A

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE

CHEMISTRY

F

Foundation Tier Paper 2

8462/2F

Tuesday 13 June 2023 Morning

Time allowed: 1 hour 45 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

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.**
- **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 oxygen.

Scientists think that there was little or no oxygen in the Earth's early atmosphere.

0 1 . 1

Which planet today has an atmosphere that is similar to the Earth's early atmosphere? [1 mark]

Tick (✓) ONE box.

- ☐ **Jupiter**
- ☐ **Mars**
- ☐ **Neptune**
- ☐ **Saturn**

0 1 . 2

Which is the approximate percentage of oxygen in the Earth's atmosphere today? [1 mark]

Tick (✓) ONE box.

☐ **20%**

☐ **50%**

☐ **80%**

☐ **100%**

[Turn over]

0 1 . 3

Which TWO of the following increased the percentage of oxygen in the Earth's atmosphere? [2 marks]

Tick (✓) TWO boxes.

☐ **Active volcanoes emitted gases**

☐ **Algae and plants evolved**

☐ **Animals evolved**

☐ **Carbonate sediments formed in oceans**

☐ **Photosynthesis took place**

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[Turn over]

0 1 . 4

Some scientists think that 1100 million years ago the Earth's atmosphere contained:

- **16% oxygen**
- **4% carbon dioxide.**

Complete FIGURE 1, on the opposite page.

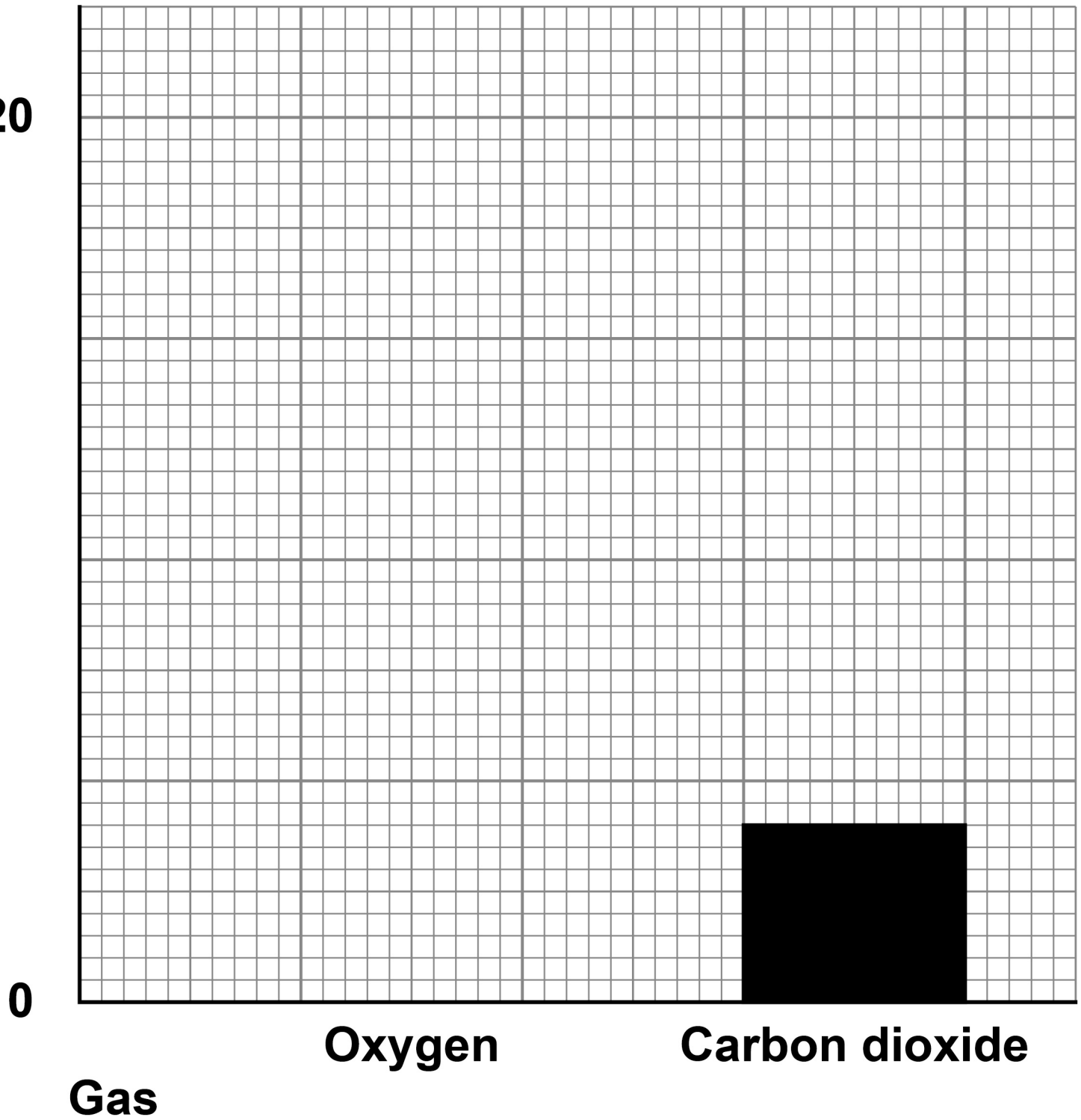
You should:

- **complete the *y*-axis scale**
- **plot the percentage of oxygen in the Earth's atmosphere 1100 million years ago.**

[2 marks]

FIGURE 1

Percentage (%) of gas in the Earth's atmosphere 1100 million years ago



Oxygen is produced when manganese dioxide is added to hydrogen peroxide solution.

The equation for the reaction is:

hydrogen peroxide $\longrightarrow$ water + oxygen

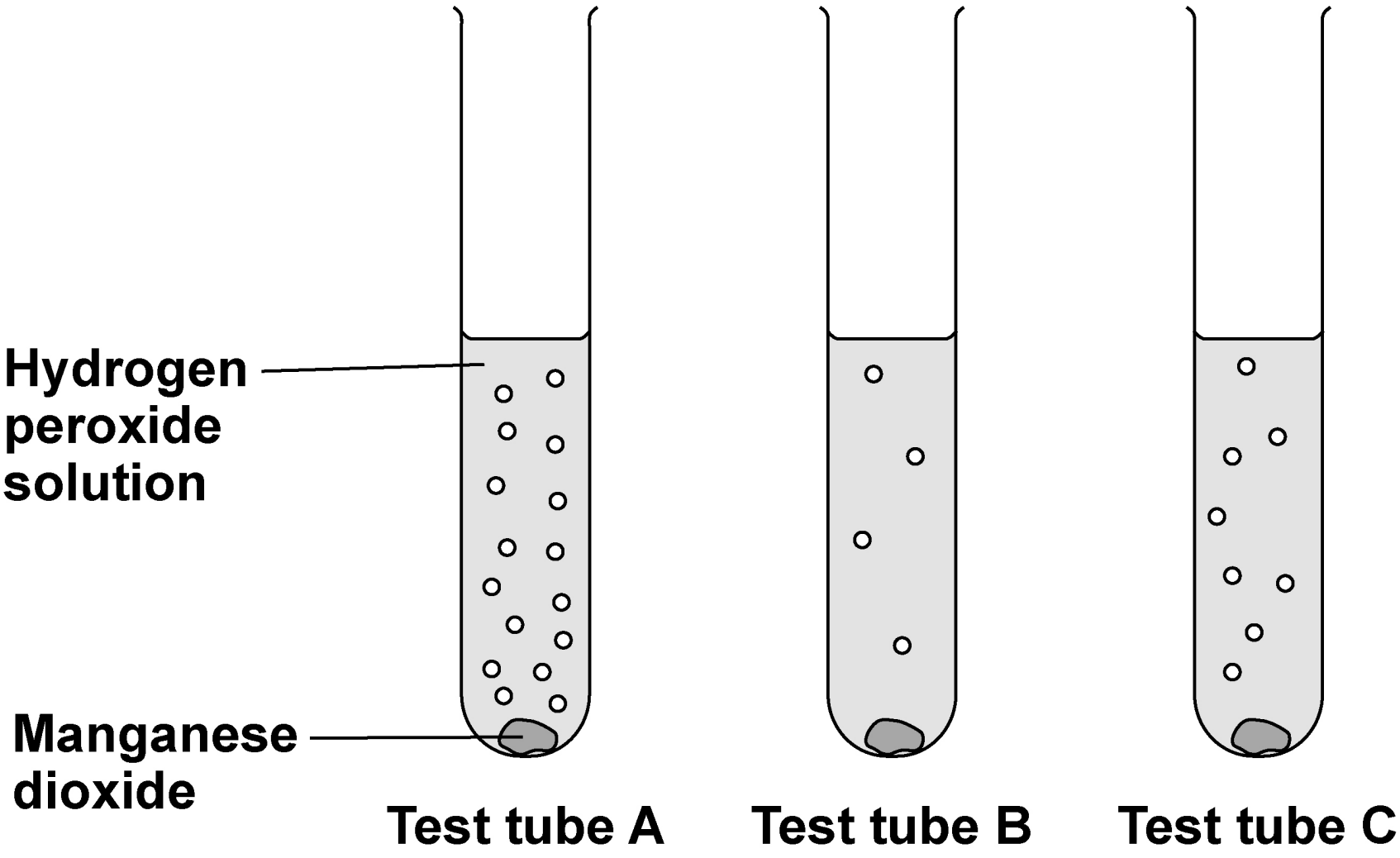
A student investigated the effect of changing the temperature on the decomposition of hydrogen peroxide.

This is the method used.

1. **Add 5 cm^3 of hydrogen peroxide solution to three test tubes labelled A, B and C.**
2. **Place each test tube in a water bath at a different temperature.**
3. **Add 0.2 g of manganese dioxide to each test tube.**

FIGURE 2, on the opposite page, shows the results.

FIGURE 2



0 1 . 5

Which test tube contained hydrogen peroxide solution at the highest temperature? [1 mark]

Tick (✓) ONE box.

☐ **Test tube A**

☐ **Test tube B**

☐ **Test tube C**

[Turn over]

0 1 . 6

The student tested the gas produced.

What is used to prove that the gas is oxygen? [1 mark]

Tick (✓) ONE box.

- ☐ **A glowing splint**
- ☐ **Bromine water**
- ☐ **Damp litmus paper**

0 1 . 7

Manganese dioxide does not appear in the chemical equation for this reaction.

Which is a correct statement about manganese dioxide in this reaction? [1 mark]

Tick (✓) ONE box.

☐ **Manganese dioxide increases the activation energy in this reaction.**

☐ **Manganese dioxide is a catalyst in this reaction.**

☐ **Manganese dioxide is used up during this reaction.**

☐ **Manganese dioxide reduces the rate of this reaction.**

0 2

This question is about glass and polymers.

Beakers can be made from borosilicate glass or poly(propene).

TABLE 1 shows information about materials used to make beakers.

TABLE 1

	Material used to make beakers	
	borosilicate glass	poly(propene)
Temperature at which melting begins in °C	850	160
Flammability	does not burn	burns
Resistance to impact	shatters	tough
Cost of 100 cm^3 beaker in £	1.50	2.00

0 2 . 1

Suggest TWO reasons why a Bunsen burner should NOT be used to heat a liquid in a poly(propene) beaker.

Use TABLE 1. [2 marks]

1 _____

_____

2 _____

_____

_____

0 2 . 2

Poly(propene) beakers are more expensive than borosilicate glass beakers.

Suggest ONE reason why using poly(propene) beakers instead of borosilicate glass beakers could save money.

Use TABLE 1, on page 14. [1 mark]

---

0 2 . 3

Which is a raw material used to make borosilicate glass?
[1 mark]

Tick (✓) ONE box.

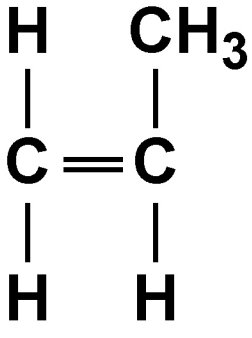
☐ **Boron trioxide**

☐ **Clay**

☐ **Limestone**

Poly(propene) is produced from propene.

The displayed structural formula of propene is:



0 2 . 4

TABLE 2 shows some information about the elements in one molecule of propene.

TABLE 2

Symbol for element	Name of element	Number of atoms of element in one molecule of propene
C		
H		

Complete TABLE 2. [2 marks]

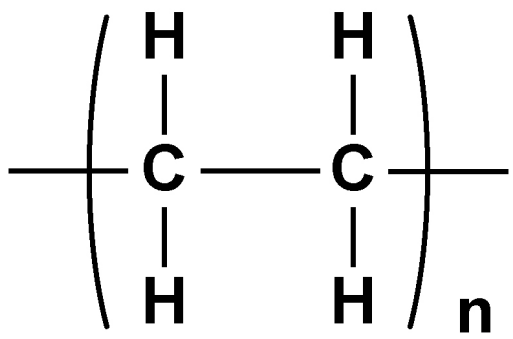
[Turn over]

0 2 . 5

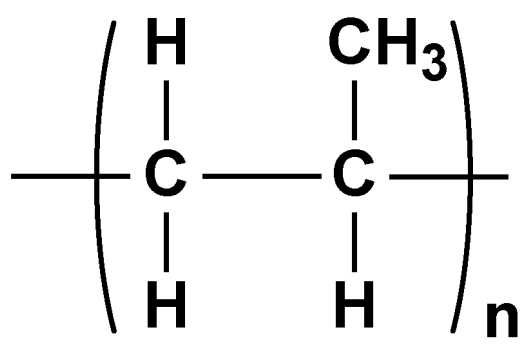
Which structure is the repeating unit of poly(propene)?
[1 mark]

Tick (✓) ONE box.

☐



☐



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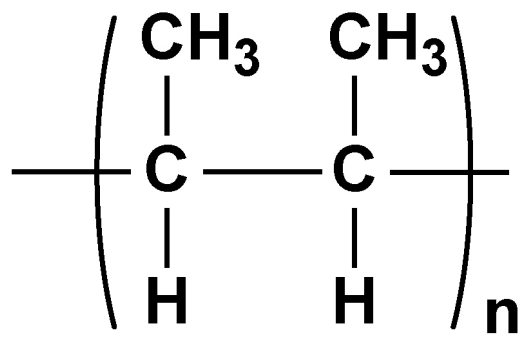

0 2 . 6

Poly(propene) is produced in three stages:

- **STAGE 1: separating large alkane molecules from crude oil**
- **STAGE 2: producing propene molecules from large alkane molecules**
- **STAGE 3: joining many propene molecules together.**

Name STAGE 1, STAGE 2 and STAGE 3.

Choose answers from the list. [3 marks]

- **cracking**
- **fermentation**
- **fractional distillation**
- **polymerisation**
- **reverse osmosis**

STAGE 1 is _____ .

STAGE 2 is _____ .

STAGE 3 is _____ .

[Turn over]

0 2 . 7

A molecule of hexene contains a double carbon–carbon bond.

Many hexene molecules join together to form poly(hexene).

Which TWO words describe a hexene molecule in this process? [2 marks]

Tick (✓) TWO boxes.

- ☐ **Alkene**
- ☐ **Catalyst**
- ☐ **Composite**
- ☐ **Element**
- ☐ **Monomer**

12

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[Turn over]

0 3

This question is about chromatography.

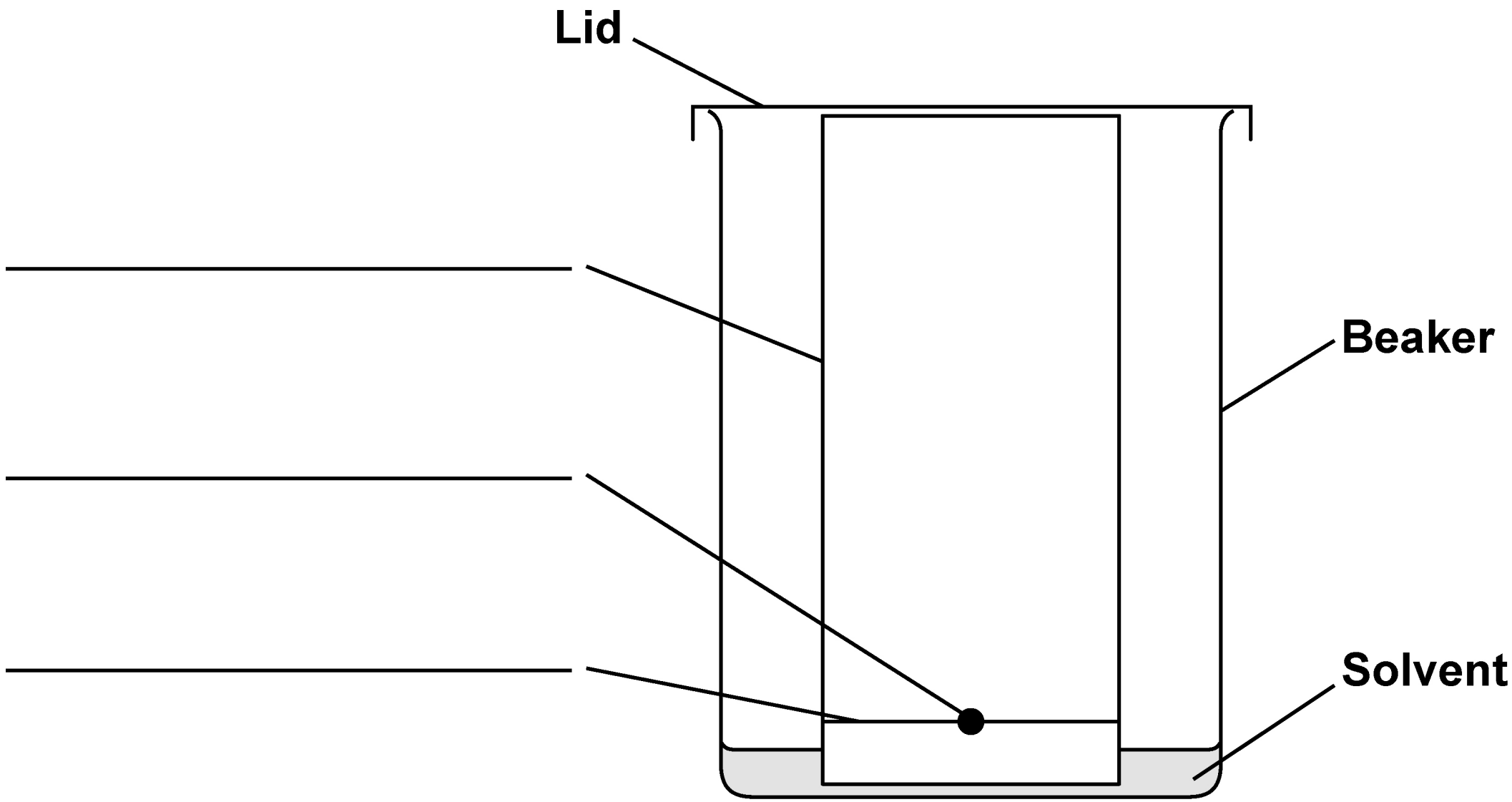
A student investigated an orange dye using paper chromatography.

0 3 . 1

FIGURE 3, on the opposite page, shows the apparatus at the start of the investigation.

Complete the labels on FIGURE 3. [3 marks]

FIGURE 3

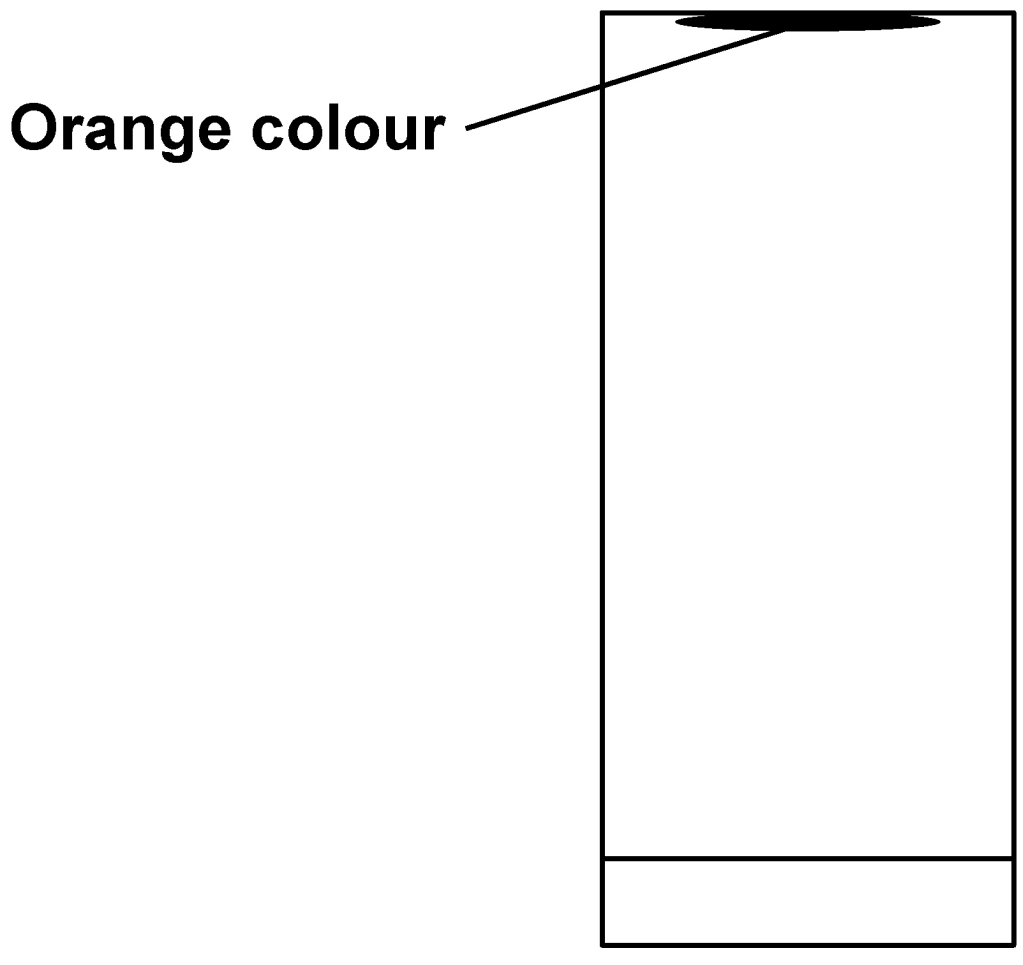


[Turn over]

0 3 . 2

FIGURE 4 shows the results at the end of the investigation.

FIGURE 4



The student made a mistake in the investigation.

What mistake did the student make to produce the results shown in FIGURE 4? [1 mark]

Tick (✓) ONE box.

☐ **Left the investigation for too long**

☐ **Used a lid on the beaker**

☐ **Used a solvent which did not dissolve the dye**

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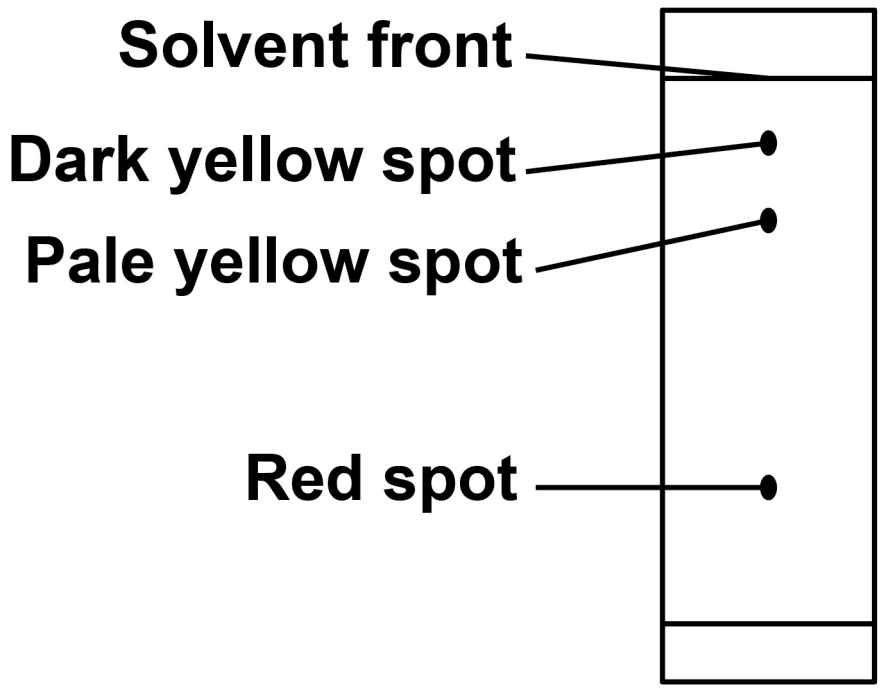
[Turn over]

A different student did the investigation correctly.

FIGURE 5 shows the results.

FIGURE 5



0 3 . 3

How do the results in FIGURE 5 show that the orange dye is NOT a pure substance? [1 mark]

0 3 . 4

Determine the R_f value for the red spot.

You should measure:

- **the distance moved by the red spot**
- **the distance moved by the solvent.**

Use FIGURE 5 and the equation:

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

[4 marks]

Distance moved by red spot _____ **cm**

Distance moved by solvent _____ **cm**

_____

_____

_____

R_f = _____

[Turn over]

BLANK PAGE

0 3 . 5

Which spot had the greatest R_f value?

Use FIGURE 5, on page 26. [1 mark]

Tick (✓) ONE box.

☐ **Dark yellow spot**

☐ **Pale yellow spot**

☐ **Red spot**

10

0 4

This question is about a reversible reaction.

A student heated calcium hydroxide to produce calcium oxide and water vapour.

This is the method used.

1. **Add 2.00 g of calcium hydroxide into a test tube.**
2. **Heat the test tube and contents for 1 minute using a Bunsen burner.**
3. **Allow the test tube and contents to cool.**
4. **Weigh the test tube and contents.**
5. **Repeat steps 2 to 4 five more times.**

0 4 . 1

TABLE 3 gives the appearance of the reactant and of the products.

TABLE 3

	COMPOUND	APPEARANCE
REACTANT	calcium hydroxide	white powder
PRODUCTS	calcium oxide	white powder
	water vapour	colourless gas

The student looked at the test tube and contents during heating.

The student could NOT tell that a chemical reaction was taking place by looking at the test tube and contents.

Give TWO reasons why.

Use the information in TABLE 3. [2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 4 . 2

Accurate results are NOT produced if solid powders escape from the test tube during heating.

Suggest why sealing the test tube with a stopper is NOT a good way of preventing the solid powders from escaping.
[1 mark]

0 4 . 3

The student wanted to calculate the mass of the contents of the test tube after each minute of heating.

The student weighed the test tube and contents after each minute of heating.

What OTHER measurement is also needed to calculate the mass of the contents of the test tube? [1 mark]

Tick (✓) ONE box.

- ☐ **The change in mass of the contents of the test tube at the end**
- ☐ **The mass of the contents of the test tube at the start**
- ☐ **The mass of the empty test tube**

The student heated 2.00 g of calcium hydroxide to produce calcium oxide and water vapour.

TABLE 4 shows the results.

TABLE 4

Total heating time in minutes	Mass of contents of test tube in grams
0	2.00
1	1.76
2	1.64
3	1.56
4	1.52
5	1.51
6	1.51

0 4 . 4

Complete the sentence.

Choose the answer from the list.

Use TABLE 4. [1 mark]

- **3 minutes**
- **4 minutes**
- **5 minutes**
- **6 minutes**

The minimum heating time needed for all of the calcium hydroxide to be changed into calcium oxide and water vapour is _____ .

[Turn over]

REPEAT OF TABLE 4

Total heating time in minutes	Mass of contents of test tube in grams
0	2.00
1	1.76
2	1.64
3	1.56
4	1.52
5	1.51
6	1.51

0 4 . 5

Calculate the total mass of water vapour produced by heating the calcium hydroxide.

Use TABLE 4. [2 marks]

Mass = _____ g

[Turn over]

The word equation for the reaction is:

calcium hydroxide ⇌ calcium oxide + water

The reaction is reversible.

When 4.00 g of calcium hydroxide is completely changed into calcium oxide and water:

- **3.03 g of calcium oxide is produced**
- **5.90 kJ of energy is taken in from the surroundings.**

0 4 . 6

3.03 g of calcium oxide reacts completely with water to produce 4.00 g of calcium hydroxide.

How much energy is transferred to the surroundings in this reaction? [1 mark]

Tick (✓) ONE box.

☐ **Less than 5.90 kJ**

☐ **5.90 kJ**

☐ **More than 5.90 kJ**

0 4 . 7

The forward reaction takes in energy from the surroundings.

Complete the sentence.

Choose the answer from the list. [1 mark]

- **combustion**
- **endothermic**
- **exothermic**

The forward reaction is _____ .

[Turn over]

9

0 5

This question is about greenhouse gases and climate change.

0 5 . 1

Which TWO gases are greenhouse gases? [2 marks]

Tick (✓) TWO boxes.

- ☐ **Argon**
- ☐ **Carbon dioxide**
- ☐ **Nitrogen**
- ☐ **Methane**
- ☐ **Oxygen**

0 5 . 2

Why are greenhouse gases essential for supporting life on Earth? [1 mark]

_____

_____

_____

The percentage of greenhouse gases in the Earth's atmosphere today is increasing.

Many scientists think that this increase is causing global climate change.

0 5 . 3

What is a cause of the greenhouse effect?

Complete the sentence. [1 mark]

Greenhouse gases absorb long wavelength

_____ .

[Turn over]

0 5 . 4

Which TWO are potential effects of global climate change?
[2 marks]

Tick (✓) TWO boxes.

- ☐ **Fewer droughts**
- ☐ **Fewer storms**
- ☐ **Higher sea levels**
- ☐ **Less coastal flooding**
- ☐ **Melting polar ice**

0 5 . 5

Water vapour is a greenhouse gas.

The percentage by mass of water vapour in the Earth's atmosphere is 0.25%.

Calculate the mass of water vapour in 350 kg of the Earth's atmosphere.

Give your answer in grams. [3 marks]

Mass = _____ g

[Turn over]

9

0 6

This question is about fuels.

The energy produced by burning fuels is used to generate electricity in power stations.

TABLE 5 shows information about three fuels used to generate electricity.

TABLE 5

	FUEL		
	COAL	**OIL**	**NATURAL GAS**
State of fuel at room temperature	**solid**	**liquid**	**gas**
Transportation of fuel to power station	**train**	**pipeline**	**pipeline**
Percentage by mass of sulfur in fuel (%)	**5**	**1**	**0.001**
Relative quantity of solid particles produced when fuel is burned	**high**	**medium**	**low**

0 6 . 1

Explain why coal is usually transported to power stations by train and NOT by pipeline.

Use TABLE 5. [2 marks]

Sulfur dioxide and particulates are atmospheric pollutants produced when fuels are burned.

0 6 . 2

1 kg of each fuel in TABLE 5, on page 44, is burned.

Which fuel produces the MOST sulfur dioxide?

Give ONE reason for your choice. [2 marks]

Fuel _____

Reason _____

_____

_____

0 6 . 3

Give ONE problem caused by sulfur dioxide. [1 mark]

_____

_____

_____

0 6 . 4

Particulates are formed from solid particles.

1 kg of each fuel in TABLE 5, on page 44, is burned.

Which fuel produces the LEAST particulates?

Give ONE reason for your choice. [2 marks]

Fuel _____

Reason _____

_____

_____

[Turn over]

0 6 . 5

Give ONE problem caused by particulates. [1 mark]

_____

_____

_____

0 6 . 6

Complete the sentence. [1 mark]

Solid particles are formed when fuels undergo incomplete

_____ .

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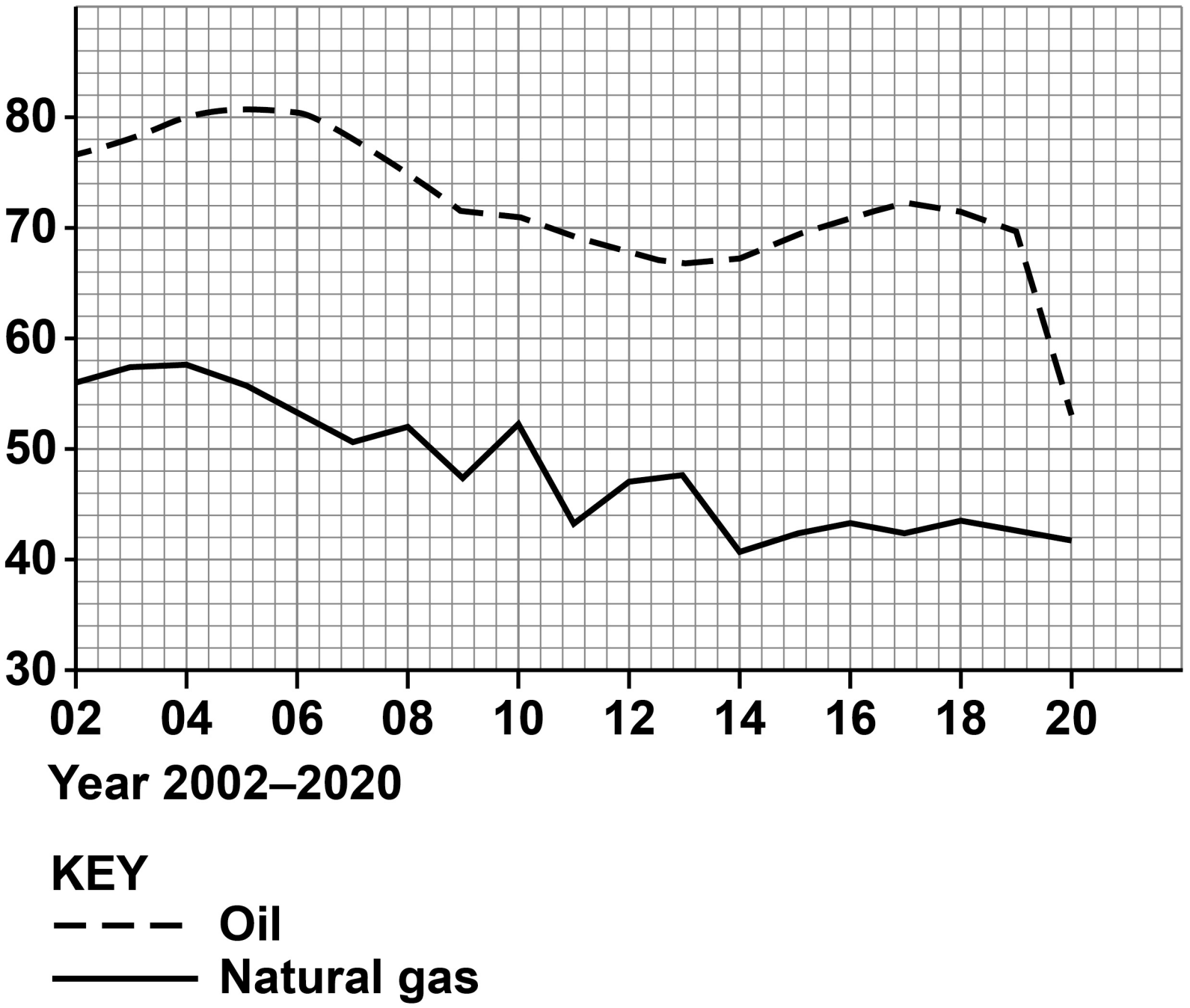
[Turn over]

0 6 . 7

FIGURE 6 shows how the use of oil and of natural gas as fuels changed in the UK between 2002 and 2020.

FIGURE 6



Describe the trends shown in FIGURE 6. [3 marks]

0 7

This question is about alloys.

Steels are alloys of iron.

0 7 . 1

Which non-metal element is in all steels? [1 mark]

Tick (✓) ONE box.

- ☐ **Carbon**
- ☐ **Iodine**
- ☐ **Sulfur**

0 7 . 2

Which TWO elements other than iron are in stainless steels?
[2 marks]

Tick (✓) TWO boxes.

☐ **Chromium**

☐ **Gold**

☐ **Magnesium**

☐ **Nickel**

☐ **Zinc**

[Turn over]

0 7 . 3

Give TWO properties of stainless steels.

Choose answers from the list. [2 marks]

- **brittle**
- **hard**
- **low density**
- **resistant to corrosion**
- **soluble in water**

Property 1 _____

Property 2 _____

BLANK PAGE

[Turn over]

Titanium is used in alloys.

TABLE 6 shows information about some alloys of titanium.

TABLE 6

TITANIUM ALLOY	OTHER METALS IN ALLOY	STRENGTH	USED IN
A	6.0% aluminium 4.0% vanadium	high	aircraft parts hip joint replacements
B	5.0% aluminium 2.5% tin	high	aircraft parts
C	3.0% aluminium 2.5% vanadium	medium	tennis rackets heart pacemakers

0 7 . 4

Calculate the mass of titanium in 5.0 kg of titanium alloy C.

Use TABLE 6. [3 marks]

Mass = _____ kg

[Turn over]

REPEAT OF TABLE 6

TITANIUM ALLOY	OTHER METALS IN ALLOY	STRENGTH	USED IN
A	6.0% aluminium 4.0% vanadium	high	aircraft parts hip joint replacements
B	5.0% aluminium 2.5% tin	high	aircraft parts
C	3.0% aluminium 2.5% vanadium	medium	tennis rackets heart pacemakers

0 7 . 5

Suggest why alloy A and alloy B are used to make aircraft parts.

Use TABLE 6. [1 mark]

0 7 . 6

Titanium alloys used for medical purposes must NOT be toxic.

Suggest why alloy B is NOT used for medical purposes.

Use TABLE 6. [1 mark]

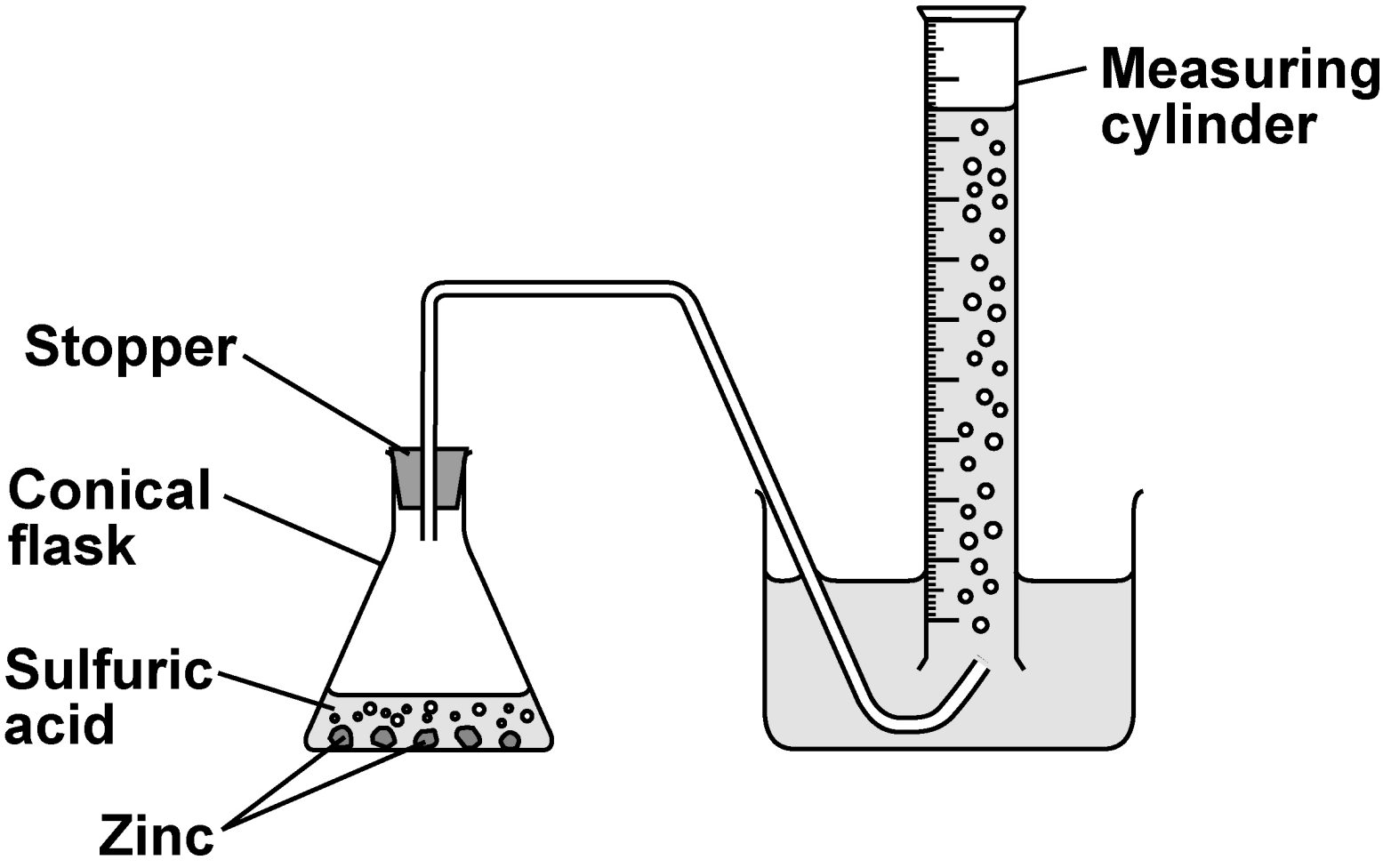
0 8

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

Hydrogen gas is produced during this reaction.

FIGURE 7 shows the apparatus.

FIGURE 7



This is the method used.

1. **Add 50 cm^3 of sulfuric acid to a conical flask.**
2. **Add 2.0 g of zinc to the conical flask.**
3. **Quickly put a stopper in the conical flask and start a timer.**
4. **Measure the time taken to collect 20 cm^3 of gas.**
5. **Repeat steps 1 to 4 three more times.**

0 8 . 1

Suggest why the stopper must be put in the conical flask as quickly as possible in STEP 3. [1 mark]

0 8 . 2

The student calculated the rate of the reaction for each trial.

TABLE 7 shows the results of the calculations.

TABLE 7

	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4
Rate of reaction in cm^3/s	0.78	0.81	0.68	0.81

Determine the mean time taken to collect 20 cm^3 of gas.

Do NOT include any anomalous results.

Use the equation:

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

[5 marks]

Mean time taken = _____ s

[Turn over]

0 8 . 3

The student changed the investigation so that the mean time taken to collect 20 cm^3 of gas was greater.

Which TWO changes would increase the mean time taken to collect 20 cm^3 of gas? [2 marks]

Tick (✓) TWO boxes.

- ☐ **Use a catalyst**
- ☐ **Use a larger conical flask**
- ☐ **Use a lower temperature**
- ☐ **Use smaller pieces of zinc**
- ☐ **Use sulfuric acid of a lower concentration**

0 8 . 4

Hydrogen gas is produced during this reaction.

Describe the test for hydrogen gas.

Give the result of the test. [2 marks]

Test _____

_____

_____

Result _____

_____

_____

10

0 9

This question is about alcohols and carboxylic acids.

Alcohols are used as fuels.

A student burned 1.00 g of six alcohols and determined the energy released from each.

TABLE 8 shows the results.

TABLE 8

Alcohol	Formula of one molecule of the alcohol	Energy released in kJ/g
Ethanol	C_2H_5OH	29.6
Propanol	C_3H_7OH	33.6
Butanol	C_4H_9OH	36.1
Pentanol	$C_5H_{11}OH$	37.7
Hexanol	$C_6H_{13}OH$	38.9
Heptanol	$C_7H_{15}OH$	39.8

0 9 . 1

Calculate the mass of ethanol that must be burned to release the same amount of energy as burning 1.00 g of heptanol.
[2 marks]

Mass = _____ g

[Turn over]

REPEAT OF TABLE 8

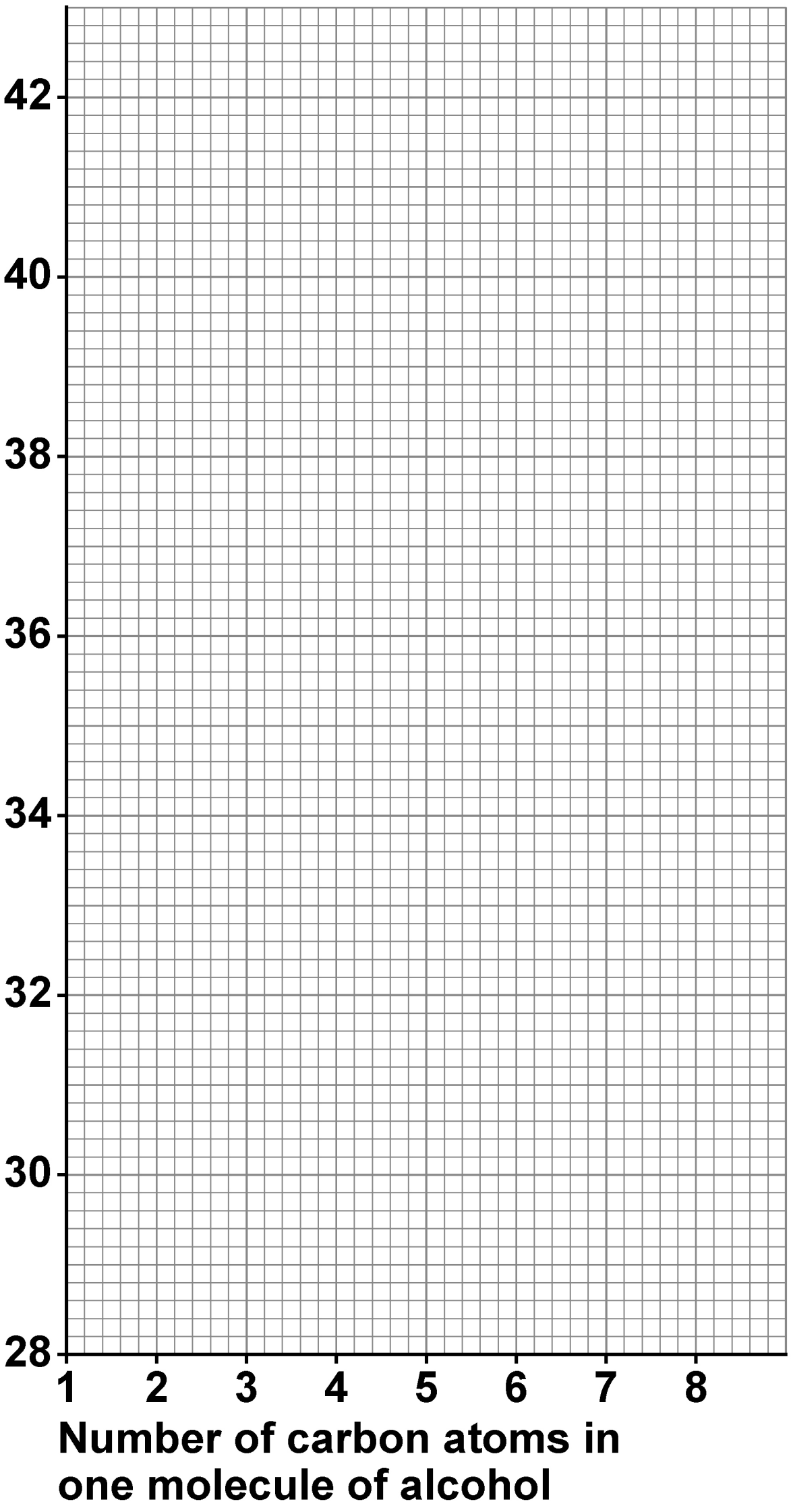
Alcohol	Formula of one molecule of the alcohol	Energy released in kJ/g
Ethanol	C_2H_5OH	29.6
Propanol	C_3H_7OH	33.6
Butanol	C_4H_9OH	36.1
Pentanol	$C_5H_{11}OH$	37.7
Hexanol	$C_6H_{13}OH$	38.9
Heptanol	$C_7H_{15}OH$	39.8

0 9 . 2

The energy released in kJ/g varies with the number of carbon atoms in one molecule of each alcohol.

Plot the data from TABLE 8 on FIGURE 8, on the opposite page. [2 marks]

FIGURE 8



[Turn over]

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0 9 . 3

Estimate the energy released in kJ when 1.00 g of octanol ($C_8H_{17}OH$) is burned.

Use FIGURE 8, on page 69. [1 mark]

Energy released = _____ kJ

[Turn over]

Carbon dioxide is produced when alcohols are burned.

Carbon dioxide is identified by bubbling the gas through limewater.

0 9 . 4

Complete the sentence.

Choose the answer from the list. [1 mark]

- **calcium chloride**
- **calcium hydroxide**
- **calcium nitrate**
- **calcium sulfate**

Limewater is an aqueous solution of

_____ .

0 9 . 5

Give the result of the test when carbon dioxide is bubbled through limewater. [1 mark]

Ethanoic acid can be produced from ethanol.

0 9 . 6

What is reacted with ethanol to produce ethanoic acid?
[1 mark]

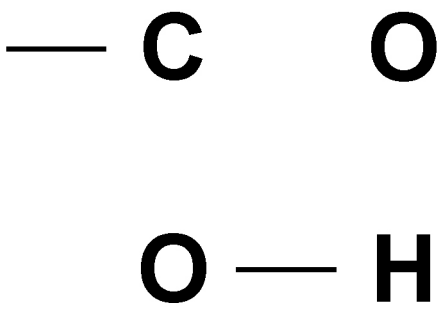
Tick (✓) ONE box.

- ☐ **A halogen**
- ☐ **An alkali metal**
- ☐ **An oxidising agent**
- ☐ **Water**

0 9 . 7

Ethanoic acid contains the functional group –COOH

Complete the displayed structural formula of this functional group. [1 mark]



0 9 . 8

Ethanoic acid reacts with different compounds.

Draw ONE line from each compound to a product of the reaction of the compound with ethanoic acid. [2 marks]

Compound	Product of the reaction with ethanoic acid
	Carbon dioxide
Ethanol	Ethene
	Ethyl ethanoate
Sodium carbonate	Hydrogen
	Poly(ethene)

11

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[Turn over]

1 0

This question is about chemical analysis.

Potassium bromide is used in medicine.

A scientist tested a sample of medicine to show the presence of potassium ions and of bromide ions.

The sample is soluble in water.

1 0 . 1

Plan a method the scientist could use to show that the sample of medicine contains potassium ions AND bromide ions.

The scientist has:

- **a Bunsen burner**
- **a metal wire**
- **test tubes**
- **a dropping pipette**
- **distilled water**
- **dilute nitric acid**
- **silver nitrate solution.**

You should give the results of the tests. [6 marks]

The scientist could also use an instrumental method to show the presence of potassium ions in the medicine.

1 0 . 2

Which instrumental method could be used to show the presence of potassium ions in the medicine? [1 mark]

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1 0 . 3

Give ONE advantage of using this instrumental method instead of a chemical test. [1 mark]

END OF QUESTIONS

8

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

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For Examiner's Use	
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