

Please write clearly in block capitals.

Centre number

1	2	3	4	5
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Candidate number

1	2	3	4
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Surname

EXAMPLE

Forename(s)

FOR

Candidate signature

FOR

I declare this is my own work.

GCSE CHEMISTRY

F

Foundation Tier

Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed)

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

0 1 This question is about the Earth's atmosphere.

0 1 . 1 How long ago was the Earth formed?

[1 mark]

Tick (✓) **one** box.

4.6 billion years ago

4.6 million years ago

4.6 thousand years ago

Table 1 shows the percentages of gases in the atmospheres of Mars and Earth today.

Table 1

Gas	Percentage of gas in atmosphere (%)	
	Mars	Earth
Carbon dioxide	95.97	0.04
Nitrogen	1.89	78.09
Oxygen	0.15	20.95
Other gases	1.99	X

0 1 . 2 Calculate the percentage X of other gases in the Earth's atmosphere.

Use **Table 1**.

[1 mark]

$$x = 100 - (0.04 + 78.09 + 20.95)$$

$$x = \underline{0.92} \%$$

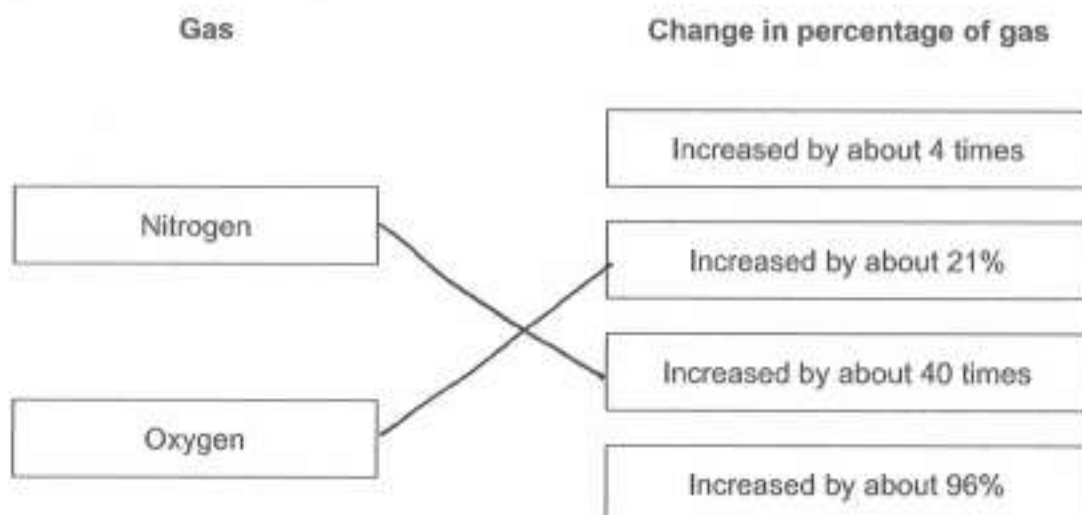
The atmosphere of the early Earth is thought to have been similar to the atmosphere of Mars today.

The percentages of nitrogen and of oxygen in the Earth's atmosphere today have changed from the percentages in the Earth's early atmosphere.

0 1 . 3 Draw **one** line from each gas to the change in the percentage of that gas.

Use **Table 1**.

[2 marks]



0 1 . 4 The percentage of carbon dioxide in the Earth's early atmosphere decreased.

Which **two** processes caused this decrease?

Tick (✓) **two** boxes.

[2 marks]

Carbon dioxide dissolving in sea water

Combustion of fossil fuels

Farming of animals

Formation of sedimentary rocks

Volcanoes releasing carbon dioxide

Turn over ►

0 1 . 5

Photosynthesis also decreased the percentage of carbon dioxide in the Earth's early atmosphere.

Photosynthesis increased the percentage of another gas.

Complete the word equation for photosynthesis.

[2 marks]

Carbon dioxide + water → glucose + Oxygen

0 1 . 6

Complete the sentence.

[1 mark]

Scientists are not certain about the percentages of gases in the Earth's early atmosphere because there is a lack of evidence.

9



Turn over for the next question

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outside the
box

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ANSWER IN THE SPACES PROVIDED

Turn over ►

0 2

This question is about water.

A student investigated the concentration of salt in sea water.

This is the method used.

1. Filter the sea water to remove sand.
2. Measure the mass of an empty evaporating dish.
3. Measure 50 cm³ of sea water into the evaporating dish.
4. Heat the evaporating dish and sea water.
5. Evaporate the sea water to dryness.
6. Measure the mass of the evaporating dish and salt.

0 2 . 1

What equipment should the student use to measure:

- the mass of the evaporating dish
- the volume of sea water?

[2 marks]

Mass of evaporating dish _____

A balance

Volume of sea water _____

measuring cylinder

0 2 . 2 Table 2 shows the student's results.

Table 2

	Mass in g
Evaporating dish	30.44
Evaporating dish and salt	30.49

The student used 50 cm³ of sea water.

Calculate the mass of salt in 1000 cm³ of this sea water.

[3 marks]

$$\begin{aligned} \text{Mass in } 50 \text{ cm}^3 &= 30.49 - 30.44 \\ &= 0.05 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{mass of salt in} &= \frac{1000}{50} \times 0.05 \\ 1000 \text{ cm}^3 & \\ &= 1 \text{ (g)} \end{aligned}$$

Mass of salt = 1 g

0 2 . 3 The salt must be completely dry.

Which **two** extra steps are needed to show that the salt is completely dry?

[2 marks]

Tick (✓) **two** boxes.

Filter the sea water again.

Heat the evaporating dish and salt again.

Measure the 50 cm³ of sea water again.

Measure the mass of the empty evaporating dish again.

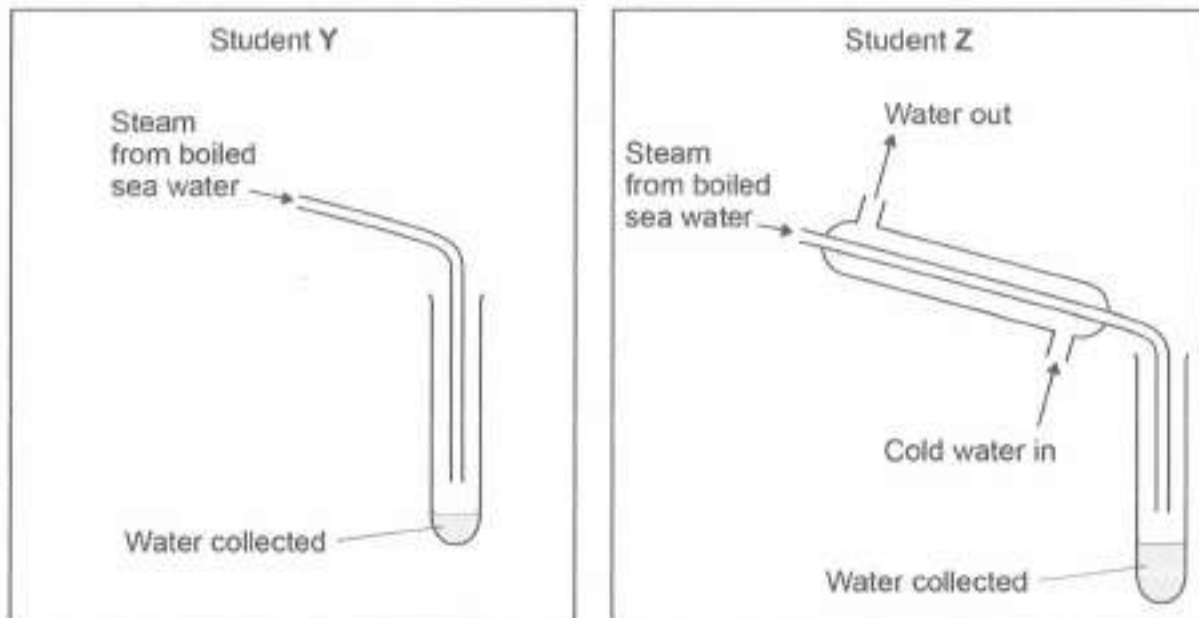
Measure the mass of the evaporating dish and salt again.

Turn over ►

Two students, Y and Z, distil sea water to collect water.

Figure 1 shows the apparatus used by each student to collect the water.

Figure 1



0 2 . 4

Students Y and Z boil the same volume of sea water for the same period of time.

Explain why student Y collects a smaller volume of water than student Z.

[2 marks]

Student Y did not use a condenser
and so the condensation of water was
less efficient.

0 2 . 5

Water obtained by distillation does **not** need to be sterilised and is safe to drink.

Suggest why.

[1 mark]

Distilled water is pure.

Fresh water needs to be sterilised before it is safe to drink.

0 2 . 6 How is fresh water sterilised?

[2 marks]

Tick (✓) two boxes.

Using ammonia

Using chlorine

Using chromatography

Using filtration

Using ozone

0 2 . 7 A student tests the pH of fresh water using universal indicator solution.

When added to the fresh water, the colour of the universal indicator solution is green.

What is the pH of this fresh water?

[1 mark]

pH = 7

13

Turn over for the next question

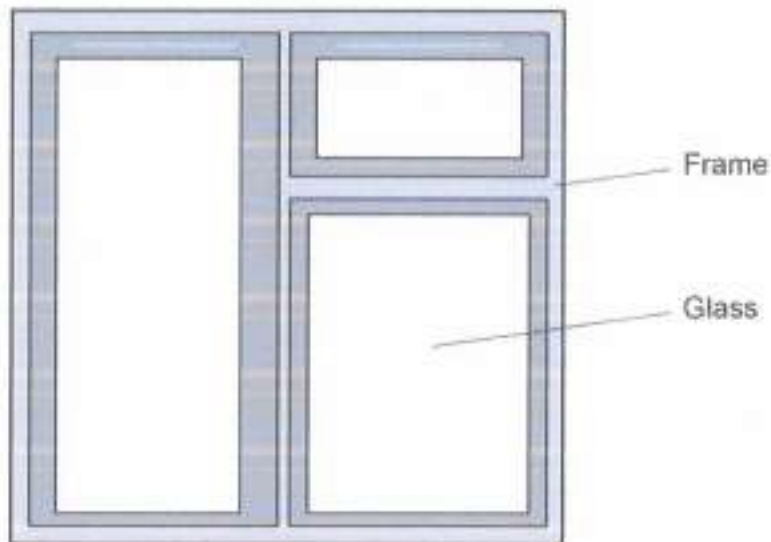
Turn over ►

0 3

This question is about substances used to make windows and window frames.

Figure 2 shows a window.

Figure 2



0 3 . 1

Glass is made by heating sand with **two** other materials.

Which **two** other materials are used to make glass?

[2 marks]

Tick (✓) **two** boxes.

Clay

Graphite

Limestone

Sodium carbonate

Sodium hydroxide

Window frames need to be:

- easy to install
- resistant to damage.

The polymers poly(chloroethene) and HDPE are used to make window frames.

Table 3 shows information about poly(chloroethene) and HDPE.

Table 3

Property	Poly(chloroethene)	HDPE
Density in g/cm^3	1.4	0.92
Relative strength	72	25

- 0 3 . 2 Suggest **one** advantage of using poly(chloroethene) compared with HDPE to make window frames.

Give **one** reason for your answer.

Use Table 3.

[2 marks]

Advantage

Stronger

Reason

Less easily damaged

- 0 3 . 3 Suggest **one** advantage of using HDPE compared with poly(chloroethene) to make window frames.

Give **one** reason for your answer.

Use Table 3.

[2 marks]

Advantage

Lighter

Reason

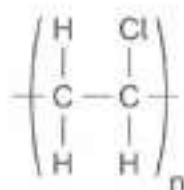
Lower density

Turn over ►



0 3 . 4 Figure 3 shows the displayed structural formula of poly(chloroethene).

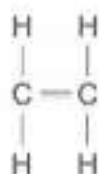
Figure 3

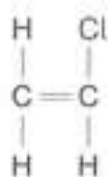


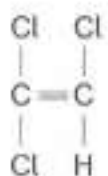
Which monomer is used to make poly(chloroethene)?

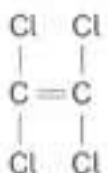
[1 mark]

Tick (✓) one box.









0 3 . 5 Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

[2 marks]

Test add damp litmus paper

Result the litmus paper will turn white

0 3 . 6 Wood can be used instead of polymers to make window frames.

- Polymers are unreactive.
- Polymers are produced from crude oil.
- Wood breaks down in wet conditions.
- Wood is produced from trees.

Suggest **one** advantage of using polymers and **one** advantage of using wood to make window frames.

[2 marks]

Advantage of polymers Long lasting

Advantage of wood Renewable

Question 3 continues on the next page

Window frames can also be made from an alloy of aluminium.

03.7 6.00 kg of the alloy is used to make a window frame.

Table 4 shows the mass of each element in 6.00 kg of the alloy.

Table 4

Element	Mass in kg
Aluminium	5.94
Magnesium	0.04
Silicon	0.02

Calculate the percentage of aluminium in 6.00 kg of the alloy.

[2 marks]

$$\% = \frac{5.94}{6.00} \times 100$$

$$= 99\%$$

Percentage of aluminium = 99 %

03.8 Why is an alloy used instead of pure aluminium to make window frames?

[1 mark]

An alloy is harder and so more durable than pure aluminium

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

Turn over ►

0 4

This question is about reactions between gases.

When hydrogen gas is heated with iodine gas, hydrogen iodide gas is produced.

The equation for this reversible reaction is:



This reversible reaction reaches equilibrium in a sealed container.

0 4 . 1

How does the equation show that the reaction is reversible?

[1 mark]

By the double headed arrow (\rightleftharpoons)

0 4 . 2

Which **two** statements are correct when the reaction reaches equilibrium?

[2 marks]

Tick (\checkmark) **two** boxes.

The forward reaction and reverse reaction are both exothermic.

The gases have escaped from the container.

The hydrogen no longer reacts with iodine.

The mass of each substance does not change.

The rates of the forward reaction and reverse reaction are equal.

0 4 . 3 The initial mixture of hydrogen and iodine in the sealed container is purple.

Hydrogen iodide is colourless.

How will the colour of the mixture in the sealed container have changed when equilibrium is reached?

[1 mark]

Tick (✓) **one** box.

The mixture will have become a deeper purple.

The mixture will have become a paler purple.

The mixture will have become colourless.

0 4 . 4 The rate of reaction between gases is affected by changing the pressure.

Complete the sentences.

[3 marks]

When the pressure of the reacting gases is increased,

the rate of reaction Increases.

This is because at higher pressures the distance

between the particles decreases.

This means that the frequency of collisions increases.

0 4 . 5 Give **one** other way of changing the rate of reaction between gases.

You should **not** refer to pressure in your answer.

[1 mark]

Add a Catalyst.

0 5

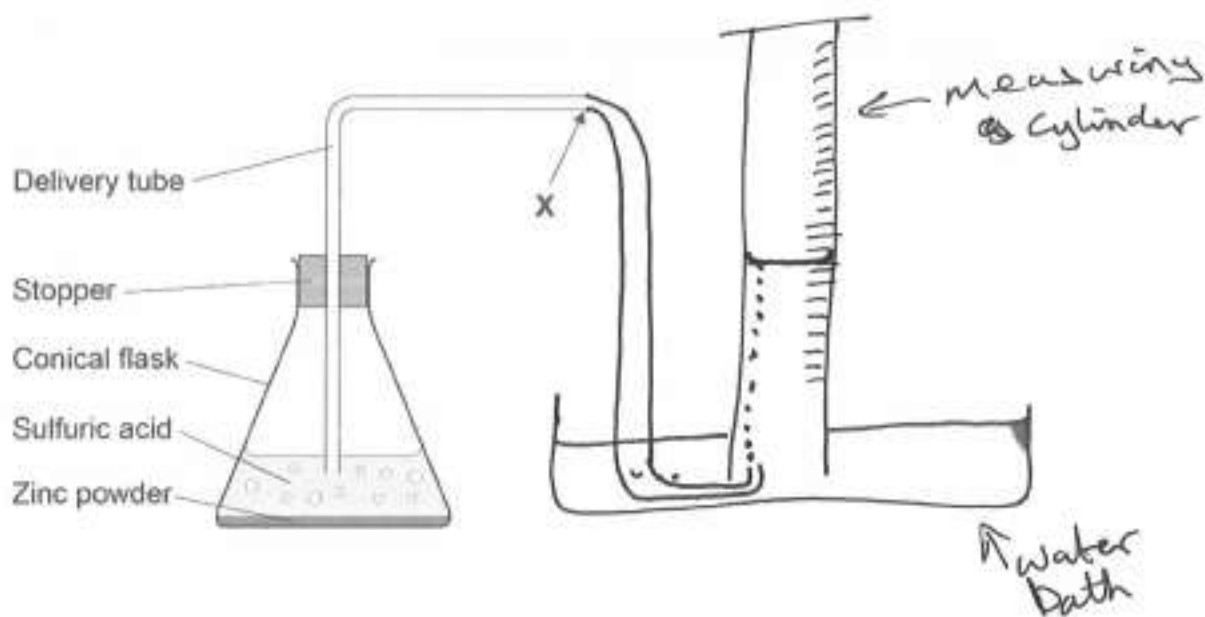
A student investigated the rate of the reaction between zinc and sulfuric acid.

This is the method used.

1. Pour 40 cm^3 of sulfuric acid into a conical flask.
2. Add 2.0 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of hydrogen gas collected every 30 seconds for 5 minutes.

Figure 4 shows part of the apparatus used.

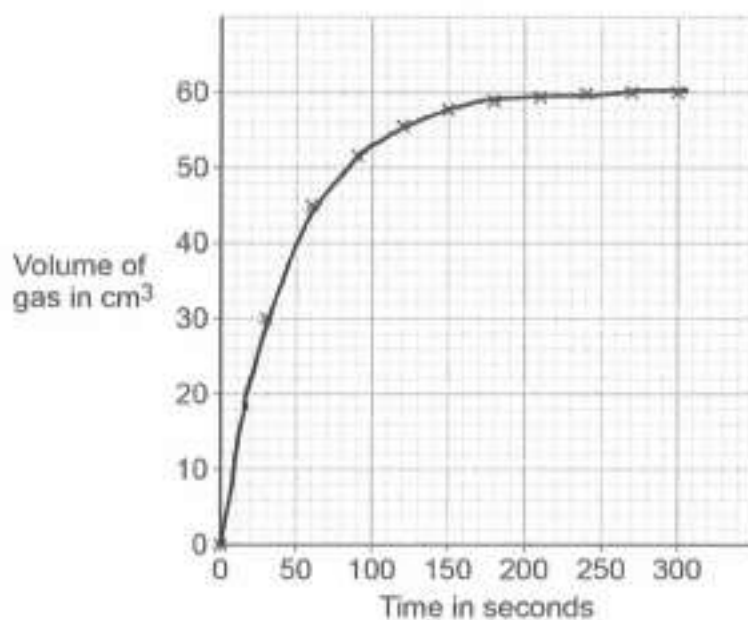
Figure 4



The student then set up the apparatus correctly.

Figure 5 shows the student's results.

Figure 5



0 5 . 3

Complete Figure 5 by drawing a line of best fit.

[1 mark]

0 5 . 4 Determine the mean rate of reaction between 0 seconds and 60 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas formed}}{\text{time taken}}$$

Use data from Figure 5.

Give the unit.

Choose the answer from the box.

[4 marks]

cm^3/s	g/s	s/cm^3	s/g
------------------------	--------------	-----------------	--------------

$$\text{Volume of Gas} = 45 \text{ cm}^3$$

$$\text{rate} = \frac{45}{60} = 0.75 \text{ cm}^3/\text{s}$$

$$\text{Mean rate of reaction} = 0.75 \quad \text{Unit} \quad \text{cm}^3/\text{s}$$

0 5 . 5 The student repeated the investigation using sulfuric acid of a higher concentration.

The student plotted the results and drew a line of best fit.

How would the line of best fit for higher concentration compare with the line of best fit for lower concentration?

[1 mark]

Tick (✓) **one** box.

The line of best fit for higher concentration would have a less steep slope.

The line of best fit for higher concentration would have a steeper slope.

The lines of best fit would have slopes with the same steepness.

9

Turn over ►



0 6

Potash alum is a chemical compound.

Potash alum contains potassium ions, aluminium ions and sulfate ions.

0 6 . 1

Which **two** methods can be used to identify the presence of potassium ions in potash alum solution?

[2 marks]

Tick (✓) **two** boxes.

Flame emission spectroscopy

Flame test

Measuring boiling point of solution

Paper chromatography

Using litmus paper

0 6 . 2

Sodium hydroxide solution is used to test for some metal ions.

Sodium hydroxide solution is added to a solution of potash alum until a precipitate forms.

Complete the sentence.

Choose the answer from the box.

[1 mark]

blue

brown

green

white

The colour of the precipitate formed is

white

0 6 . 3

Complete the sentence.

Choose the answer from the box.

[1 mark]

barium chloride solution	limewater
red litmus paper	silver nitrate solution

Sulfate ions can be identified using dilute hydrochloric acid

and barium chloride solution.

0 6 . 4

A solution of potash alum has a concentration of 258 g/dm³Calculate the mass of potash alum needed to make 800 cm³ of a solution of potash alum with a concentration of 258 g/dm³

Give your answer to 3 significant figures.

[4 marks]

$$\frac{800 \text{ cm}^3}{1000} = 0.8 \text{ dm}^3$$

$$\text{Mass} = 0.8 \times 258 \text{ (g)}$$

$$= 206.4 \text{ g}$$

Mass (3 significant figures) = 206 g

8

07

This question is about organic compounds.

07.1

Butane is an alkane with small molecules.

Complete the sentence.

Choose the answer from the box.

[1 mark]

fertiliser

formulation

fuel

Butane can be used as a Fuel.

07.2

Poly(propene) is a polymer.

What is the name of the monomer used to produce poly(propene)?

[1 mark]

Tick (✓) one box.

Propane

Propanoic acid

Propanol

Propene

Ethene and steam react to produce ethanol.

The equation for the reversible reaction is:



0 7 . 3

The reaction produces a maximum theoretical mass of 400 kg of ethanol from 243 kg of ethene and 157 kg of steam.

A company produces 380 kg of ethanol from 243 kg of ethene and 157 kg of steam.

The percentage yield of ethanol is less than 100%

Calculate the percentage yield of ethanol.

Use the equation:

$$\text{percentage yield of ethanol} = \frac{\text{mass of ethanol actually made}}{\text{maximum theoretical mass of ethanol}} \times 100$$

[2 marks]

$$\% = \frac{380}{400} \times 100 = 95\%$$

Percentage yield = 95 %

0 7 . 4

What are **two** possible reasons why the percentage yield of ethanol is less than 100%?

[2 marks]

Tick (✓) **two** boxes.

Ethanol is the only product of the reaction.

Ethanol is very unreactive.

Some ethanol changes back into ethene and steam.

Some ethanol escapes from the apparatus.

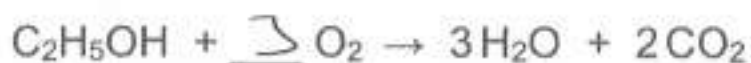
Some ethanol reacts with steam.

Turn over ►

0 7 . 5 Ethanol burns in oxygen.

Balance the equation for the reaction.

[1 mark]



0 7 . 6 Two processes for producing ethanol are:

- fermentation
- hydration (reacting ethene with steam).

Table 5 shows information about the processes.

Table 5

Feature	Process	
	Fermentation	Hydration
Raw material	sugar	crude oil
Energy usage	low	high
Rate of reaction	slow	fast
Purity of ethanol	15%	98%

Give **two** advantages and **two** disadvantages of using fermentation to produce ethanol.

[4 marks]

Advantage of fermentation 1 Low energy usage

Advantage of fermentation 2 uses renewable materials unlike hydration.

Disadvantage of fermentation 1 slow rate of reaction

Disadvantage of fermentation 2 low purity

0 8 . 2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

When oil is burnt in the high temperatures of combustion, sulfur impurities may combine with oxygen in the air to form sulfur dioxide. This will then react with moisture in the atmosphere to form acid rain in the form of sulfuric acid. This will fall to the Earth, damaging forests and aquatic habitats.

The carbon in the oil will also react with the air to form CO_2 . When released this greenhouse gas will accelerate climate change, leading to flooding and extreme weather.



0 8 . 3

Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

Solar energy is renewable

0 8 . 4

Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1 Sunshine is not always reliable

2 Solar pannels require a lot of space.

12

Turn over for the next question

Turn over ►

0 9

This question is about alkanes.

Table 6 shows information about some alkanes.

Table 6

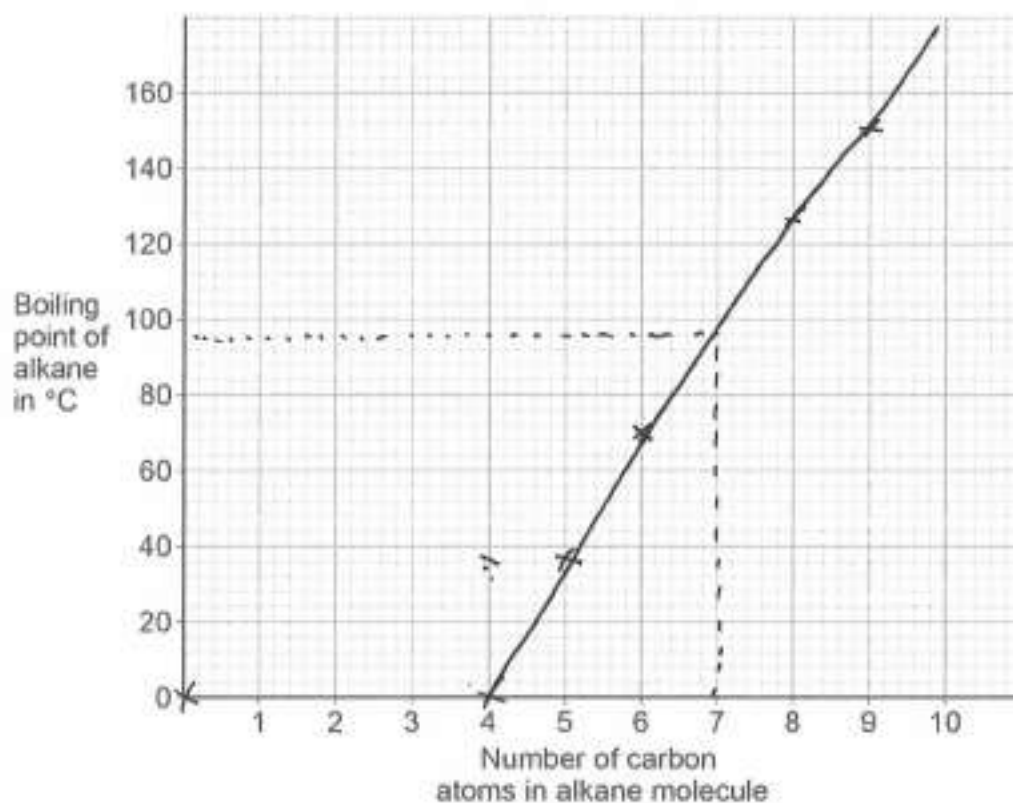
Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	X
8	126
9	151

0 9 . 1

Plot the data from Table 6 on Figure 7.

[2 marks]

Figure 7



0 5 . 4 Determine the mean rate of reaction between 0 seconds and 60 seconds.

Use the equation:

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Use data from Figure 5.

Give the unit.

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Paper chromatography

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Complete the sentence.

Choose the answer from the box.

[1 mark]

blue

brown

green

white

The colour of the precipitate formed is white.

0 6 . 3 Complete the sentence.

Choose the answer from the box.

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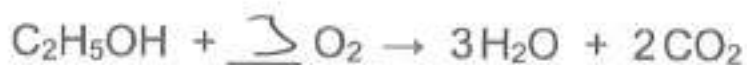
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Turn over ►

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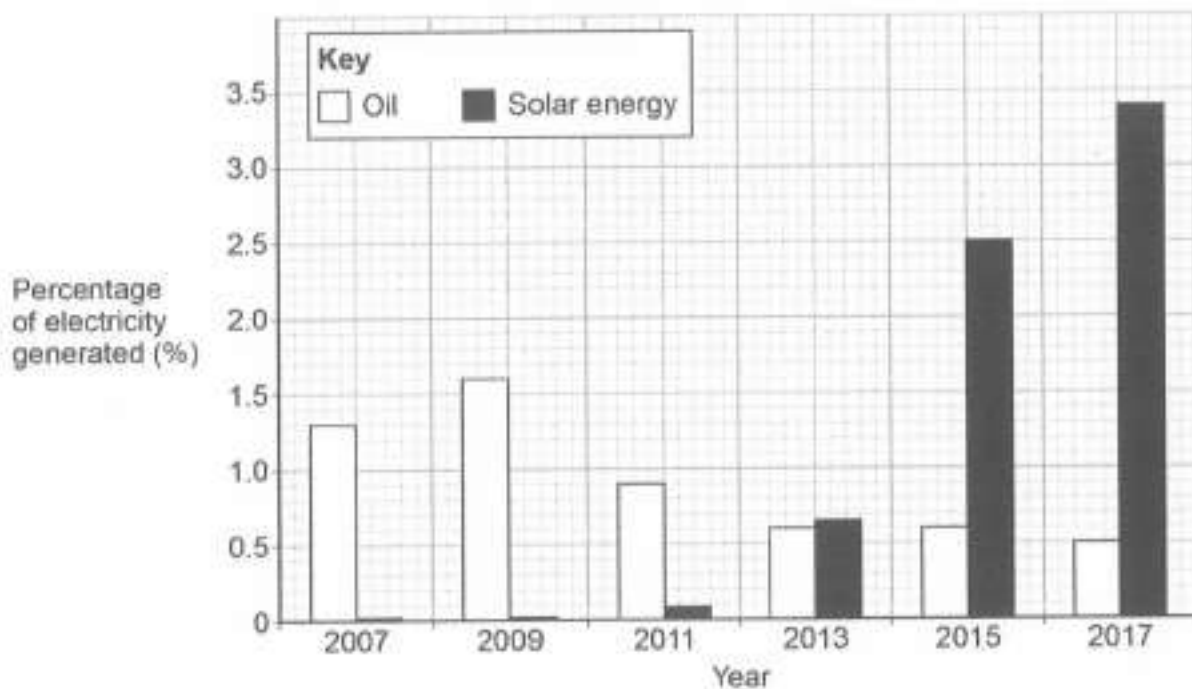
0 8

This question is about fuels and energy.

Figure 6 shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Figure 6



0 8 . 1

Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from Figure 6 in your answer.

[3 marks]

Oil use rose between 2007 to 2009 from 1.3% in 2007 to 1.6% in 2009 before falling to 0.5% in 2017. Solar remained unchanged between 2009 and 2007 at less than 1% before rapidly rising to 3.4% in 2017

Turn over ►



08.2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

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The carbon in the oil will also react with the air to form CO_2 . When released this greenhouse gas will accelerate climate change, leading to flooding and extreme weather.



08.3

Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

Solar energy is renewable

08.4

Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1 Sunshine is not always reliable

2 Solar pannels require a lot of space.

12

Turn over for the next question

Turn over ►

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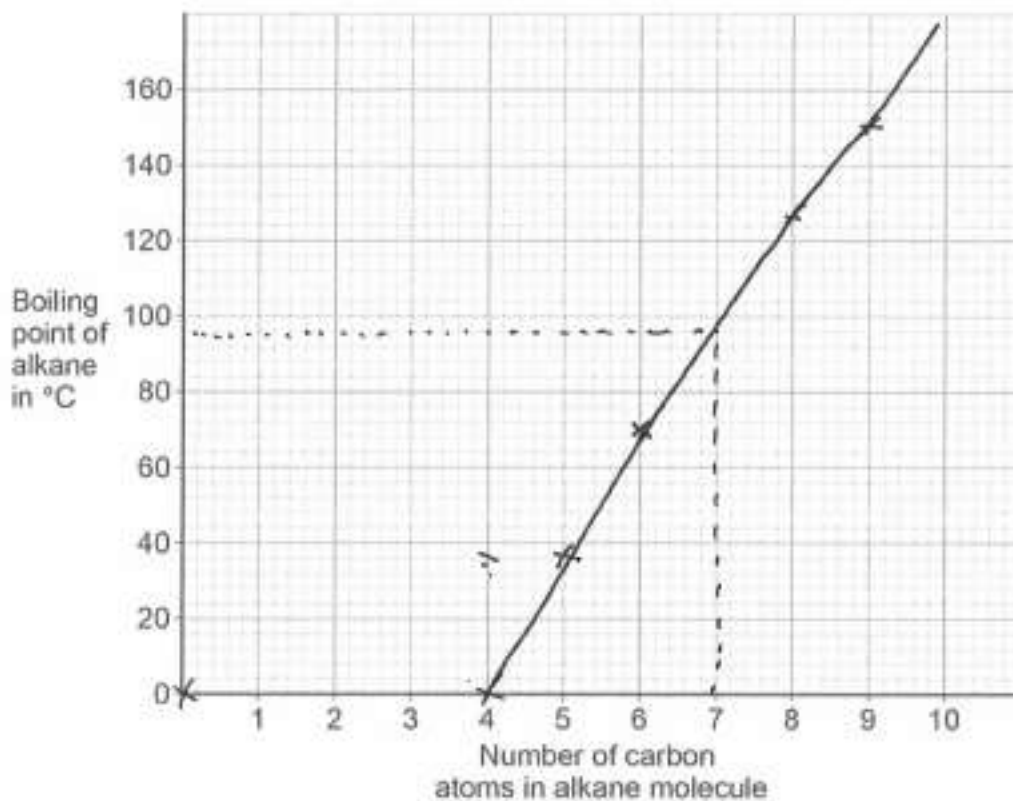
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4	0
5	36
6	69
7	X
8	126
9	151

0 9 . 1

Plot the data from Table 6 on Figure 7.

[2 marks]

Figure 7



Please write clearly in block capitals.

Centre number

1	2	3	4	5
---	---	---	---	---

Candidate number

1	2	3	4
---	---	---	---

Surname

EXAMPLE

Forename(s)

EG

Candidate signature



I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 2

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use

Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

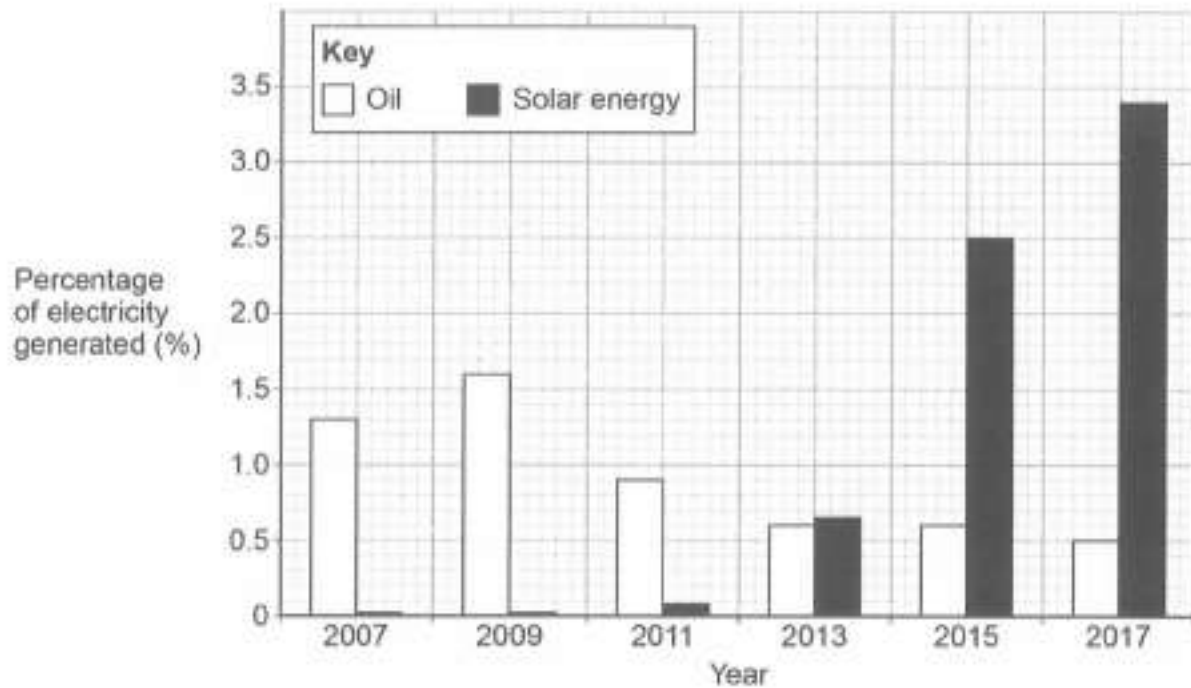
0 1

This question is about fuels and energy.

Figure 1 shows the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Figure 1



0 1 . 1

Describe the changes in the percentage of electricity generated in the UK between 2007 and 2017 using:

- oil
- solar energy.

Use data from Figure 1 in your answer.

[3 marks]

Between 2007 and 2009 the percentage of oil rose from 1.3% to 1.6 before steadily declining down to 0.5% between 2009 and 2017. Solar remained constant at less than 1% between 2007 and 2009 before rapidly increasing to 3.4% by 2017.

Turn over ►

0 1. 2 Oil contains carbon and some sulfur.

When oil is burned, the products of combustion may be released into the atmosphere.

Explain the environmental effects of releasing these products of combustion into the atmosphere.

[6 marks]

When oil is burned in a combustion engine, the high temperatures will drive reaction between the sulfur impurities in oil and oxygen from the air. This leads to the formation of sulfur dioxide gas. Once emitted, sulfur dioxide gas will go on to react with water vapour in clouds and the atmosphere to produce sulphuric acid. This then falls to Earth as acid rain. acid rain can do damage to aquatic environments, killing fish and aquatic plants. It may also damage forests as well as man made structures such as limestone statues. CO_2 is also produced which exacerbates global warming

0 1 . 3

Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

Sunlight is renewable, oil is not

0 1 . 4

Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

- 1 Sunlight is not reliable, especially in cloudier climates
- 2 Solar cells require a lot of space

12

Turn over for the next question

Turn over ►

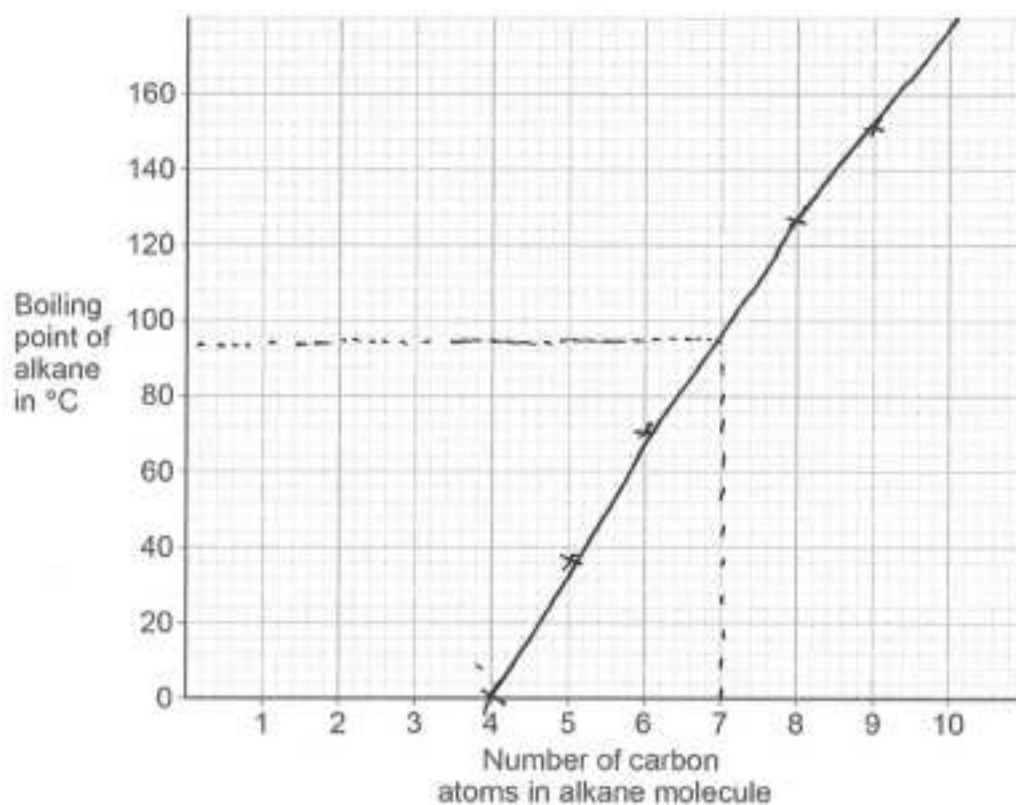
0 2

This question is about alkanes.

Table 1 shows information about some alkanes.**Table 1**

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	X
8	126
9	151

0 2 . 1

Plot the data from **Table 1** on **Figure 2**.**[2 marks]****Figure 2**

0 2 . 2 Predict the boiling point X of the alkane with seven carbon atoms in a molecule.

Use Table 1 and Figure 2.

[1 mark]

x = 98 °C

0 2 . 3 Figure 2 is **not** suitable to show the boiling point of the alkane with three carbon atoms in a molecule.

Suggest **one** reason why.

[1 mark]

The boiling point would be below 0

0 2 . 4 What is the state at 20 °C of the alkane with four carbon atoms in a molecule?

Use Table 1.

[1 mark]

Gas

Question 2 continues on the next page

Table 1 is repeated below.

Table 1

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	X
8	126
9	151

The alkane with nine carbon atoms in a molecule is called nonane.

0 2 . 5 Complete the formula of nonane.

[1 mark]



0 2 . 6 Nonane will condense lower in a fractionating column during fractional distillation than the other alkanes in Table 1.

Explain why.

You should refer to the temperature gradient in the fractionating column.

[2 marks]

Nonane has the highest boiling point. Therefore it will condense at a higher temperature. In a fractional distillation column the highest temperature is at the bottom. Hence nonane condenses low down.

0 3

This question is about paper chromatography.

A food colouring contains a dye.

0 3 . 1

Plan an investigation to determine the R_f value for the dye in this food colouring.

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Your plan should include the use of:

- a beaker
- a solvent
- chromatography paper.

[6 marks]

On a rectangular sheet of chromatography paper, use a pencil to draw a line one cm up from the short edge of the paper. Place a spot of food colouring on the line. Place the paper into a beaker and pour in an appropriate solvent. Do not fill the beaker past the start line on the chromatography paper. Place a lid on the beaker and allow the solvent front to move up the chromatography paper. Once it is almost at the top, remove the paper and draw a line along the front. Dry the paper and measure the distances from the solvent front and the centre of the food colouring dot to the start line. Use these values to calculate R_f .

0 3 . 2 Two students investigated a dye in a food colouring using paper chromatography.

Each student did the investigation differently.

The R_f values they determined for the **same** dye were different.

How did the students' investigations differ?

[1 mark]

Tick (✓) **one** box.

Different length of paper used

Different period of time used

Different size of beaker used

Different solvent used

0 3 . 3 Paper chromatography involves a stationary phase.

What is the stationary phase in paper chromatography?

[1 mark]

Tick (✓) **one** box.

Beaker

Dye

Paper

Solvent

0 4

This question is about poly(ethene) and polyesters.

0 4 . 1

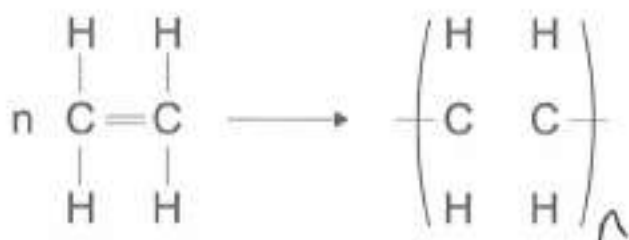
Poly(ethene) is produced from ethene.

Figure 3 shows part of the displayed structural formula equation for the reaction.

Complete Figure 3.

[2 marks]

Figure 3



0 4 . 2

Poly(ethene) is a thermosoftening polymer.

Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

[2 marks]

Poly(ethene) can be melted down
and turned into new products by
reshaping it.

0 4 . 3

Ethene produces different forms of poly(ethene).

How can different forms of poly(ethene) be produced from ethene?

[1 mark]

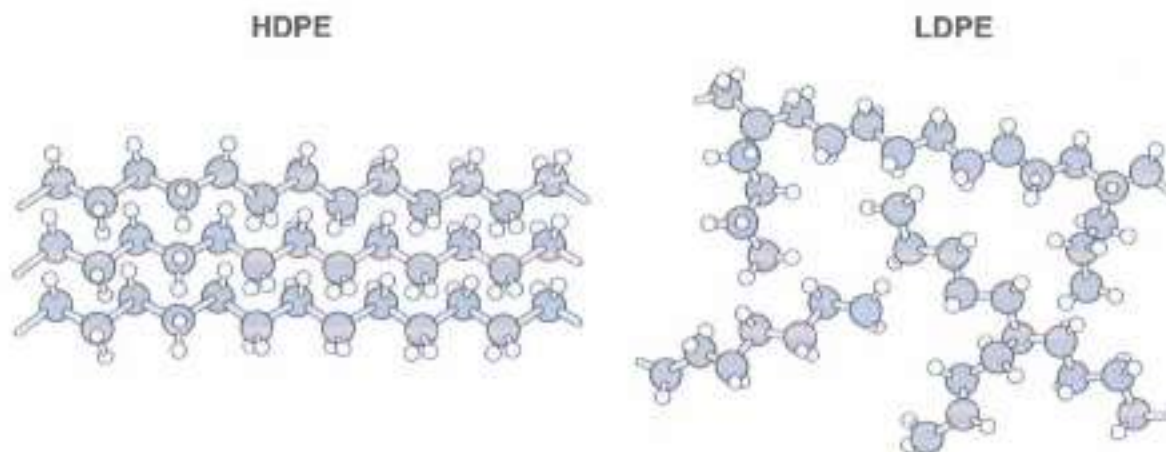
By using different reaction conditions

0 4 . 4 Two different forms of poly(ethene) are:

- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

Figure 4 represents part of the structures of HDPE and LDPE.

Figure 4



Explain why HDPE has a higher density than LDPE.

[2 marks]

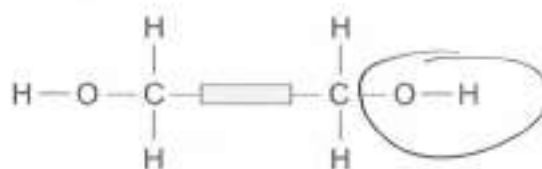
The polymer chains are closer together
and so there are more atoms contained
within a unit volume

Question 4 continues on the next page.

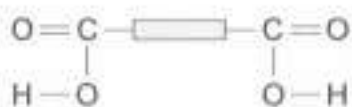
Figure 5 shows three monomers, A, B and C.

Monomer A can react with monomer B and with monomer C to produce polyesters.

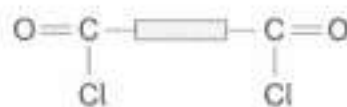
Figure 5



Monomer A



Monomer B



Monomer C

0 4 . 5

Draw a circle on Figure 5 around an alcohol functional group.

[1 mark]

0 4 . 6

Complete Table 2 to show the formula of the small molecule produced when:

- monomer A reacts with monomer B
- monomer A reacts with monomer C.

[1 mark]

Table 2

Reacting monomers	Formula of small molecule produced
A and B	H ₂ O
A and C	HCl

0 5

This question is about fertilisers.

Some fertilisers are described as NPK fertilisers because they contain three elements needed for healthy plant growth.

0 5 . 1

Which **two** compounds each contain **two** of these elements?**[2 marks]**Tick (✓) **two** boxes.

Ammonium nitrate

Ammonium phosphate

Calcium chloride

Calcium phosphate

Potassium chloride

Potassium nitrate

0 5 . 2

Rocks containing calcium phosphate are treated with acid to produce soluble salts that can be used as fertilisers.

Name the soluble salts produced when calcium phosphate reacts with:

- nitric acid
- phosphoric acid.

[2 marks]

Nitric acid

Calcium nitrate

Phosphoric acid

Calcium dihydrogenphosphate

0 5 . 3 Ammonium sulfate is a compound in fertilisers.

Ammonium sulfate can be made using an industrial process or in the laboratory.

In the industrial process, the following steps are used.

1. React streams of ammonia solution and sulfuric acid together.
2. Evaporate the water by passing the solution down a warm column.
3. Collect dry crystals continuously at the bottom of the column.

In the laboratory, the following steps are used.

1. React ammonia solution and sulfuric acid in a conical flask.
2. Evaporate water from the solution until crystals start to form.
3. Leave to cool and crystallise further.
4. Separate the crystals using filtration.
5. Dry the crystals between pieces of filter paper.

Evaluate the two methods for producing a large mass of ammonium sulfate.

[4 marks]

The industrial process is continuous and so can produce more ammonium sulfate per unit time than the lab process. It is also larger scale and so is able to meet demand for a large mass. The lab process is small scale and therefore unable to meet mass demand.

0 6

This question is about cycloalkenes.

Cycloalkenes are ring-shaped hydrocarbon molecules containing a double carbon-carbon bond.

Cycloalkenes react in a similar way to alkenes.

0 6 . 1

Describe a test for the double carbon-carbon bond in cycloalkene molecules.

Give the result of the test.

[2 marks]

Test Add Bromine water to a solution
suspected of containing cycloalkenes

Result if double bonds are present, the
orange bromine water will turn colourless

0 6 . 2

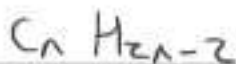
Table 3 shows the name and formula of three cycloalkenes.

Table 3

Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}

Determine the general formula for cycloalkenes.

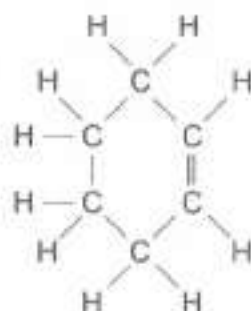
[1 mark]



General formula = _____

Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6



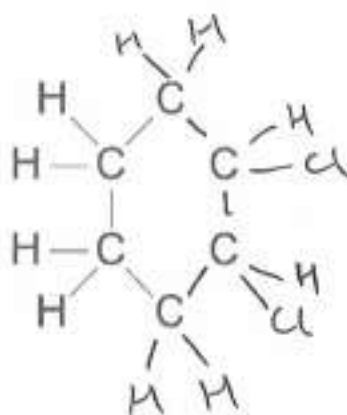
Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

0 6 . 3

Complete Figure 7 to show the displayed structural formula of $C_6H_{10}Cl_2$

[2 marks]

Figure 7



0 6 . 4

Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

$$M_r = 10 + 6(12) + 2(35.5) \quad \%Cl = \frac{2(35.5)}{153} \times 100 \quad [3 \text{ marks}]$$

$$= 153 \quad = \frac{71}{153} \times 100$$

$$= 46.4\%$$

Percentage by mass = 46.4 %

0 7

Potash alum is a chemical compound.

The formula of potash alum is $\text{KAl}(\text{SO}_4)_2$

0 7 . 1

Give a test to identify the Group 1 metal ion in potash alum.

You should include the result of the test.

[2 marks]

Test Flame test

Result A lilac flame

0 7 . 2

Name **one** instrumental method that could identify the Group 1 metal ion and show the concentration of the ion in a solution of potash alum.

[1 mark]

flame emission spectroscopy

A student identifies the other metal ion in potash alum.

The student tests a solution of potash alum by adding sodium hydroxide solution until a change is seen.

0 7 . 3 Give the result of this test.

[1 mark]

White precipitate

0 7 . 4 This test gives the same result for several metal ions.

What additional step is needed so that the other metal ion in potash alum can be identified?

Give the result of this additional step.

[2 marks]

Additional step add excess Sodium hydroxide solution

Result precipitate dissolves

0 7 . 5 Describe a test to identify the presence of sulfate ions in a solution of potash alum.

Give the result of the test.

[3 marks]

Test Add barium chloride solution and then hydrochloric acid

Result white precipitate will form

0 8

This question is about copper and alloys of copper.

Solders are alloys used to join metals together.

Some solders contain copper.

Table 4 shows information about three solders, A, B and C.

Table 4

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

0 8 . 1

Solder B and solder C are now used more frequently than solder A for health reasons.

Suggest one reason why.

Use Table 4.

[1 mark]

Solder A contains lead which
is toxic

0 8 . 2

Suggest one reason why solders B and C have different melting points.

Use Table 4.

[1 mark]

The proportions of the metals used
are different.

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

0 8 . 3

Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

[3 marks]

1 Conserves copper ore supplies

2 Recycling uses less energy than manufacture from scratch

3 Reduction of waste.

Question 8 continues on the next page

Copper is extracted from low-grade ores by phytomining.

0 8 . 4

Describe how copper is extracted from low-grade ores by phytomining.

[4 marks]

Plants are grown on land containing copper ore. These plants are then burnt to produce ash. This ash is dissolved in acid to produce a copper containing solution. The solution is electrolysed to remove the copper for use.

0 8 . 5

Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

[2 marks]

1. Phytomining takes a long time
2. It requires a lot of land that may not be available.

0 9

A student investigated how a change in concentration affects the rate of the reaction between zinc powder and sulfuric acid.

The equation for the reaction is:

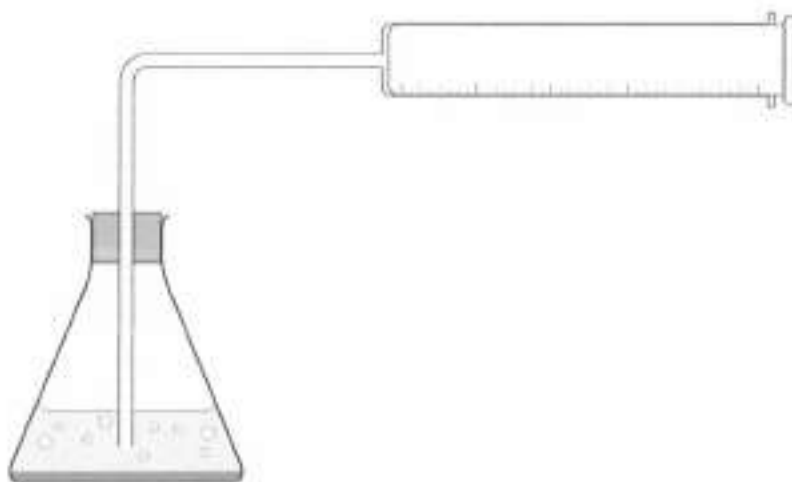


This is the method used.

1. Pour 50 cm³ of sulfuric acid of concentration 0.05 mol/dm³ into a conical flask.
2. Add 0.2 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of gas collected every 30 seconds for 5 minutes.
5. Repeat steps 1 to 4 with sulfuric acid of concentration 0.10 mol/dm³

Figure 8 shows the apparatus used.

Figure 8



0 9 . 1

The student made an error in setting up the apparatus in Figure 8.

What error did the student make?

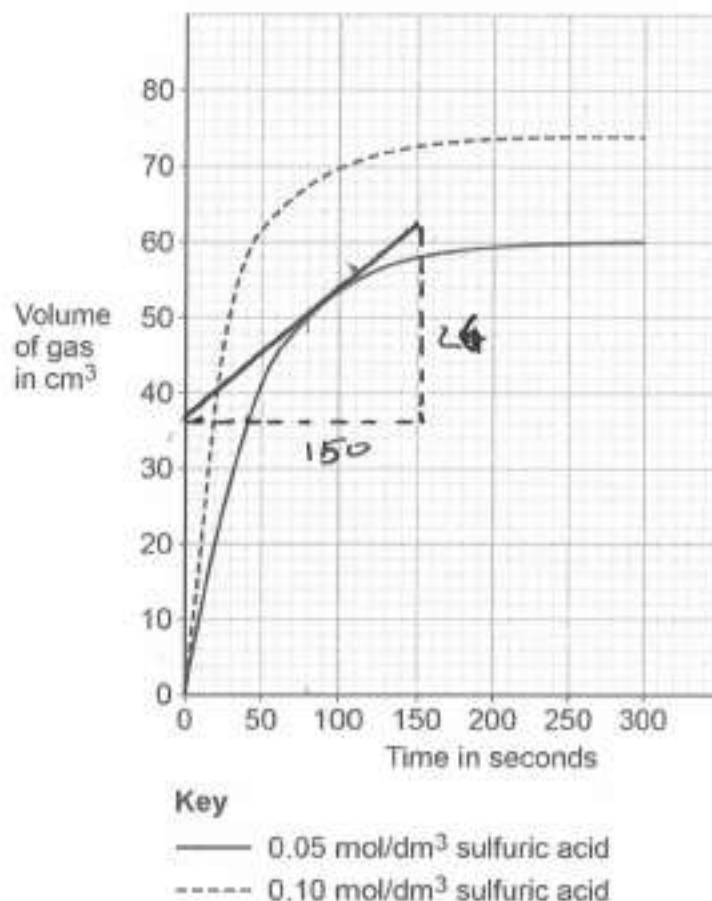
[1 mark]

The delivery tube is in the sulfuric acid

The student corrected the error.

Figure 9 shows the student's results.

Figure 9



0 9 . 2

Explain why the lines of best fit on Figure 9 become horizontal.

[2 marks]

The reaction has stopped because one of the reactants has been used up

0 9 . 3

How does Figure 9 show that zinc powder reacts more slowly with 0.05 mol/dm^3 sulfuric acid than with 0.10 mol/dm^3 sulfuric acid?

[1 mark]

The line for 0.05 mol/dm^3 is less steep than that for 0.10 mol/dm^3

0 9 . 4

Determine the rate of the reaction for 0.05 mol/dm³ sulfuric acid at 80 seconds.

Show your working on Figure 9.

Give your answer to 2 significant figures.

[5 marks]

$$\text{Gradient} = \frac{\Delta y}{\Delta x} \quad \Delta y = 26 \text{ cm}^3$$

$$\Delta x = 150 \text{ s}$$

$$\text{Gradient} = \frac{26}{150}$$

$$= 0.173 \text{ cm}^3 \text{ s}^{-1}$$

Rate of reaction (2 significant figures) = 0.17 cm³/s

0 9 . 5

The activation energy for the reaction between zinc and sulfuric acid is lowered if a solution containing metal ions is added.

What is the most likely formula of the metal ions added?

[1 mark]

Tick (✓) one box.

Al³⁺Ca²⁺Cu²⁺Na⁺

1 0

This question is about alkenes and alcohols.

Ethene is an alkene produced from large hydrocarbon molecules.

Large hydrocarbon molecules are obtained from crude oil by fractional distillation.

1 0 . 1

Name the process used to produce ethene from large hydrocarbon molecules.

[1 mark]

Cracking

1 0 . 2

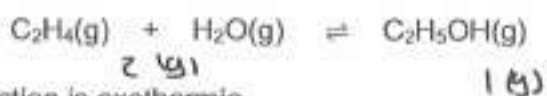
Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

A high temperature between 300-900°C
and the use of either steam or
a catalyst.

10.3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:



The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

Firstly a reasonable compromise temperature must be found. A high temperature will drive a fast reaction by raising the number of successful reactant collisions. However a high temperature will also favour the left side of the equilibrium to compensate for its exothermicity. The compromise temperature will have to balance these competing factors of rate and yield whilst also considering cost. A compromise pressure will also be needed. Here a higher pressure increases both rate and yield as it drives more frequent collisions and shifts the equilibrium left right as there are half the moles of gas present. However, a high pressure is costly to safely maintain so is not economically viable. The chosen pressure must balance rate and yield against cost.

Turn over ▶

1 0 . 4 Ethanol can also be produced from sugar solution by adding yeast.

Name this process.

[1 mark]

fermentation

1 0 . 5 Butanol can be produced from sugar solution by adding bacteria.

Sugar solution is broken down in similar ways by bacteria and by yeast.

Suggest the reaction conditions needed to produce butanol from sugar solution by adding bacteria.

[2 marks]

The bacteria need a warm and
anaerobic environment to fermentat
the sugar

Ethanol and butanol can be used as fuels for cars.

1 0 . 6

A car needs an average of 1.95 kJ of energy to travel 1 m

Ethanol has an energy content of 1300 kilojoules per mole (kJ/mol).

Calculate the number of moles of ethanol needed by the car to travel 200 km

[3 marks]

$$200 \text{ km} = 200 \times 10^3 \text{ m} = 2 \times 10^5 \text{ m}$$

$$\frac{\text{moles ethanol}}{\text{meter}} = \frac{1.95}{1300} = 1.5 \times 10^{-3} \text{ mole}$$

$$\text{moles for } 200 \text{ km} = 2 \times 10^5 \times 1.5 \times 10^{-3}$$

$$= 300 \text{ moles}$$

Number of moles = 300 mol

1 0 . 7

When butanol is burned in a car engine, complete combustion takes place.

Write a balanced equation for the complete combustion of butanol.

You do **not** need to include state symbols.

[2 marks]



17

END OF QUESTIONS