).

Their structural formulae are shown below:



- (a) Suggest and explain why the alcohol and the ether **cannot** be distinguished from each other by an examination of their combustion products.

.....

.....

.....

.....

(2 marks)

- (b) **All the information needed to answer part (b) is given in the question.**

Read the information in the box about infra red spectroscopy.

Infra red spectroscopy is an instrumental method of analysis, which is used **to identify bonds and functional groups** in organic compounds.

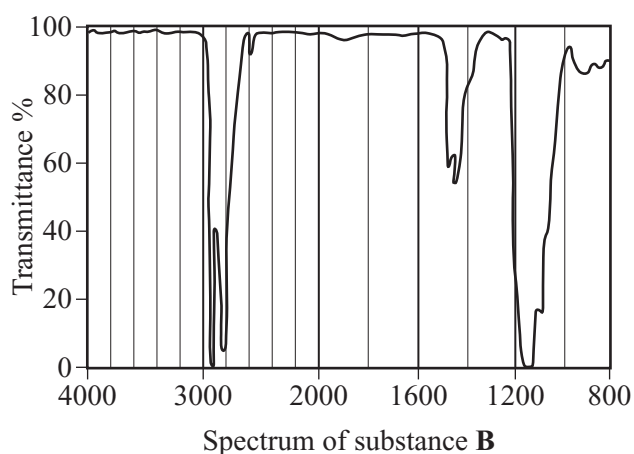
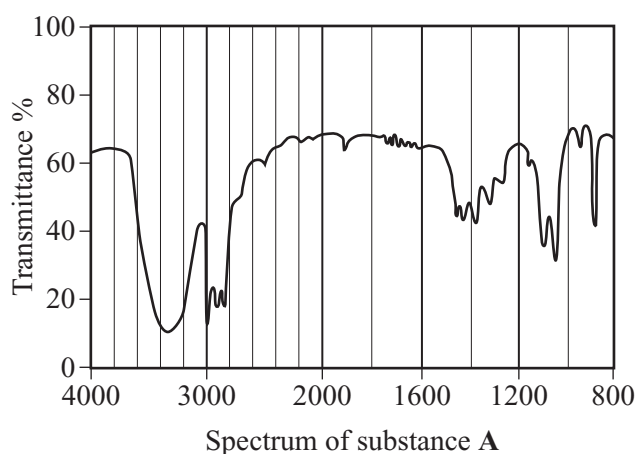
When infra red light is shone through an organic compound, some of the light is absorbed. When this happens, less of the light is transmitted and this produces a pattern of troughs called an infra red spectrum. Different bonds and functional groups absorb different amounts of infra red light and produce different patterns.

Identification of a particular bond or functional group is made by matching it to its absorption range in the infra red spectrum.

The table shows the approximate absorption range of some bonds.

Bond	Approximate absorption range
C—H	2850 – 3000
C—C	800 – 1000
C—O	1000 – 1300
O—H	3230 – 3550

The infra red spectra of substances **A** and **B** are shown below.



Use the information given to suggest why spectrum **A** is that of the alcohol and spectrum **B** is that of the ether.

Explanation:

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(2 marks)

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE