



Please write clearly in block capitals.

Centre number

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Candidate number

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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 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
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| 9 | |
| 10 | |
| TOTAL | |



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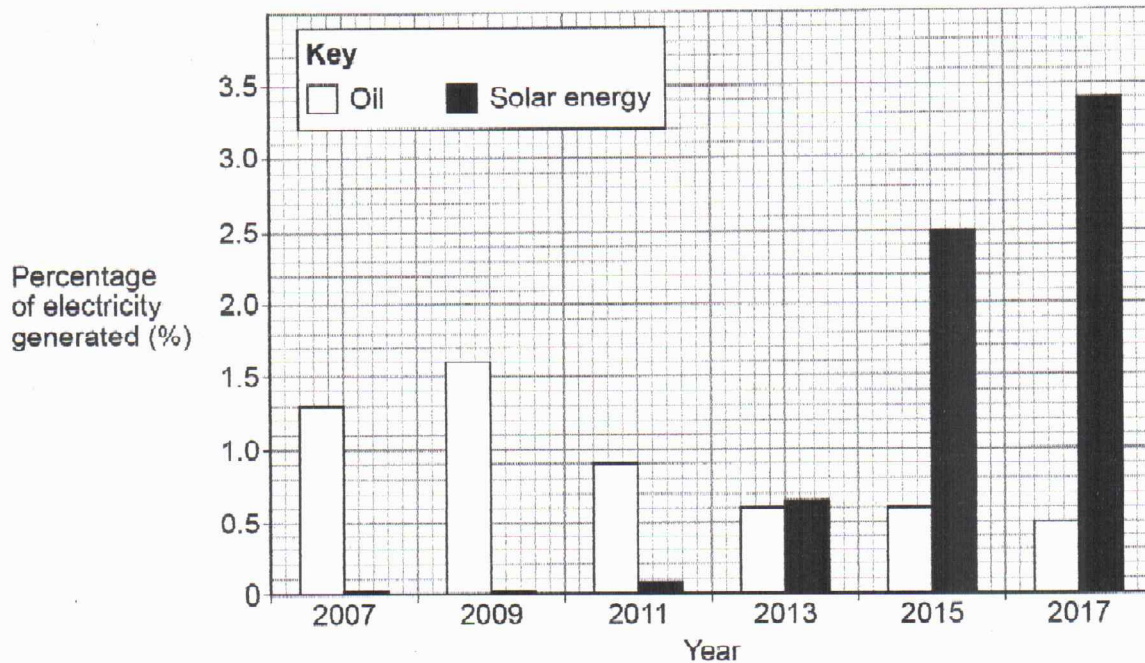
0 1

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 by 3.4%, which increased from 0% to 3.4%. Between 2013 and 2015 no change in oil use.

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]

The carbon dioxide produced is a green house gas and the surface temperature increases which results in global warming. When levels of carbon dioxide rises it results in climate change which leads to the polar ice caps melt and increases sea levels which results to flooding. The extreme weather events is affected which reduces the biodiversity.

Sulfur dioxide is produced and causes the acid rain which damages buildings or statues. It also impacts trees and damage the ecosystem of aquatic animals. Sulfur dioxide leads also to respiratory problems in humans such as asthma.



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
while oil is a finite resource.

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 The amount of sunshine is unreliable due to different weather changes.
- 2 There has been increased demand for more energy.

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Turn over for the next question

Turn over ►



0 2

This question is about alkanes.

Table 1 shows information about some alkanes.

Table 1

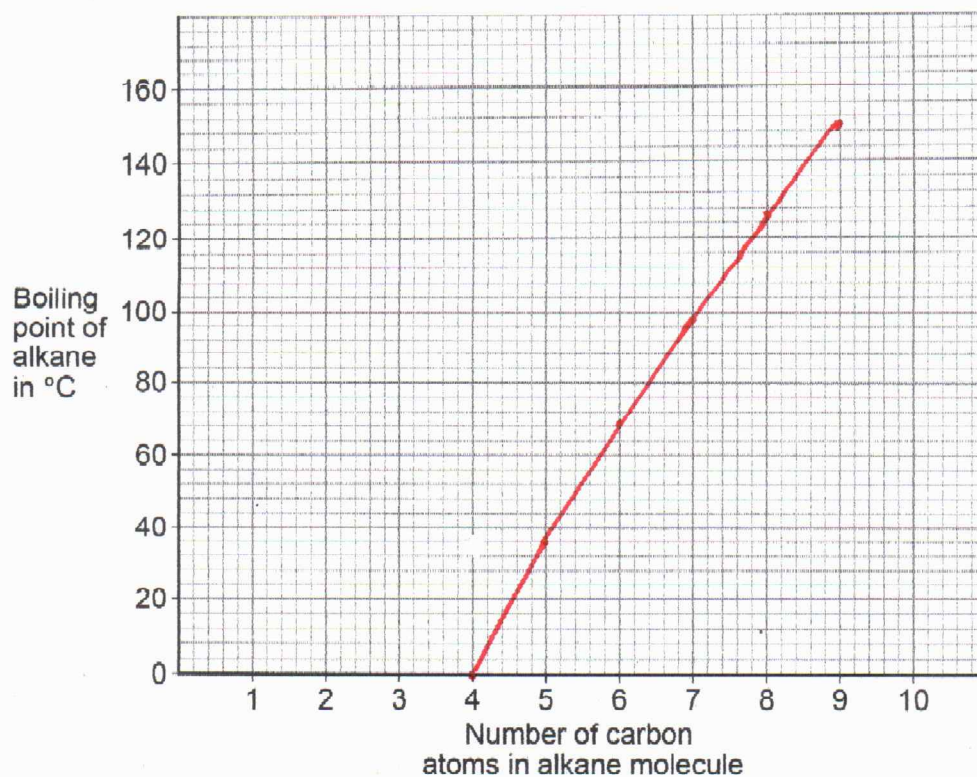
| Number of carbon atoms in alkane molecule | Boiling point of alkane in °C |
|-------------------------------------------|-------------------------------|
| 4 | 0 |
| 5 | 36 |
| 6 | 69 |
| 7 | X |
| 8 | 126 |
| 9 | 151 |

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 = 97 °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 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]

gas

Question 2 continues on the next page

Turn over ►



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 a higher boiling point so nonane
condenses where the column has a
higher temperature.



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]

You are required to draw a line using a pencil at the bottom of the chromatography paper (baseline). Place spots of food colouring. Use a suitable solvent. The solvent depends on what's being tested. Some compounds dissolve well in water. Place the chromatography paper in a beaker and dissolve it in solvent. The solvent is below startline. Use a lid on top of the beaker to stop the solvent evaporating. Wait for solvent to travel up the paper until near top. Mark the solvent front and dry the chromatography paper. Measure distance between startline and centre of spot, then measure distance between startline and solvent front. Then obtain the R_f value.



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 *The lengths of paper should be same.*
- Different period of time used *-length of time should be equal.*
- Different size of beaker used *-use same sizes of beakers.*
- 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 *→ Mobile phase*

Stationary phase is a strip or piece of paper in the solvent.

8

Turn over ►



0 4

This question is about poly(ethene) and polyesters.

0 4 . 1

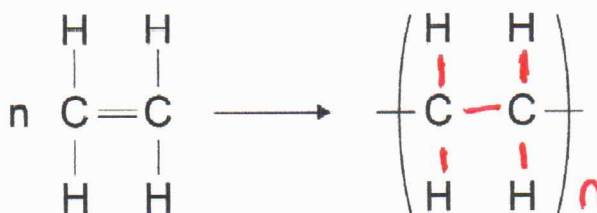
Poly(ethene) is produced from ethene.

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]

The polyethene melts so can be reshaped into new products, since thermosoftening polymers melt when they are heated.

0 4 . 3

Ethene produces different forms of poly(ethene).

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

[1 mark]

They use different conditions such as temperature and pressures.

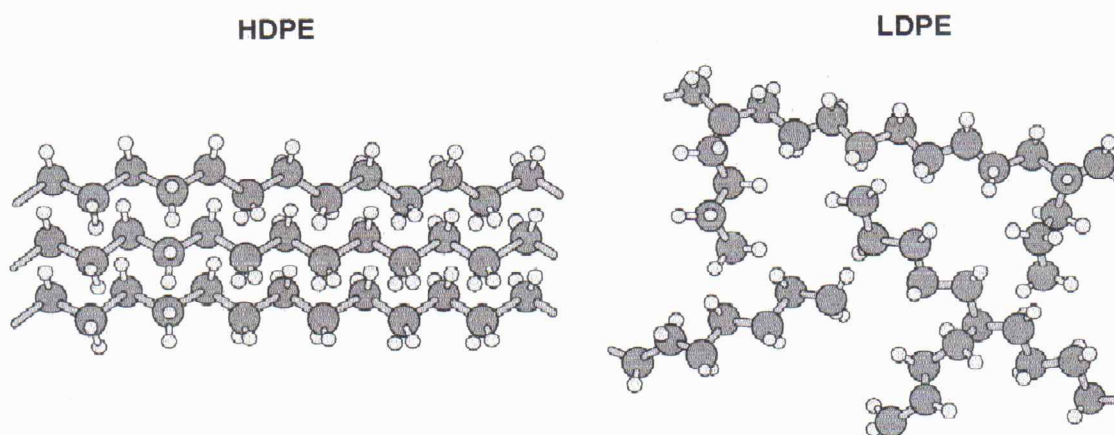


0 4 . 4 Two different forms of poly(ethene) are:

- 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 HDPE polymer chain molecules are closer together and so more molecules per unit volume.

Question 4 continues on the next page.

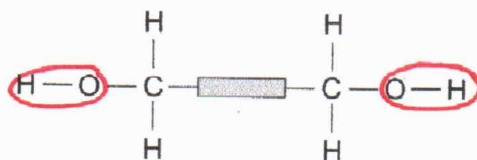
Turn over ►



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

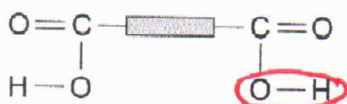
Monomer A can react with monomer B and with monomer C to produce polyesters.

Figure 5



Monomer A

The functional
group of ethanol
is -OH.



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

 $\text{NH}_4\text{NO}_3 \rightarrow$ Contains Nitrogen

Ammonium phosphate

Calcium chloride

 $\text{CaCl}_2 \rightarrow$ does not contain elements N, P, or K.

Calcium phosphate

does not contain the elements.

Potassium chloride

It only contains Potassium.

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 dihydrogen phosphate



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]

Using the industrial process is suitable because the amount of ammonium sulfate is a larger scale. It is also a quicker and a continuous process thus leading to more consistent processes and enhance product quality, in turn can reduce waste generation, product losses and down time.



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 any compound
solution that contain carbon-carbon double bond.

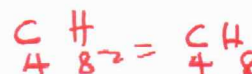
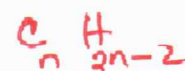
Result The bromine water changes from
brown-orange to colourless.

0 6 . 2

Table 3 shows the name and formula of three cycloalkenes.

Table 3

| Name | Formula |
|--------------|--------------------------------|
| Cyclobutene | C ₄ H ₆ |
| Cyclopentene | C ₅ H ₈ |
| Cyclohexene | C ₆ H ₁₀ |



Determine the general formula for cycloalkenes.

[1 mark]

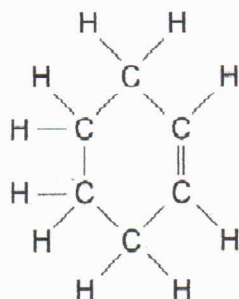
The number of hydrogen atoms less two.

General formula = C_n H_{2n-2}



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

Figure 6



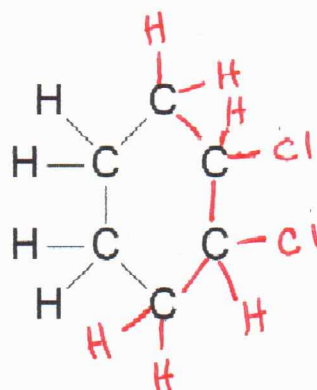
Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

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

[3 marks]

$$\begin{array}{l|l}
 \text{R.F.M } C_6H_{10}Cl_2 & \% \text{ chlorine} = \frac{71}{153} \times 100\% \\
 \hline
 (12 \times 6) + (1 \times 10) + (35.5 \times 2) & \\
 \hline
 = 72 + 10 + 71 & = \underline{\underline{46.4\%}} \\
 \hline
 = \underline{\underline{153}} &
 \end{array}$$

Percentage by mass = 46.4 %

8

Turn over ►



07

Potash alum is a chemical compound.

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

07.1

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

You should include the result of the test.

[2 marks]

Test It can be done using a flame test
with clean nichrome wire.Result It burns in a lilac flame.

07.2

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]

A white precipitate will be formed.

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 It is required to add excess sodium hydroxide solution.

Result The precipitate will dissolve.

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 You are required to add barium chloride solution and then add dilute hydrochloric acid.

Result A white precipitate will be formed.



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 (harmful) in humans health.

0 8 . 2

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

Use Table 4.

[1 mark]

Since they are alloys, they have different proportions of Metals thus distorts the arrangement.



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 scrap copper is cheaper thus helps in conservation of copper ores.
- 2 Processing copper ores is most expensive since more energy is needed and recycling uses less energy.
- 3 Recycling of scrap copper reduces unwanted waste and limits quarrying which has environmental impacts.

Question 8 continues on the next page

Turn over ►



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]

Phytomining uses plants. In order to extract copper phytomining uses plants to absorb copper compounds from the ground. The copper compounds from the soil build up in the cells of the plant. Plants can be burnt to release copper. The ash from the plant contains the copper compounds from which copper is extracted. The ash is reacted with sulfuric acid to make copper sulfate solution.

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

Suggest two reasons why.

[2 marks]

- 1 There has been availability of high grade ores.
- 2 There is not enough land available and phytomining takes a long time.

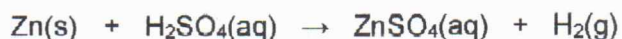
11



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:

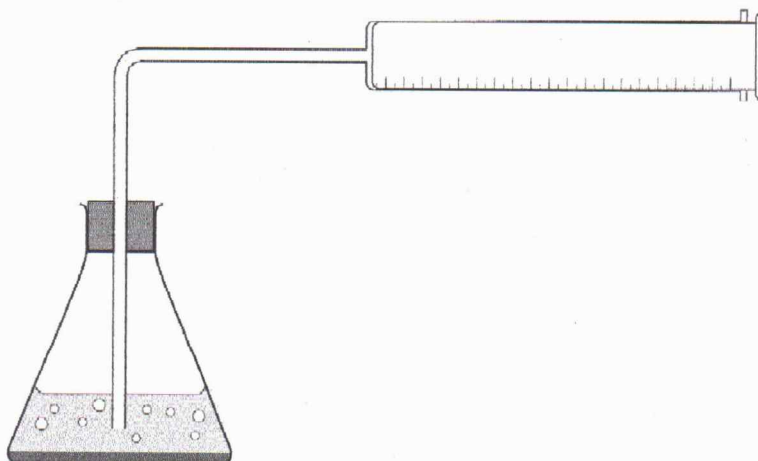


This is the method used.

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 dipped in the sulfuric acid.

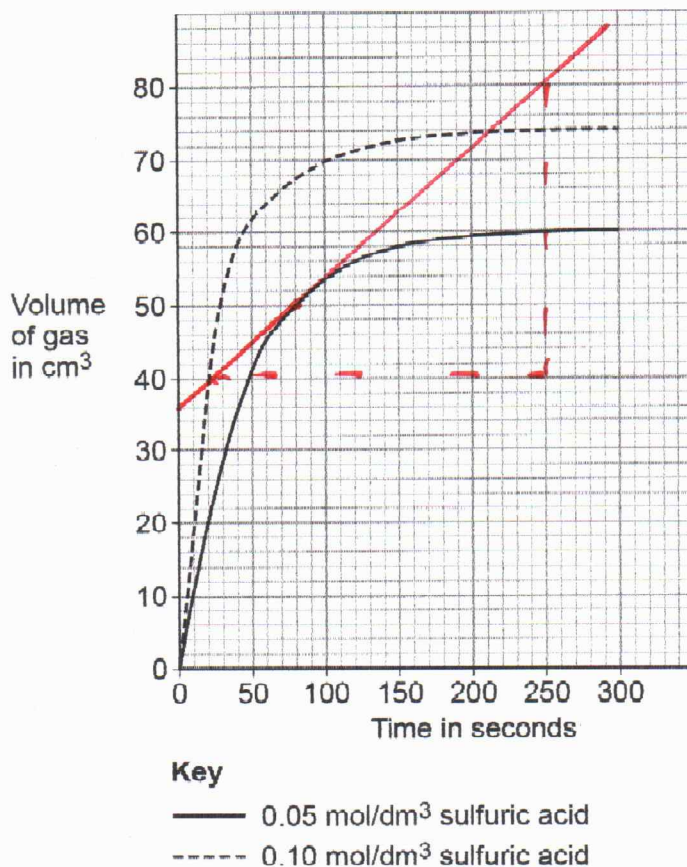
Turn over ►



The student corrected the error.

Figure 9 shows the student's results.

Figure 9



09.2 Explain why the lines of best fit on Figure 9 become horizontal. [2 marks]

This is because the reaction has stopped, confirming that all the reactants has been used up.

09.3 How does Figure 9 show that zinc powder reacts more slowly with 0.05 mol/dm³ sulfuric acid than with 0.10 mol/dm³ sulfuric acid? [1 mark]

The curve for 0.05 mol/dm³ sulfuric acid is less steep and produces less gas in a fixed time.



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]

$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$

$$= \frac{80 - 40}{250 - 20}$$

$$= \frac{40}{230}$$

$$= 0.1739 \text{ cm}^3/\text{s}$$

$$\approx 0.17$$

Rate of reaction (2 significant figures) = 0.17 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+}

- Al does not react with H_2SO_4 due to its great affinity of oxygen.

Ca^{2+}

- There is a layer of insoluble sulfate is formed thus slowing/stopping the reaction

Cu^{2+}

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 (It occurs through steam / use of catalysts)

1 0 . 2

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

[2 marks]

- High temperature of about 600-700°C is required

- The reaction has to occur in presence of catalyst silica and alumina.



1 0 . 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]

For the hydration of ethene temperature should be about 300°C . This higher temperatures give higher rate of reaction because there will be more frequent collisions. Higher temperatures use more energy so costs increase.

The pressure for the process is about 60-70 atmospheres. Higher pressure gives the higher rate because more frequent collisions, because the reaction is exothermic higher pressure gives higher yield, because there are more molecules on left hand side.

A catalyst which is phosphoric acid is needed to speed up the rate of reaction. A higher rate will occur because the activation energy is reduced.

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 reaction takes place in the absence of oxygen with warm temperatures of about 15 - 35°C. If the temperature is too low the reaction will be slow but high temperatures denatures enzymes.



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]

Convert 200km into Metres

$$1\text{km} = 1000\text{m}$$

$$200\text{km} = ?$$

$$200 \times 1000 = 200,000\text{m}$$

$$\begin{aligned} \text{Number of Moles} &= \frac{200,000 \times 1.95 \text{ kJ}}{1300 \text{ kJ}} \\ &= \underline{300 \text{ moles}} \end{aligned}$$

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

