

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                  |      |
| 3                  |      |
| 4                  |      |
| 5                  |      |
| 6                  |      |
| 7                  |      |
| 8                  |      |
| 9                  |      |
| 10                 |      |
| <b>TOTAL</b>       |      |



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



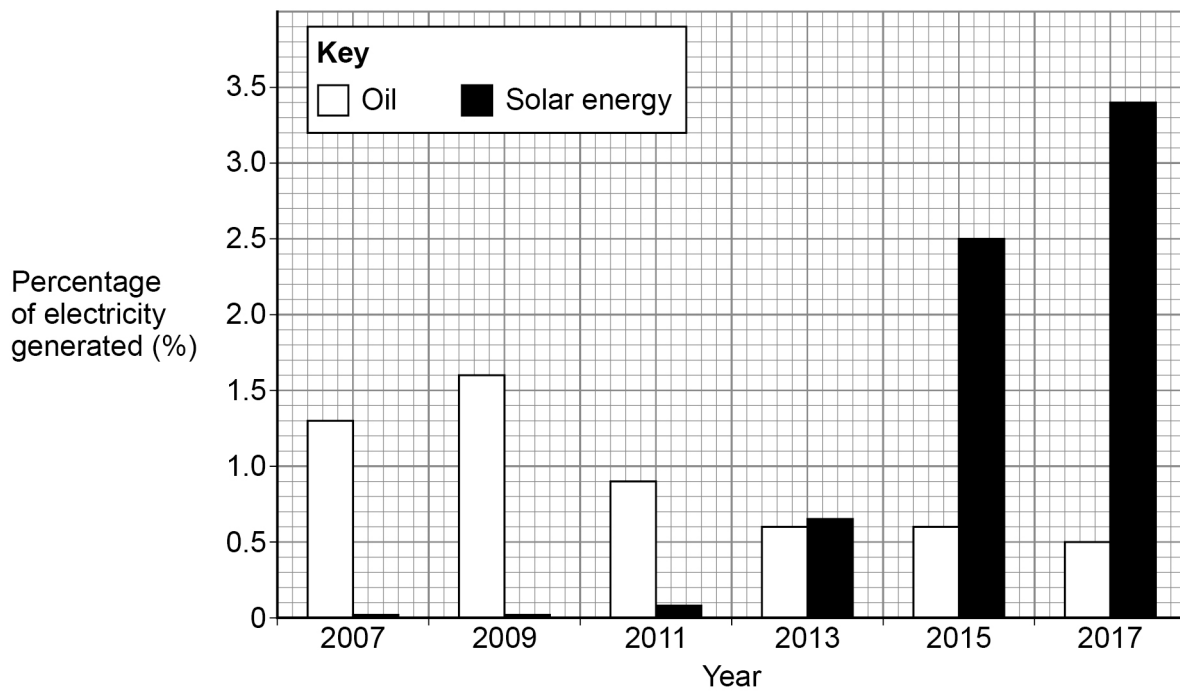
0 1

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]**

---



---



---



---



---



---

Turn over ►



|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 2 |
|---|---|---|---|

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

**[6 marks]**

[illegible]

0 1 . 3

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

**[1 mark]**

---

---

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 

---

2 

---

---

---

12

**Turn over for the next question**

**Turn over ►**

0 2

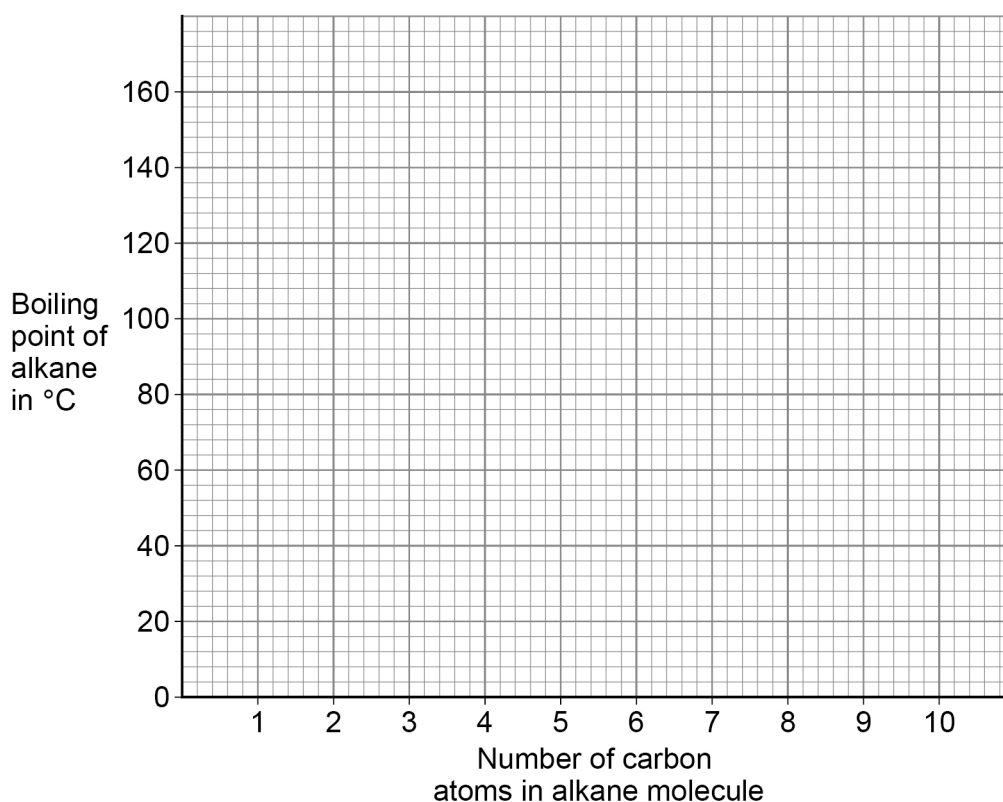
This question is about alkanes.

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

| Number of carbon atoms<br>in alkane molecule | Boiling point of alkane<br>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** = \_\_\_\_\_ °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]

---

---

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]

---

**Question 2 continues on the next page**

**Turn over ►**



**Table 1** is repeated below.

**Table 1**

| Number of carbon atoms<br>in alkane molecule | Boiling point of alkane<br>in °C |
|----------------------------------------------|----------------------------------|
| 4                                            | 0                                |
| 5                                            | 36                               |
| 6                                            | 69                               |
| 7                                            | <b>X</b>                         |
| 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]**

$C_9H$  \_\_\_\_\_

**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]**

---



---



---



---

8



**Turn over for the next question**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Turn over ►**



A food colouring contains a dye.

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]**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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

☐

Turn over ►



0 4

This question is about poly(ethene) and polyesters.

0 4 . 1

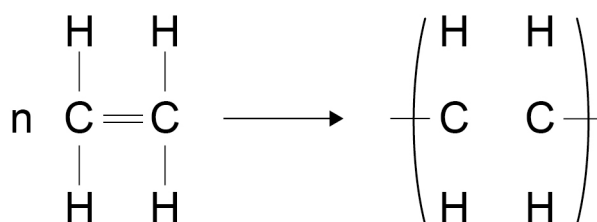
Poly(ethene) is produced from ethene.

**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]

---



---



---



---

0 4 . 3

Ethene produces different forms of poly(ethene).

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

[1 mark]

---



---



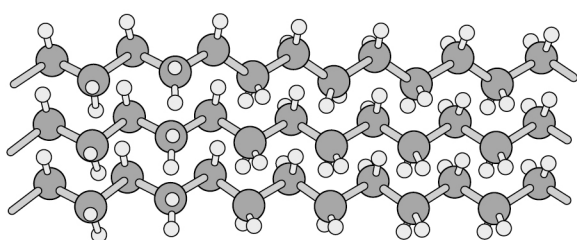
**0 4 . 4** Two different forms of poly(ethene) are:

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

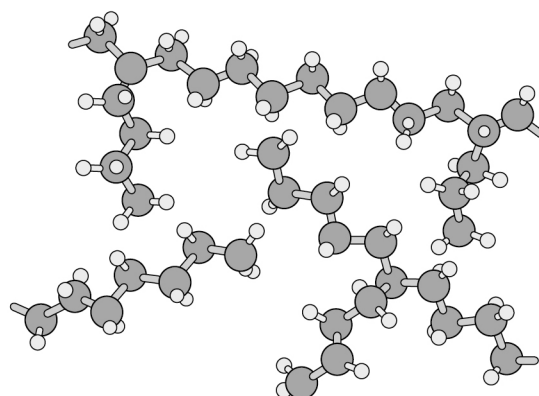
**Figure 4** represents part of the structures of HDPE and LDPE.

**Figure 4**

**HDPE**



**LDPE**



Explain why HDPE has a higher density than LDPE.

**[2 marks]**

---

---

---

---

**Question 4 continues on the next page.**

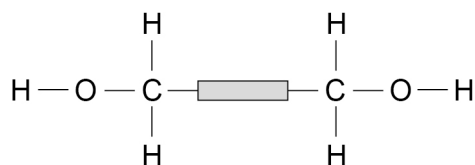
**Turn over ►**



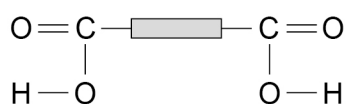
**Figure 5** shows three monomers, **A**, **B** and **C**.

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

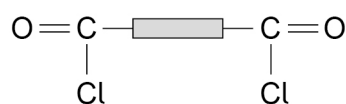
**Figure 5**



Monomer **A**



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 |
|-----------------------|------------------------------------|
| <b>A</b> and <b>B</b> |                                    |
| <b>A</b> and <b>C</b> |                                    |



**Turn over for the next question**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Turn over ►**



**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 \_\_\_\_\_

Phosphoric acid \_\_\_\_\_



|   |   |   |   |
|---|---|---|---|
| 0 | 5 | . | 3 |
|---|---|---|---|

In the industrial process, the following steps are used.

- 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]**

[illegible]

8

**Turn over ►**



**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 \_\_\_\_\_

\_\_\_\_\_

Result \_\_\_\_\_

\_\_\_\_\_

**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]**

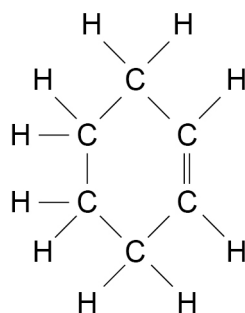
\_\_\_\_\_

General formula = \_\_\_\_\_



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

**Figure 6**



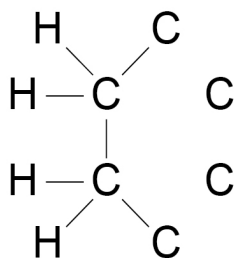
Chlorine reacts with cyclohexene to produce a compound with the formula  $C_6H_{10}Cl_2$

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

[3 marks]

---



---



---



---

Percentage by mass = \_\_\_\_\_ %

8

Turn over ►



|   |   |
|---|---|
| 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 \_\_\_\_\_

\_\_\_\_\_

Result \_\_\_\_\_

\_\_\_\_\_

|   |   |   |   |
|---|---|---|---|
| 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]

\_\_\_\_\_

\_\_\_\_\_



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]

---

---

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 \_\_\_\_\_

---

Result \_\_\_\_\_

---

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 \_\_\_\_\_

---

---

Result \_\_\_\_\_

---

---

9

Turn over ►



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    |
|----------|---------------------|---------------------|
| <b>A</b> | 183                 | tin, copper, lead   |
| <b>B</b> | 228                 | tin, copper, silver |
| <b>C</b> | 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]

---



---

0 8 . 2

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

Use **Table 4**.

[1 mark]

---



---



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 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

3 \_\_\_\_\_

\_\_\_\_\_

**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]

---

---

---

---

---

---

---

---

0 8 . 5

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

Suggest **two** reasons why.

[2 marks]

1 

---

---

2 

---

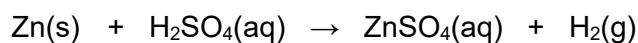
---



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:

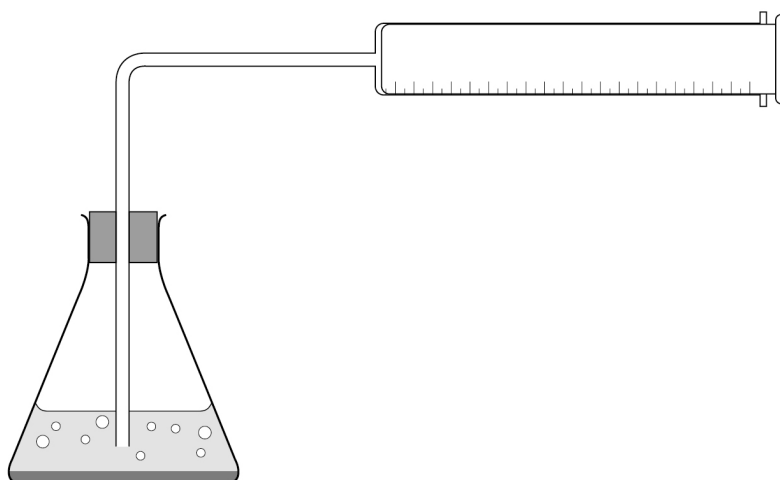


This is the method used.

1. Pour 50 cm<sup>3</sup> of sulfuric acid of concentration 0.05 mol/dm<sup>3</sup> 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<sup>3</sup>

**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]

---



---

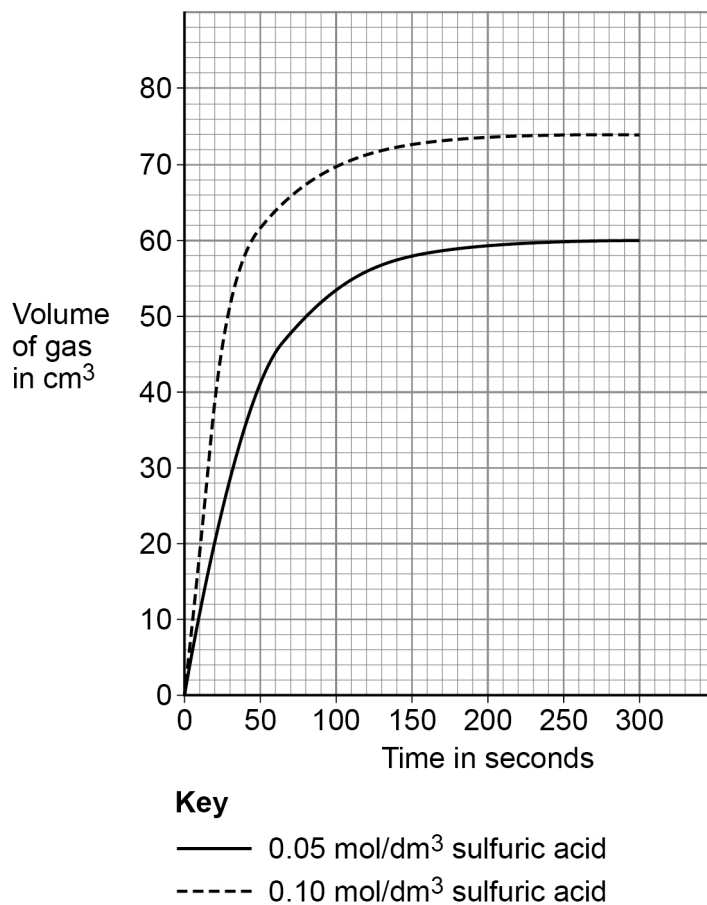
Turn over ►



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]

---



---



---



---

0 9 . 3

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

[1 mark]

---



---



0 9 . 4

Determine the rate of the reaction for 0.05 mol/dm<sup>3</sup> sulfuric acid at 80 seconds.Show your working on **Figure 9**.

Give your answer to 2 significant figures.

**[5 marks]**


---



---



---



---



---



---

Rate of reaction (2 significant figures) = \_\_\_\_\_ cm<sup>3</sup>/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<sup>3+</sup>☐Ca<sup>2+</sup>☐Cu<sup>2+</sup>☐Na<sup>+</sup>☐

10

Turn over ►



|   |   |
|---|---|
| 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]**

---

|   |   |   |   |
|---|---|---|---|
| 1 | 0 | . | 2 |
|---|---|---|---|

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

**[2 marks]**

---

---

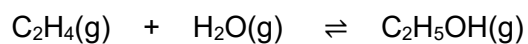
---

---



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]**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

**Turn over ►**



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

Name this process.

**[1 mark]**

---

**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]**

---

---

---

---



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]

---

---

---

---

---

Number of moles = \_\_\_\_\_ 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]

---

END OF QUESTIONS



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



[illegible]

[illegible]

[illegible]

**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

**Copyright information**

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from [www.aqa.org.uk](http://www.aqa.org.uk).

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2021 AQA and its licensors. All rights reserved.

