# GCSE
# CHEMISTRY

**H**

**Higher Tier   Paper 2**

# 8462/2H

**Time allowed: 1 hour 45 minutes**

**At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.**

**[Turn over]**

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.

- Answer ALL questions in the spaces provided. Do not write 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.**

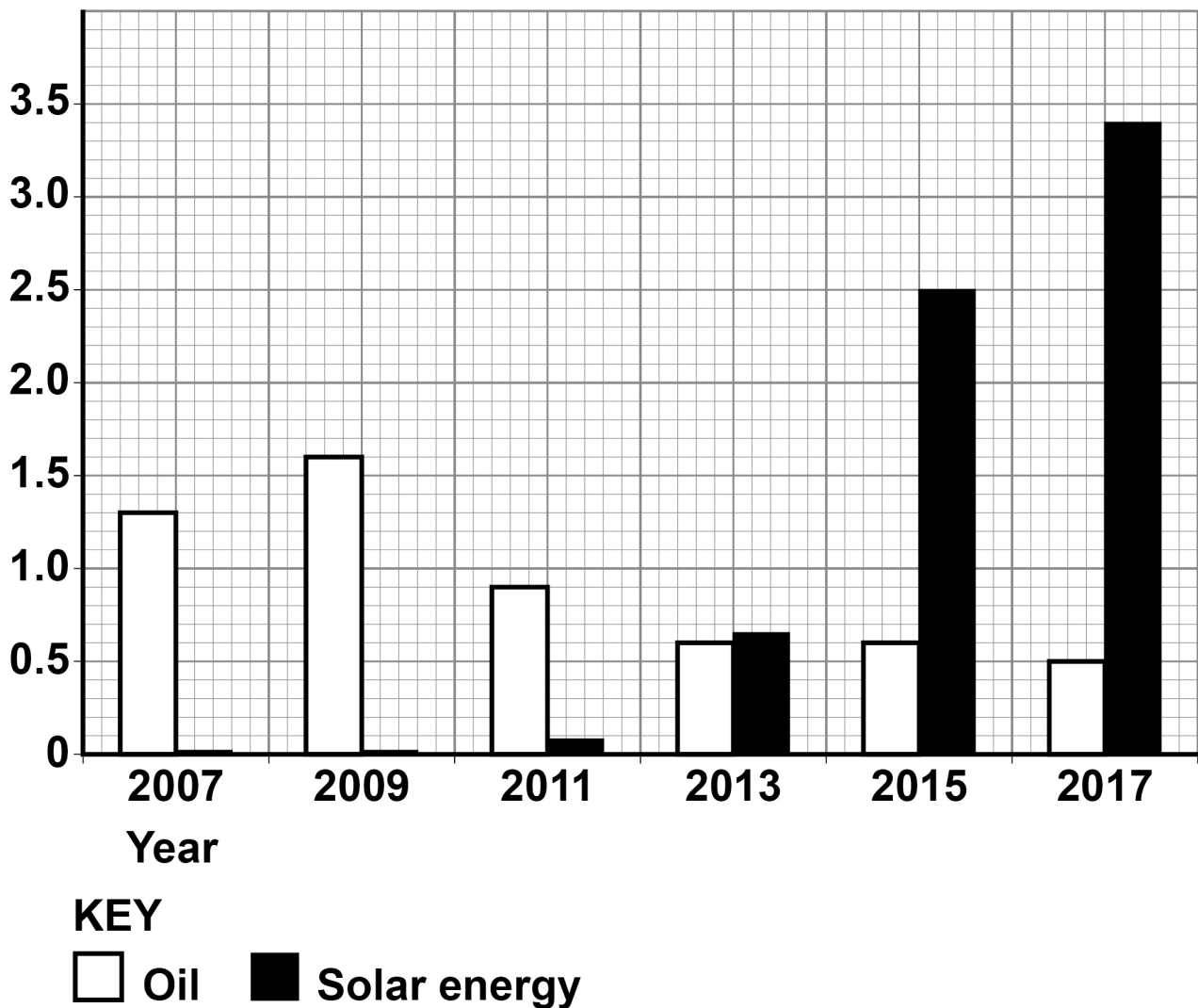**DO NOT TURN OVER UNTIL TOLD TO DO SO**

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

Percentage of electricity generated (%)



Year

KEY

☐ Oil   ■ Solar energy

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**

**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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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

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**[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, on the opposite page.  [2 marks]

0 2 . 2

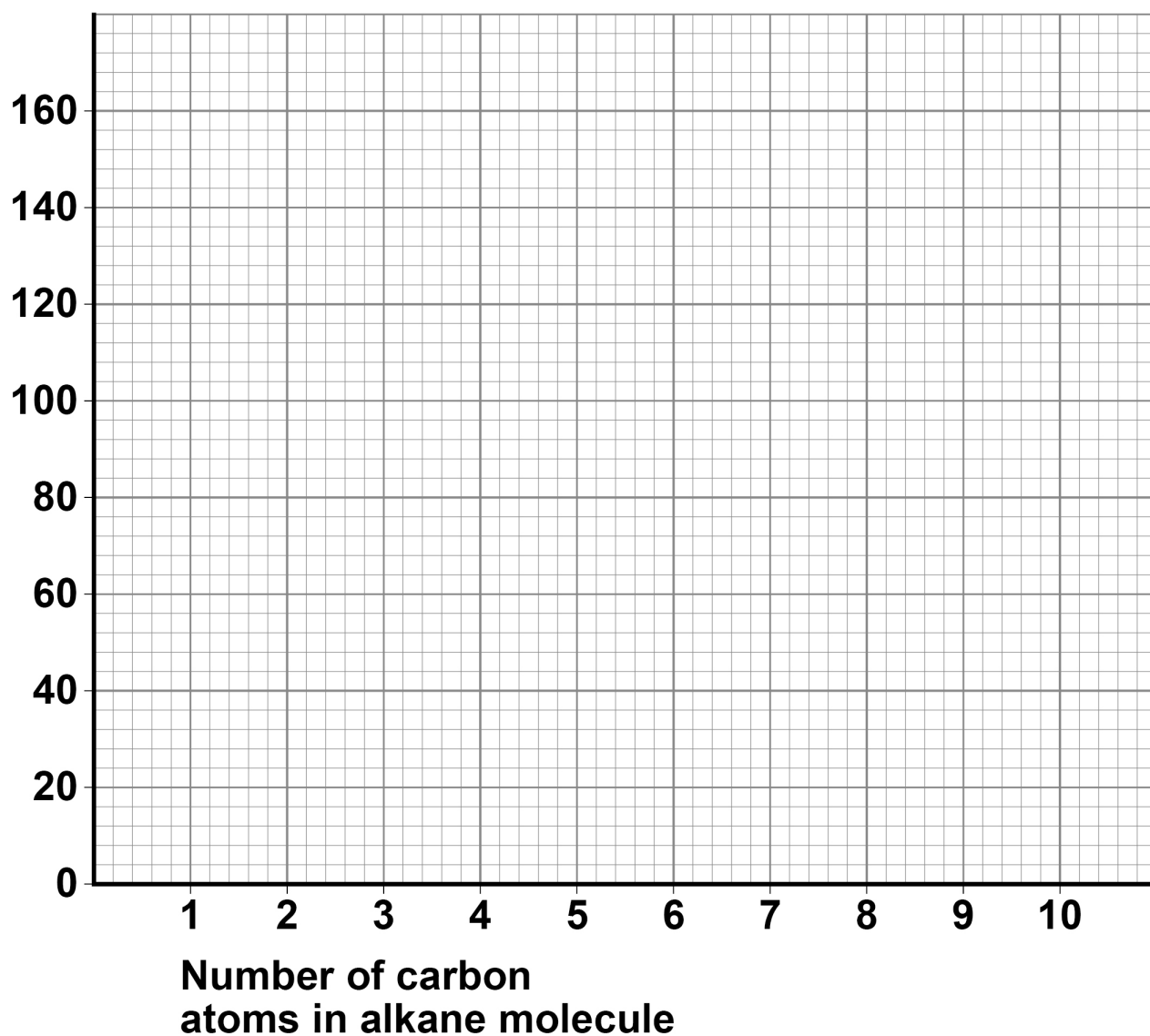Predict the boiling point X of the alkane with seven carbon atoms in a molecule.

Use TABLE 1 and FIGURE 2.  [1 mark]

X = _____ °C

**FIGURE 2**

Boiling
point of
alkane
in °C



Number of carbon
atoms in alkane molecule

**[Turn over]**

**BLANK PAGE**

**0 2** . **3**

**FIGURE 2, on page 11, 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, on page 10.  [1 mark]**

_____

_____

**[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]**

$C_9H$ _____

**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]**

_____

_____

_____

_____

_____

_____

**[Turn over]**

**8**

**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]

_____

_____

_____

_____

_____

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**

0 4

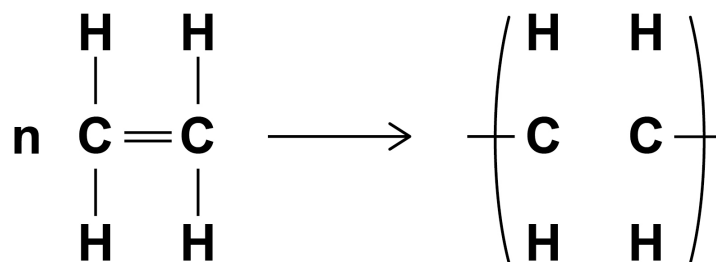This question is about poly(ethene) and polyesters.

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

$$n \; \begin{matrix} H & H \\ | & | \\ C=C \\ | & | \\ H & H \end{matrix} \longrightarrow \left( \begin{matrix} H & H \\ | & | \\ C & C \\ | & | \\ H & H \end{matrix} \right)$$

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]**

_____
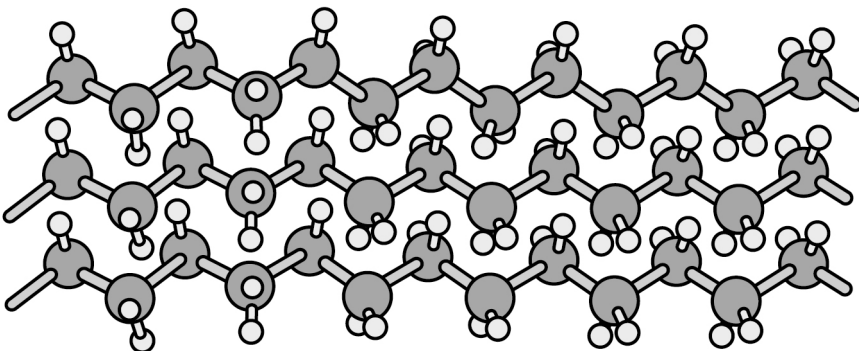
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**[Turn over]**

0 4 . 4

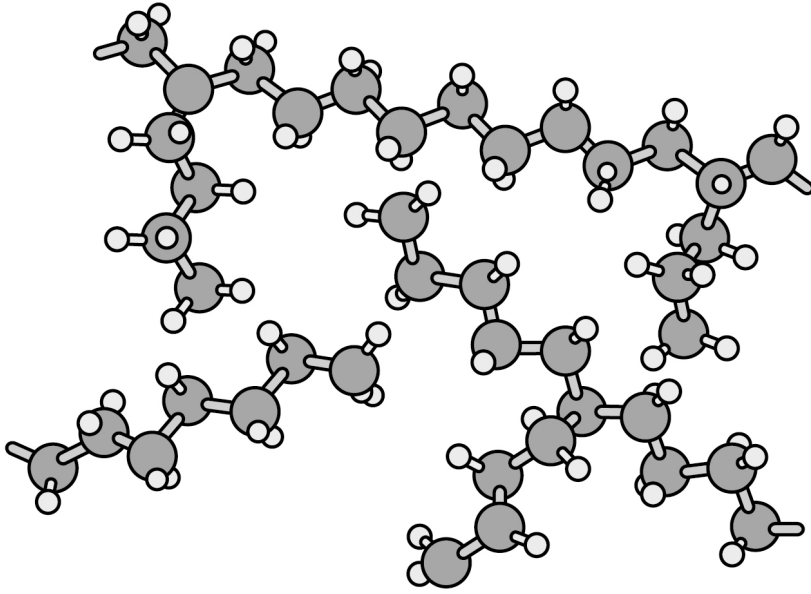**Two different forms of poly(ethene) are:**

- **high density poly(ethene) (HDPE)**

- **low density poly(ethene) (LDPE).**

**FIGURE 4, below and on the opposite page, represents part of the structures of HDPE and LDPE.**

**FIGURE 4**

**HDPE**

**LDPE**



**Explain why HDPE has a higher density than LDPE.
[2 marks]**
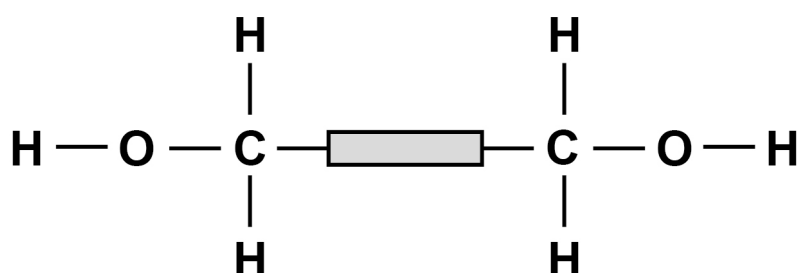
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**[Turn over]**

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

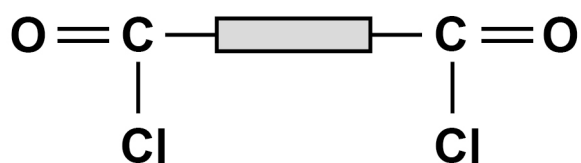Monomer A can react with monomer B and with monomer C to produce polyesters.

FIGURE 5

Monomer A

$$H-O-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\boxed{\phantom{xxxx}}-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-O-H$$

Monomer B

$$O=\overset{\displaystyle C}{\underset{\underset{\displaystyle H-O}{|}}{}}-\boxed{\phantom{xxxx}}-\overset{\displaystyle C}{\underset{\underset{\displaystyle O-H}{|}}{}}=O$$

Monomer C

$$O=\overset{\displaystyle C}{\underset{\underset{\displaystyle Cl}{|}}{}}-\boxed{\phantom{xxxx}}-\overset{\displaystyle C}{\underset{\underset{\displaystyle Cl}{|}}{}}=O$$
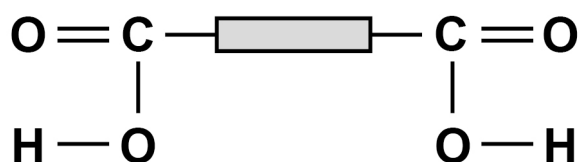
0 4 . 5

**Draw a circle on FIGURE 5, on the opposite page, 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 |  |
| A and C |  |

9

**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** _____

_____

**[Turn over]**

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]**

8

**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.**
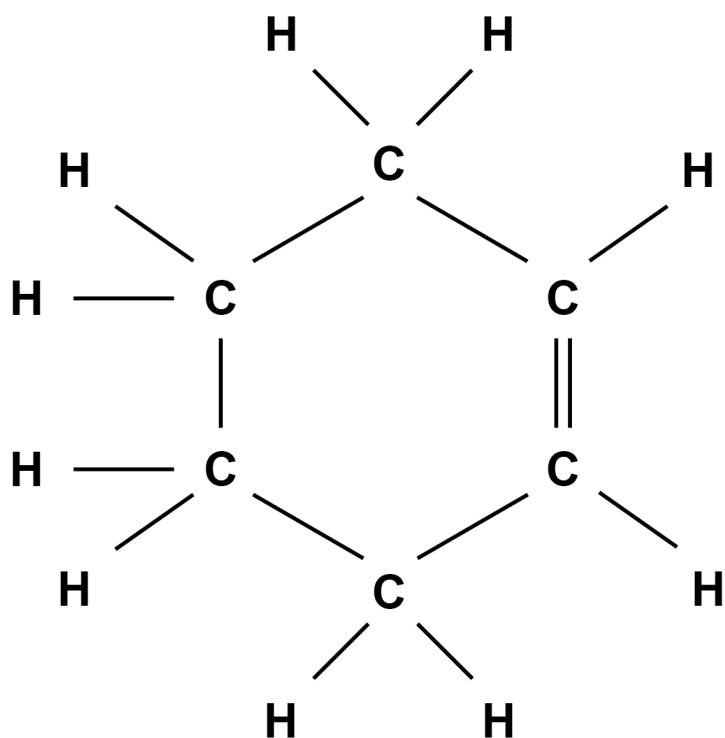**[1 mark]**

_____

_____

**General formula =** _____

**[Turn over]**

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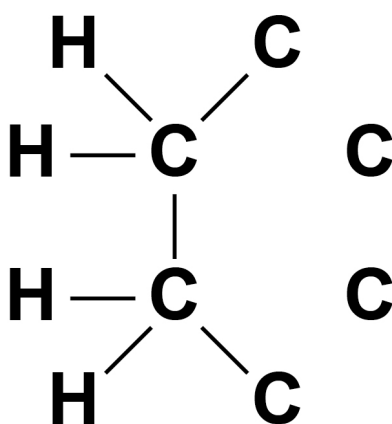
**FIGURE 6**



**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



[Turn over]

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

**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 _____

_____

_____

Result _____

_____

_____

**[Turn over]**

**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** _____

_____

_____

**[Turn over]**

**07**.**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

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**[Turn over]**

1

| 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, on the opposite page.  [1 mark]**

_____

_____

_____

| 0 | 8 | . | 2 |

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

**Use TABLE 4, on the opposite page.  [1 mark]**

_____

_____

_____

**[Turn over]**

**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** _____

_____

_____

**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]**

_____

_____

_____

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_____

_____

_____

**[Turn over]**

**0 8 . 5**

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

**Suggest TWO reasons why.  [2 marks]**

**1** _____

_____

_____

**2** _____

_____

_____

**11**

**BLANK  PAGE**

**[Turn over]**

## 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:

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

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, on the opposite page, shows the apparatus used.

**FIGURE 8**
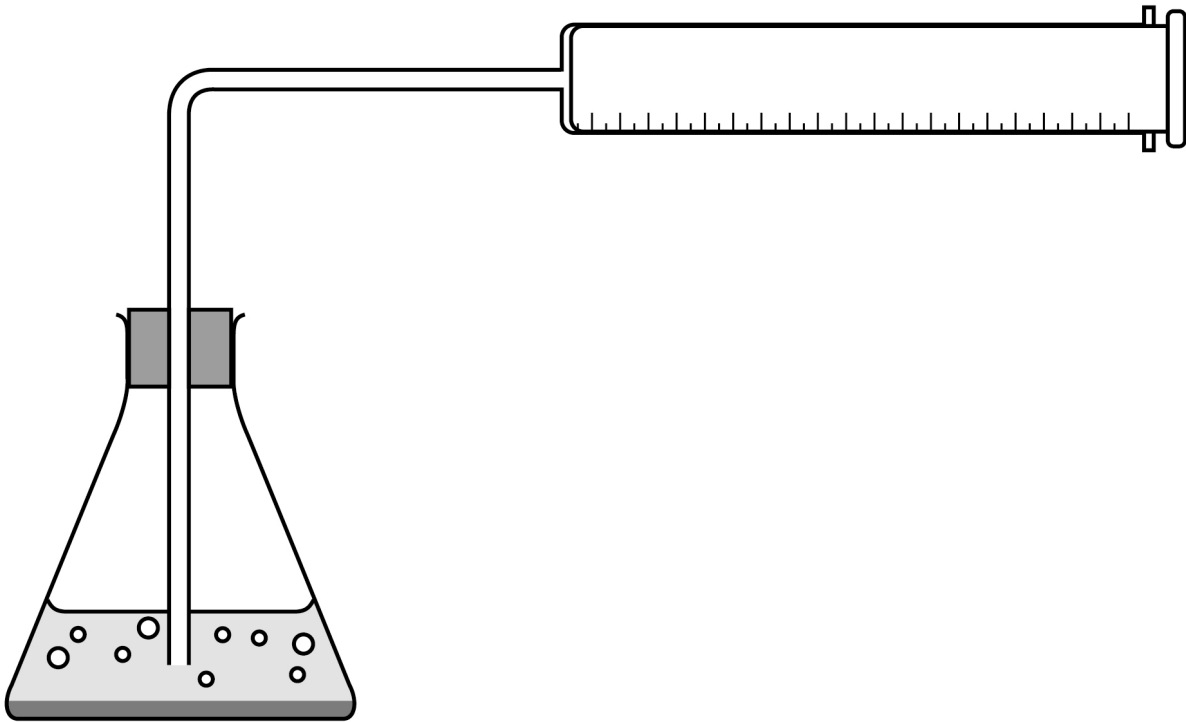


**0 9 . 1**

**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, on the opposite page, shows the student's results.

| 0 | 9 |  . | 2 |

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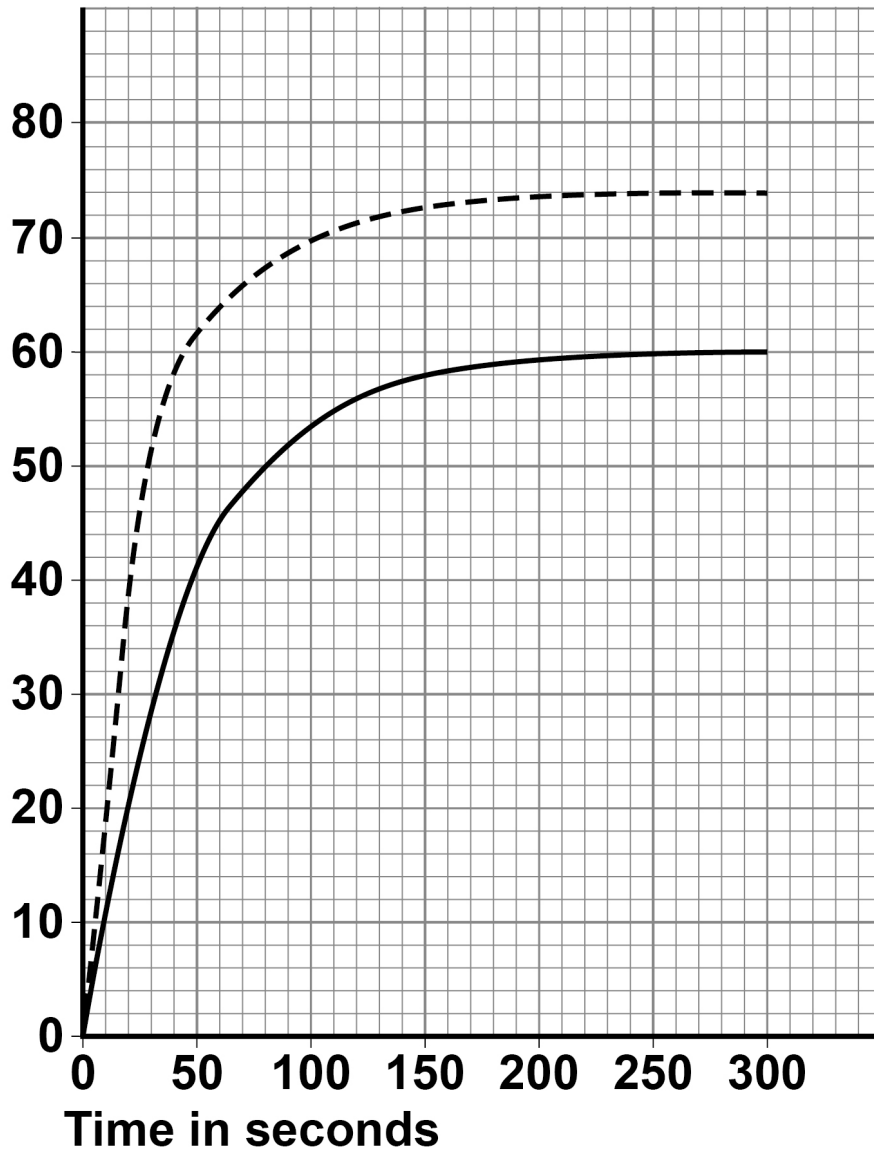
_____

_____

_____

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_____

| 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]

_____

_____

_____

# FIGURE 9
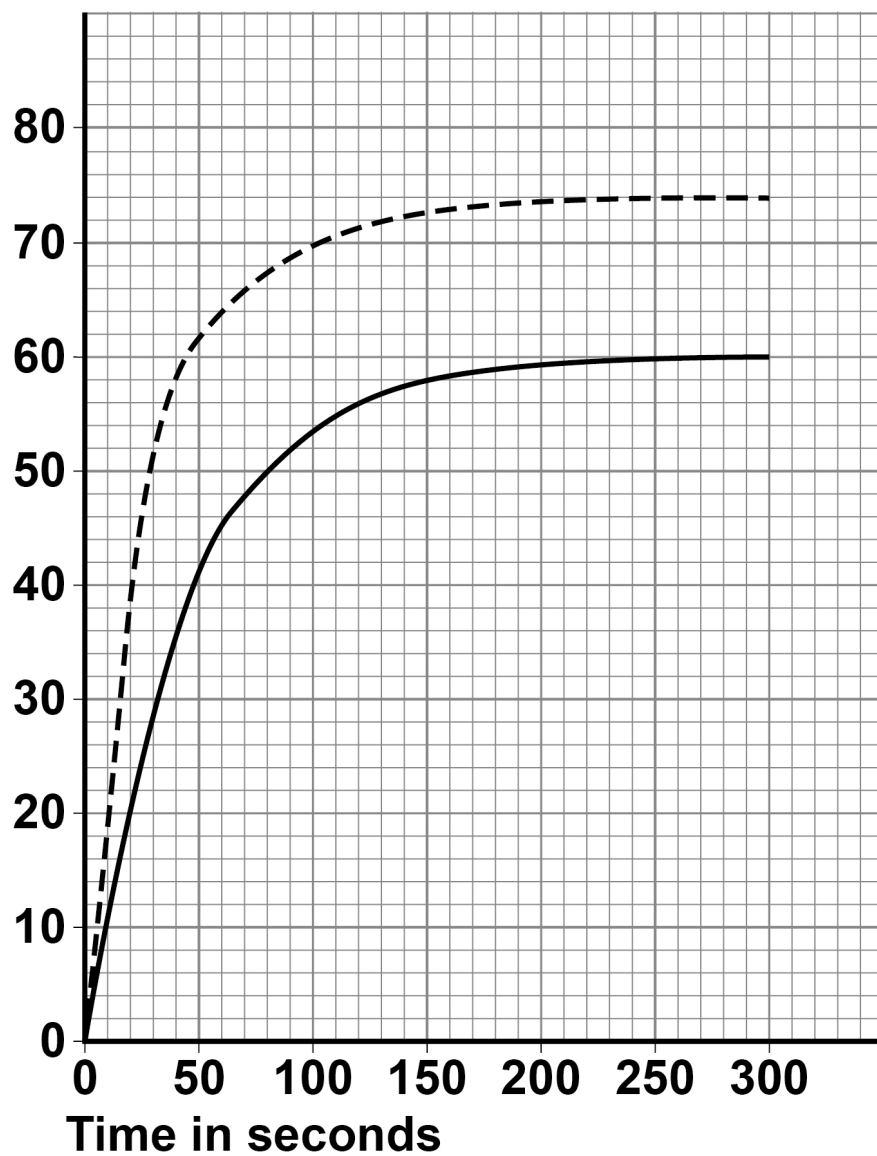


Volume of gas in cm³ vs Time in seconds

KEY

—— 0.05 mol/dm³ sulfuric acid

---- 0.10 mol/dm³ sulfuric acid

[Turn over]

**REPEAT OF FIGURE 9**

Volume
of gas
in cm$^3$



Time in seconds

KEY

——— 0.05 mol/dm$^3$ sulfuric acid

- - - - 0.10 mol/dm$^3$ sulfuric acid

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, on the opposite page.

Give your answer to 2 significant figures.  [5 marks]

_____

_____

_____

_____

_____

_____

_____

Rate of reaction (2 significant figures) =

_____ cm$^3$/s

[Turn over]

**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.**

☐ $Al^{3+}$

☐ $Ca^{2+}$

☐ $Cu^{2+}$

☐ $Na^+$

10

**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]

_____

[Turn over]

**1 0 . 2**

**Describe the conditions used to produce ethene from large hydrocarbon molecules.  [2 marks]**

_____

_____

_____

_____

_____

10 . 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]

_____

_____

_____

_____

_____

_____

_____

[Turn over]

**10.4**

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

**Name this process.  [1 mark]**

_____

**10.5**

**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]**

_____

_____

_____

_____

**[Turn over]**

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**

**17**

**Additional page, if required.**
**Write the question numbers in the left-hand margin.**

**Additional page, if required.**
**Write the question numbers in the left-hand margin.**

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