AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

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	
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TOTAL	

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ANSWER IN THE SPACES PROVIDED

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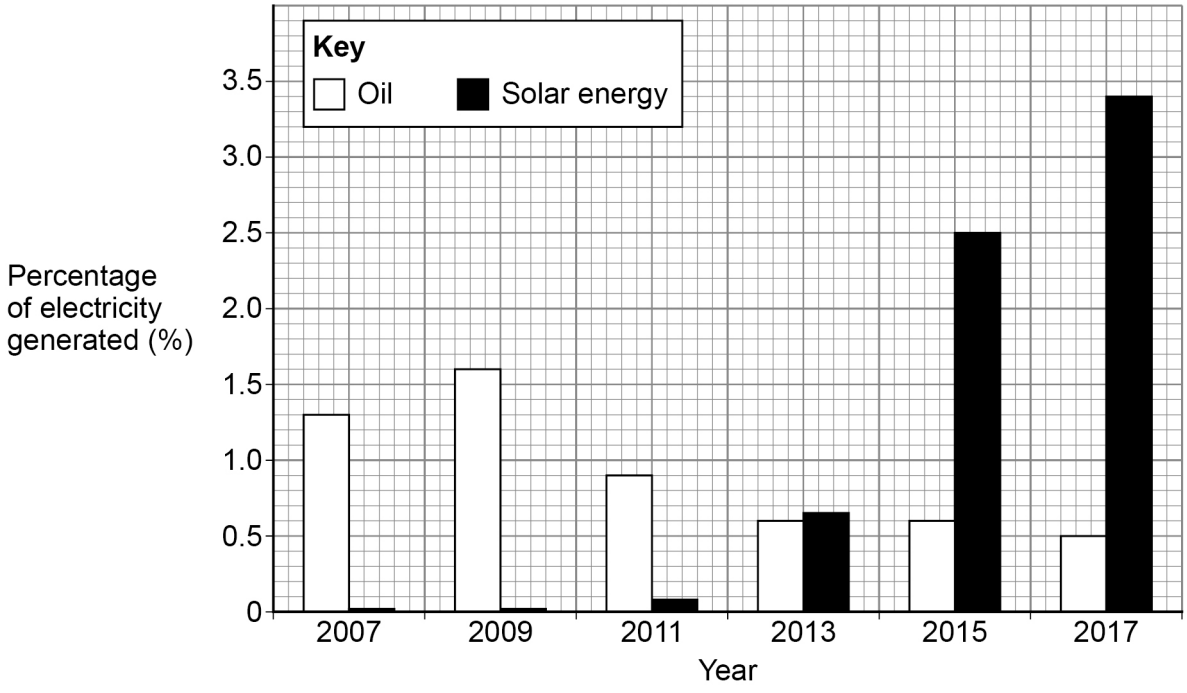
0 1 This question is about fuels and energy.

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]

The use of oil has decreased from 1·3% to 0·5%
The use of solar energy has increased from 0% to 3·4%

Between 2007 and 2011, more oil was used and between 2013 and 2017, more solar energy was used.

Do not write outside the box

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]

Combustion of carbon produces carbon dioxide, which is a greenhouse gas, causing the surface temperature of the Earth to increase, leading to global warming and extreme weather events.

Incomplete combustion of carbon produces carbon monoxide which is toxic, and carbon particulates or soot, causing global dimming and respiratory problems in humans.

Combustion of sulfur produces sulfur dioxide which causes acid rain which damages trees and buildings as well as causing respiratory problems in humans.

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0 1 . 3 Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

Solar is a renewable source of energy.

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 Amount of sunshine is unreliable

2 Increased demand for energy.

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Turn over for the next question

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0 2 This question is about alkanes.

Table 1 shows information about some alkanes.

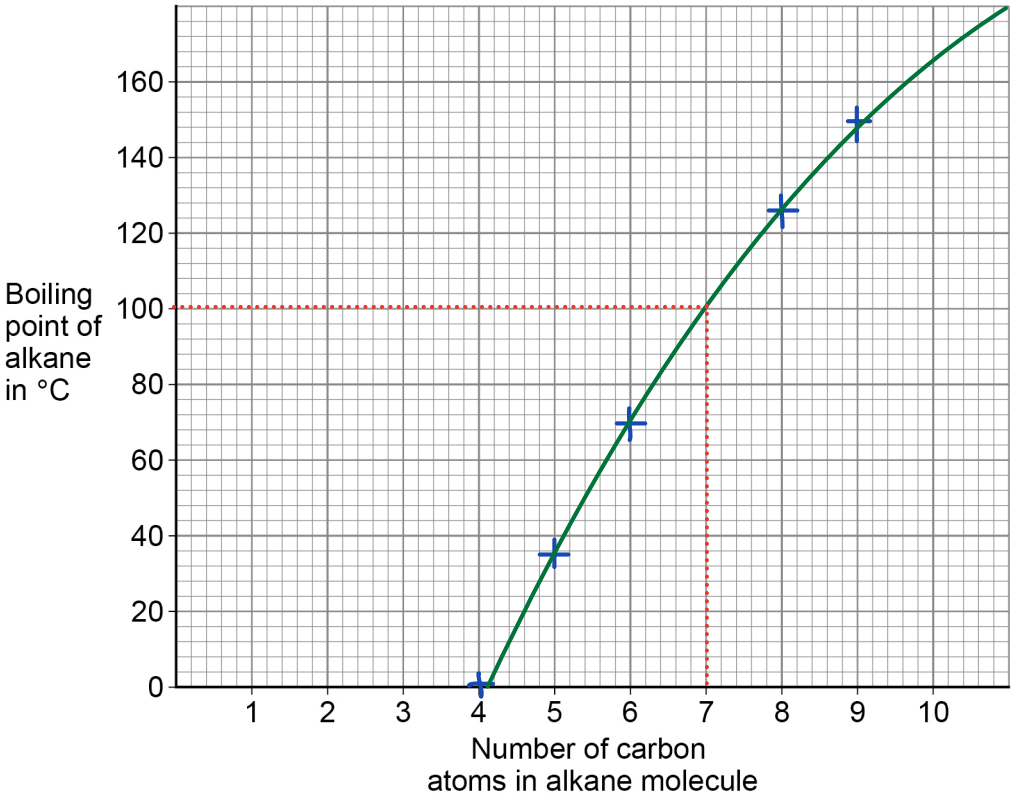
Table 1

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



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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 = 100 °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 of this molecule is lower than 0°C

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]

A Gas.

Question 2 continues on the next page

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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. C_nH_{2n+2}

[1 mark]

C_9H_{20}

$C_9H_{(2\times9)+2}$

C_9H_{20}

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 a higher boiling point than other alkanes. So, nonane condenses where the column has a higher temperature. i.e. lower down the fractionating column.

8

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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]

Draw, in pencil, a start line on chromatography paper
Place spot of food colouring on start line
Use of a suitable solvent
Place solvent in beaker
Place chromatography paper in beaker
so that chromatography paper is in solvent,
but solvent is below start line.
Use a lid over the beaker
Wait for solvent to travel up the chromatography
paper, until it is near the top.
Mark position of the solvent front.
Dry the chromatography paper
Measure distance between start line and
centre of spot.
Measure distance between start line and
solvent front.
Use measurements to determine Rf value.

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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 ☐

8

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0 4 This question is about poly(ethene) and polyesters.

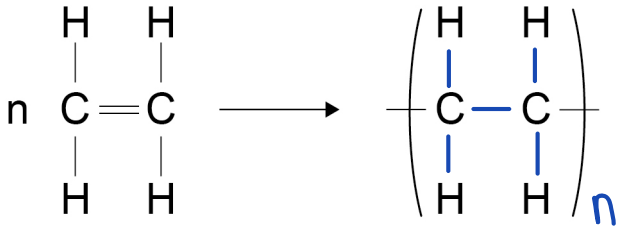
0 4 . 1 Poly(ethene) is produced from ethene.

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) melts, so it can be reshaped into new products.

0 4 . 3 Ethene produces different forms of poly(ethene).

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

[1 mark]

Use different reaction conditions

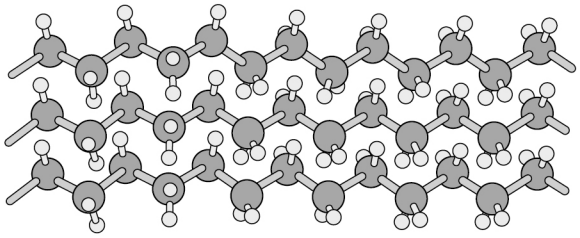
0 4 . 4 Two different forms of poly(ethene) are:

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

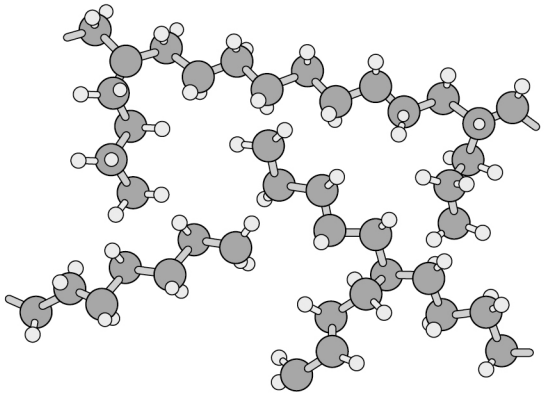
Figure 4 represents part of the structures of HDPE and LDPE.

Figure 4

HDPE



LDPE



Explain why HDPE has a higher density than LDPE.

[2 marks]

In HDPE the polymer chains are closer together so there are more atoms per unit volume

Question 4 continues on the next page.

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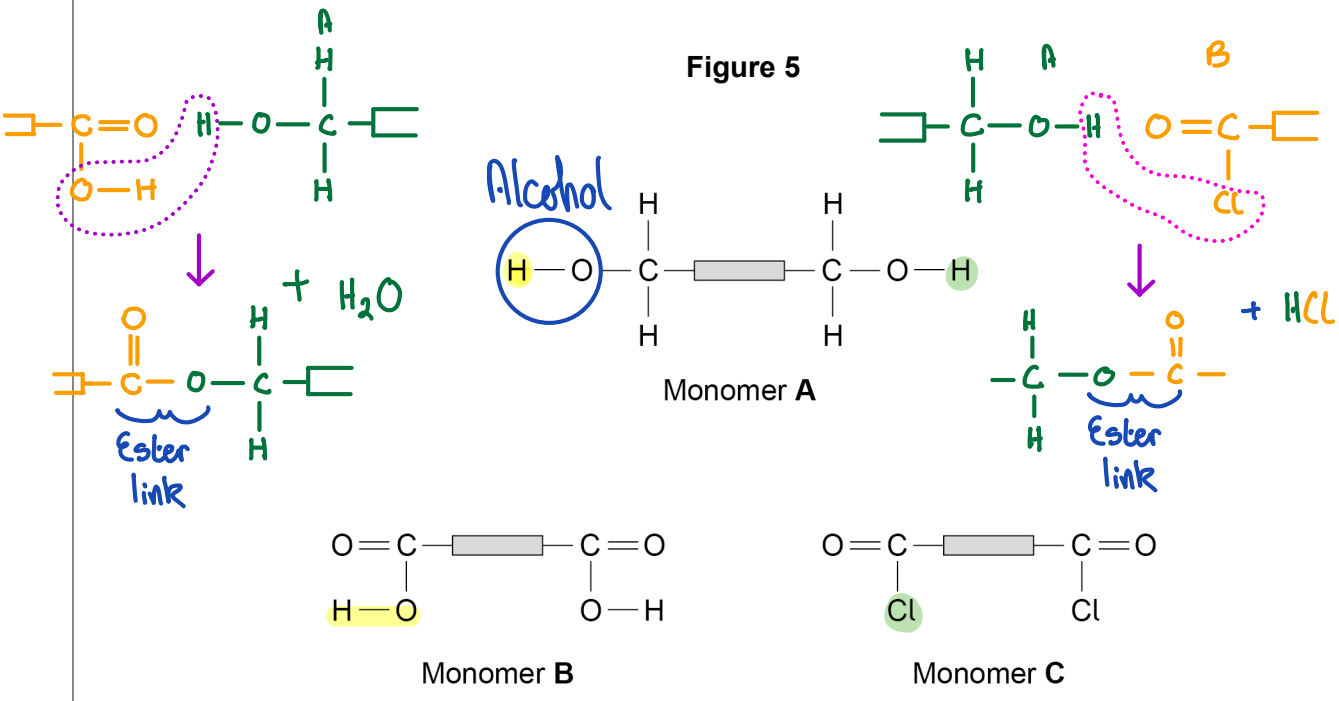
Figure 5 shows three monomers, **A**, **B** and **C**.

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

Figure 5



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_2O
A and **C**	HCl

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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	N	☐
Ammonium phosphate	N + P	✓
Calcium chloride		☐
Calcium phosphate	P	☐
Potassium chloride	K	☐
Potassium nitrate	K + N	✓

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 $Ca_3(PO_4)_2 + 6HNO_3 \longrightarrow 2H_3PO_4 + 3Ca(NO_3)_2$
- phosphoric acid. $Ca_3(PO_4)_2 + 6H_3PO_4 \longrightarrow 3Ca(H_2PO_4)_2 + 3H_2$

[2 marks]

Nitric acid Calcium nitrate $Ca(NO_3)_2$

Phosphoric acid Calcium dihydrogenphosphate $Ca(H_2PO_4)_2$

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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]

Industrial Process:

- larger scale
- quicker
- continuous process

In the laboratory, only small batches can be produced. This is slow, inefficient and only produces small quantities.

8

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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]

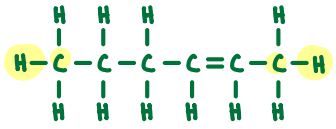
Test Add bromine water

Result Changes from brown/orange to colourless.

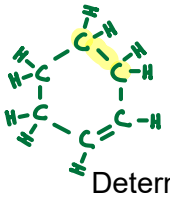
0 6 . 2 **Table 3** shows the name and formula of three cycloalkenes.

alkene: C_nH_{2n}

Table 3



Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}



When the end C atoms join together to form a ring, 2 H atoms removed

Determine the general formula for cycloalkenes.

[1 mark]

C	2×C H
4	8 - 2 = 6
5	10 - 2 = 8
6	12 - 2 = 10
n	2n - 2

General formula = C_nH_{2n-2}

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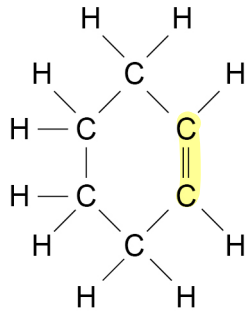
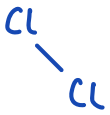
Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6





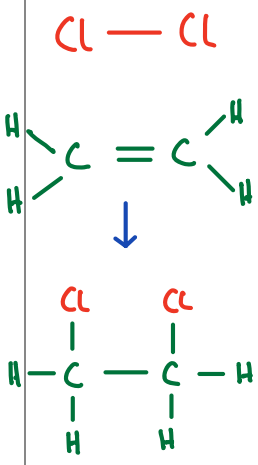
Cl_2 behaves like Br_2
Test for =!
Same Group (7)

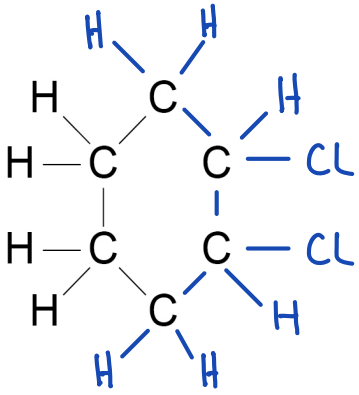
Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

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

[3 marks]

M_r $C_6H_{10}Cl_2$ $= (12\times6)+(1\times10)+(35.5\times2)$

$= 153$

M_r Cl_2 $= (35.5\times2) = 71$

% Cl $= \frac{71}{153} \times 100\%$

Percentage by mass = 46.4 %

8

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0 7 Potash alum is a chemical compound.

The formula of potash alum is $KAl(SO_4)_2$

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 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.

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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

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 dilute hydrochloric acid

Result White precipitate forms.

N.B. Ba test for sulfates:

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_{4\,(s)}$

white precipitate

9

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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]

Lead is toxic / poisonous

0 8 . 2 Suggest **one** reason why solders **B** and **C** have different melting points.

Use **Table 4.**

[1 mark]

The proportions of metals are different

Do not write outside the box

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 Recycling conserves copper ores

2 Recycling uses less energy

3 Recycling reduces waste.

Question 8 continues on the next page

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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]

Grow plants on land containing copper ores
Plants are burnt to produce ash
Ash dissolved in acid to produce a solution of a copper compound.
Extract copper by electrolysis of solution or displacement of copper from solution

0 8 . 5 Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

[2 marks]

1 High grade ores are still available

2 Phytomining takes a long time

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Do not write outside the box

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:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

This is the method used.

1. Pour 50 cm^3 of sulfuric acid of concentration 0.05 mol/dm^3 into a conical flask.

2. Add 0.2 g of zinc powder to the conical flask.

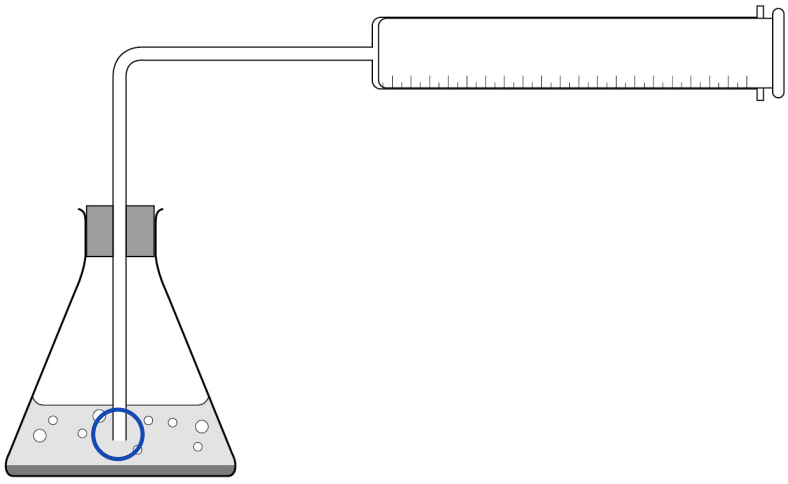
3. Put the stopper in the conical flask.

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/dm^3

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]

Delivery tube is in sulfuric acid

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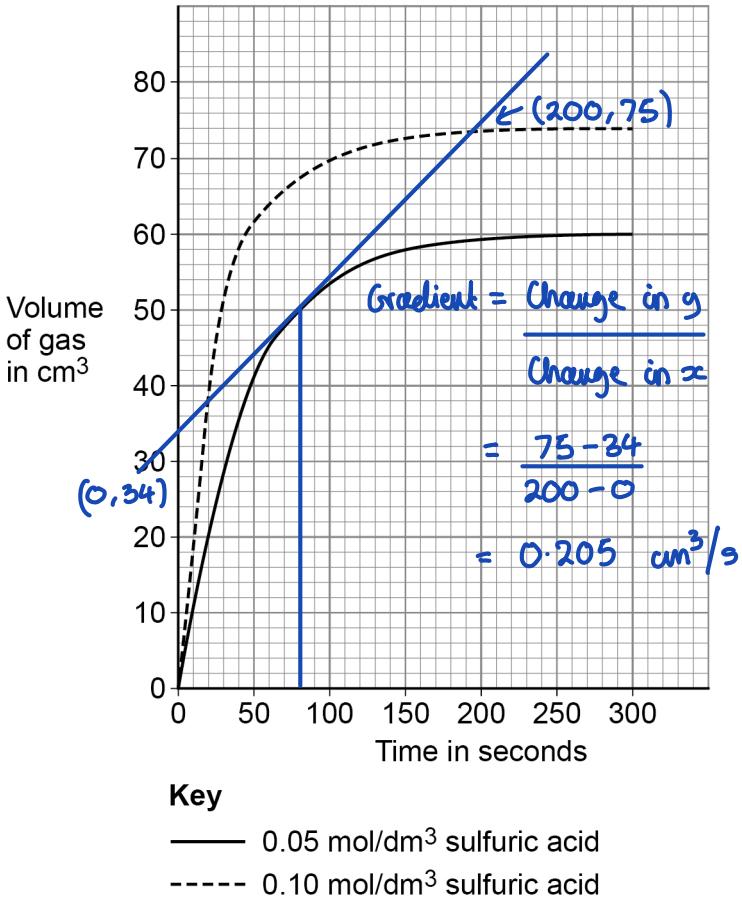
The student corrected the error.

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]

Reaction has stopped because a reactant 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} sulfuric acid is less steep.

Do not write outside the box

0 9 . 4 Determine the rate of the reaction for 0.05 mol/dm^3 sulfuric acid at 80 seconds.

Show your working on **Figure 9**.

Give your answer to 2 significant figures.

[5 marks]

Draw tangent at 80s on 0.05 mol dm^{-3} curve

Gradient of tangent calculated:

Gradient = $\frac{\text{Change in } y}{\text{Change in } x}$ Rate = gradient

$= \frac{75-34}{200-0}$

$= 0.205$ cm^3/s Rate of reaction (2 significant figures) = 0.21 (2 s.f.) cm^3/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.

Al^{3+}	
Ca^{2+}	
Cu^{2+}	✓
Na^+	

Transition metals are good catalysts

Cu is only Transition metal listed

10

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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]

Steam or catalytic cracking

1 0 . 2 Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

High temperature

Steam / catalyst

Do not write outside the box

1 0 . 3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The forward reaction is exothermic.

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

[6 marks]

Rate:

Higher Temperature gives higher rate due to more frequent collisions.

Higher Pressure gives higher rate due to more frequent collisions.

Catalyst can be used to give higher rate by reducing activation energy.

Yield

Higher Temperature gives lower yield because reaction is exothermic

Higher Pressure gives higher yield because there are more gas molecules on left hand side.

Other Factors:

High Temperatures and Pressures use more energy and increase cost.

High Pressure requires stronger reaction vessels so increased cost.

Compromise

Chosen Temperatures and Pressures are a compromise between rate, yield and cost.

Do not write outside the box

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]

Warm

Anaerobic conditions

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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]

Energy needed to travel 200 km: 200 × 1000 m
= 200,000 m × 1·95 kJ
= 390,000 kJ
N° moles = 390,000 kJ / 1300 kJ/mol = 300 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]

$C_4H_9OH + 6\,O_2 \rightarrow 4\,CO_2 + 5\,H_2O$

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END OF QUESTIONS

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