Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
CHEMISTRY

F

Foundation Tier Paper 2

Tuesday 13 June 2023 Morning 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	
TOTAL	

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

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% ☐

Question 1 continues on the next page

Do not write outside the box

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	✓

Do not write outside the box

0 1 . 4 Some scientists think that 1100 million years ago the Earth's atmosphere contained:

- 16% oxygen
- 4% carbon dioxide.

Complete **Figure 1**.

You should:

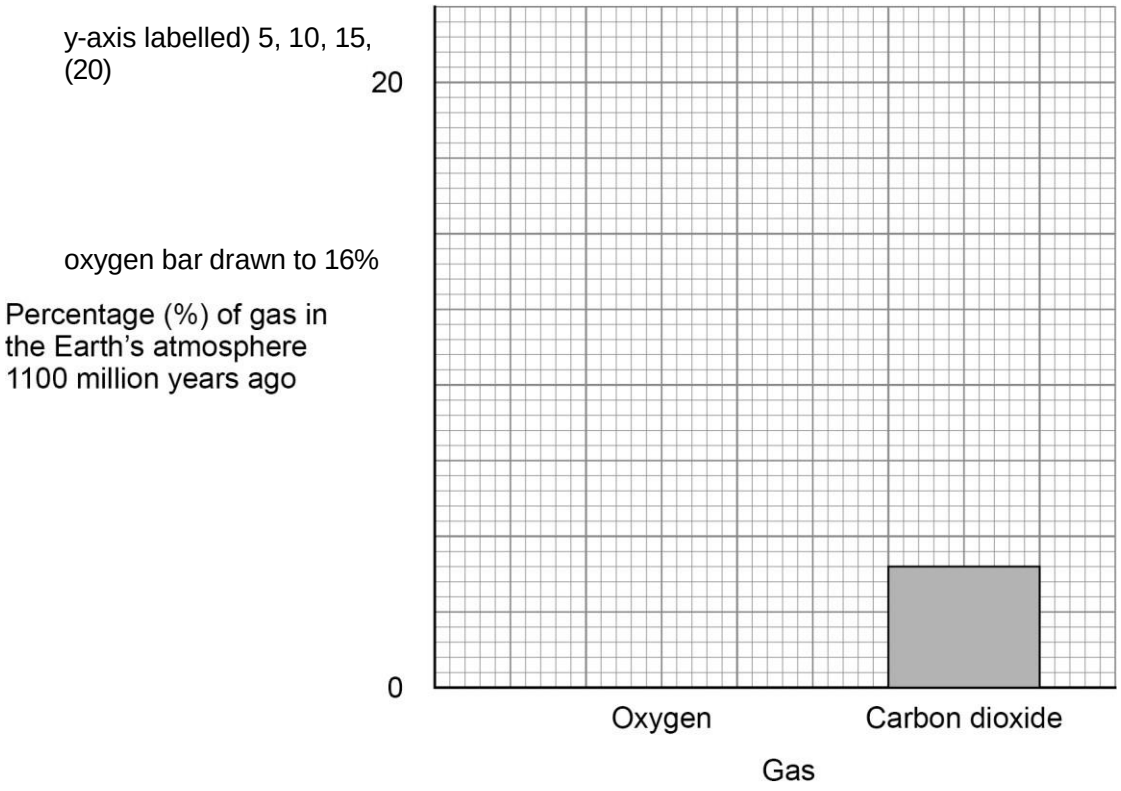
- complete the *y*-axis scale
- plot the percentage of oxygen in the Earth's atmosphere 1100 million years ago.

[2 marks]

Figure 1

y-axis labelled) 5, 10, 15, (20)

oxygen bar drawn to 16%



Question 1 continues on the next page

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

The equation for the reaction is:

hydrogen peroxide → water + oxygen

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

This is the method used.

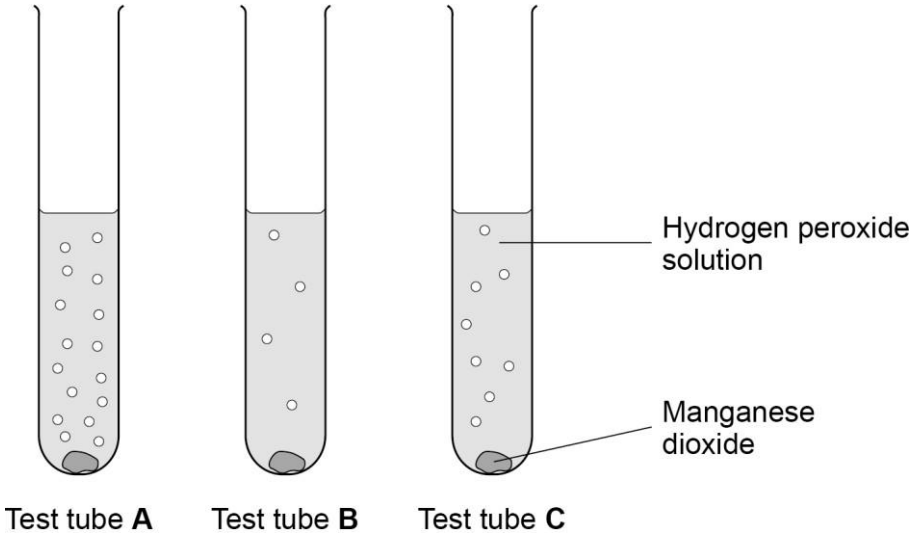
1. Add 5 cm^3 of hydrogen peroxide solution to three test tubes labelled **A**, **B** and **C**.

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 shows the results.

Figure 2



Do not write outside the box

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** ☐

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. ☐

9

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

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 cm³ 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 the poly(propene) beaker will begin to) melt

2 (the poly(propene) beaker will) burn / ignite

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**.

[1 mark]

(poly(propene) beakers are) less easily broken

Turn over ►

Do not write outside the box

0 2 . 3 Which is a raw material used to make borosilicate glass?

[1 mark]

Tick (✓) **one** box.

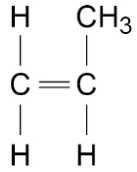
Boron trioxide ☑

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	Carbon	3
H	Hydrogen	6

Complete **Table 2**.

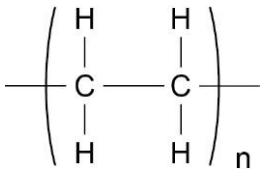
[2 marks]

Do not write outside the box

0 2 . 5 Which structure is the repeating unit of poly(propene)?

[1 mark]

Tick (✓) **one** box.



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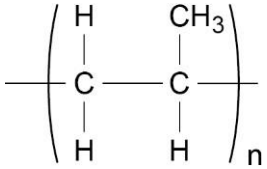

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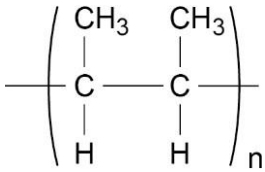

☐

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 box.

[3 marks]

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

Stage 1 is Fractional Distillation .

Stage 2 is Cracking .

Stage 3 is Polymerisation .

Do not write outside the box

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

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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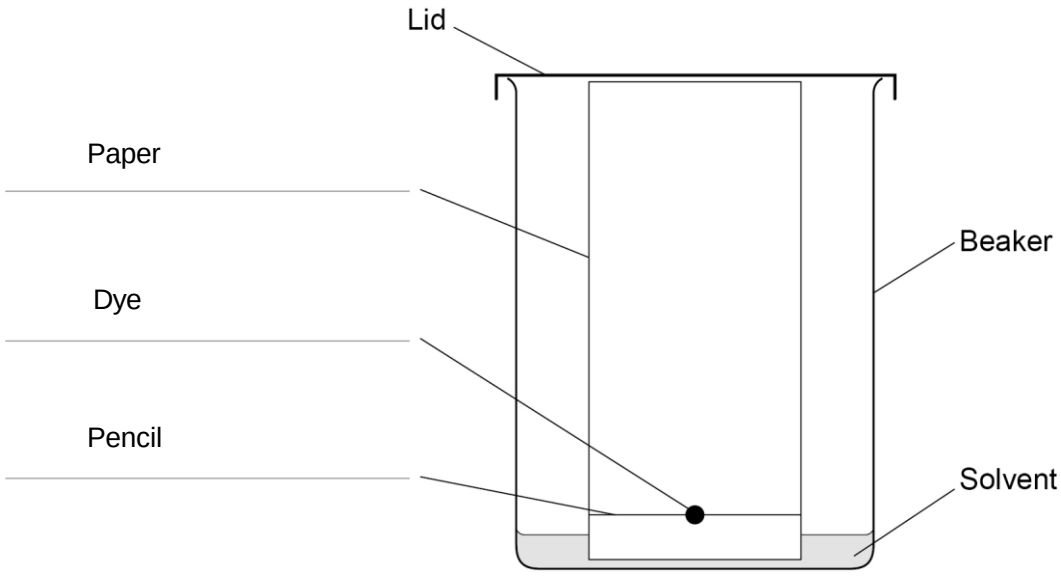
0 3 This question is about chromatography.

A student investigated an orange dye using paper chromatography.

0 3 . 1 **Figure 3** shows the apparatus at the start of the investigation.

Figure 3



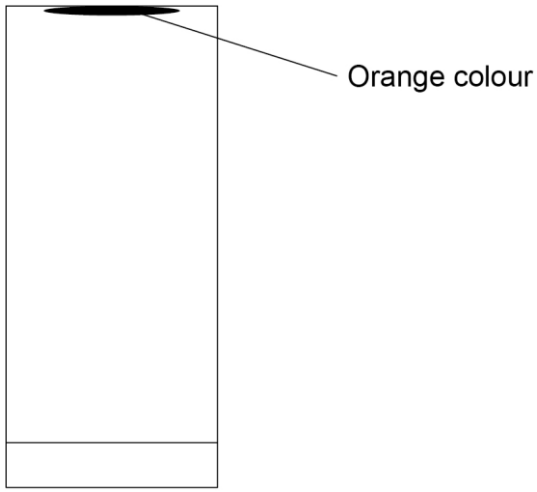
Complete the labels on **Figure 3**.

[3 marks]

Do not write outside the box

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 ☐

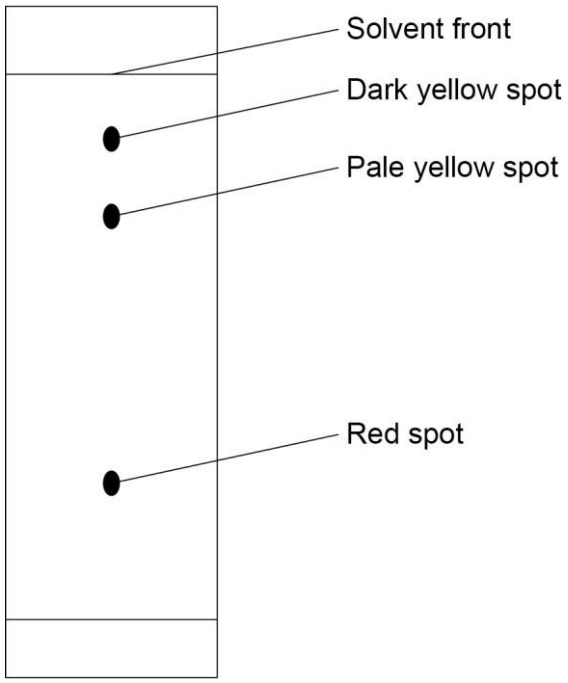
Question 3 continues on the next page

Do not write outside the box

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]

more than one spot

Do not write outside the box

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 1.8 (cm) cm

Distance moved by solvent 7.2 (cm) cm

R_f = 0.25

0 3 . 5 Which spot had the greatest R_f value?

Use **Figure 5**.

[1 mark]

Tick (✓) **one** box.

Dark yellow spot ✓

Pale yellow spot

Red spot

10

Turn over for the next question

Do not write outside the box

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 water (vapour) is colourless

2 (calcium hydroxide and calcium oxide are) both white (powders / solids)

Do not write outside the box

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]

the stopper would be pushed out

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	✓

Question 4 continues on the next page

Do not write outside the box

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 box.

Use **Table 4**.

[1 mark]

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

0 4 . 5 The minimum heating time needed for all of the calcium hydroxide to be changed into calcium oxide and water vapour is 5 Minu .

the calcium hydroxide.

[2 marks]

= _____ g

Do not write outside the box

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 box.

[1 mark]

combustion	**endothermic**	**exothermic**

The forward reaction is Endothermic .

9

Do not write outside the box

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]

(greenhouse gases) maintain temperatures on Earth (high enough to support life)

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 radiation .

Do not write outside the box

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 =) $\frac{0.25}{100} \times 350$

= 0.875 (kg)

= 875 (g)

Mass = _____ g

9

Do not write outside the box

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]

coal is a solid

(so solid) coal cannot flow through pipelines

Do not write outside the box

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

0 6 . 2 1 kg of each fuel in **Table 5** is burned.

Which fuel produces the **most** sulfur dioxide?

Give **one** reason for your choice.

[2 marks]

Fuel Coal

Reason Highest percentage of sulphur

0 6 . 3 Give **one** problem caused by sulfur dioxide.

[1 mark]

acid rain

0 6 . 4 Particulates are formed from solid particles.

1 kg of each fuel in **Table 5** is burned.

Which fuel produces the **least** particulates?

Give **one** reason for your choice.

[2 marks]

Fuel Gas

Reason Fewest solid particles

0 6 . 5 Give **one** problem caused by particulates.

[1 mark]

global dimming

Do not write outside the box

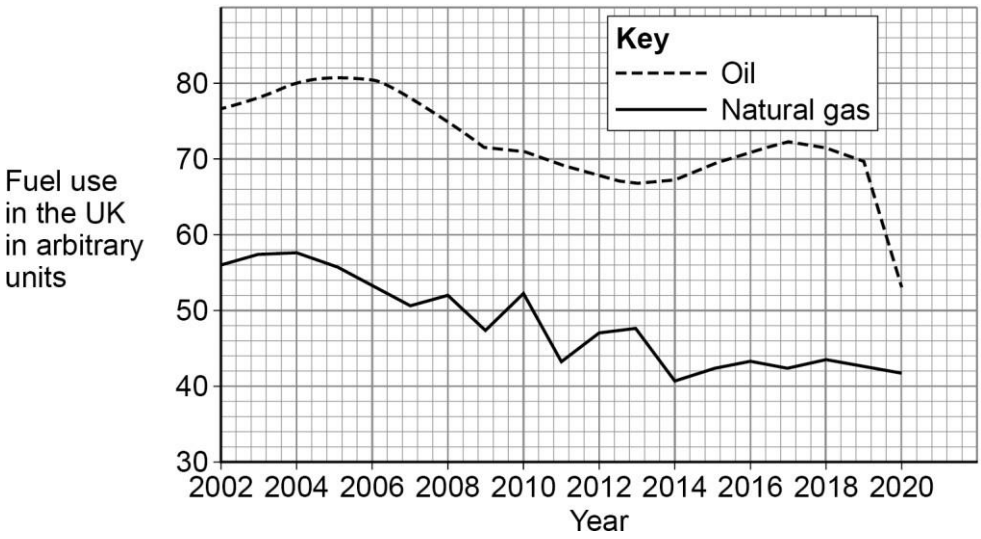
0 6 . 6 Complete the sentence.

[1 mark]

Solid particles are formed when fuels undergo incomplete Combustion .

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]

• more oil is used than gas

• use of oil has decreased overall

• use of oil increased in some years

12

Do not write outside the box

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 ☐

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 Give **two** properties of stainless steels.

Choose answers from the box.

[2 marks]

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

Property 1 Hard

Property 2 Resistant to corrosion

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]

(percentage of titanium = 100 – 3.0 – 2.5) = 94.5 (%)

(mass =) 94.5 / 100 × 5.0

= 4.725 (kg)

Mass = _____ kg

Do not write outside the box

0 7 . 5 Suggest why alloy **A** and alloy **B** are used to make aircraft parts.

Use **Table 6**.

[1 mark]

(both are) strong

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]

tin is toxic

10

Turn over for the next question

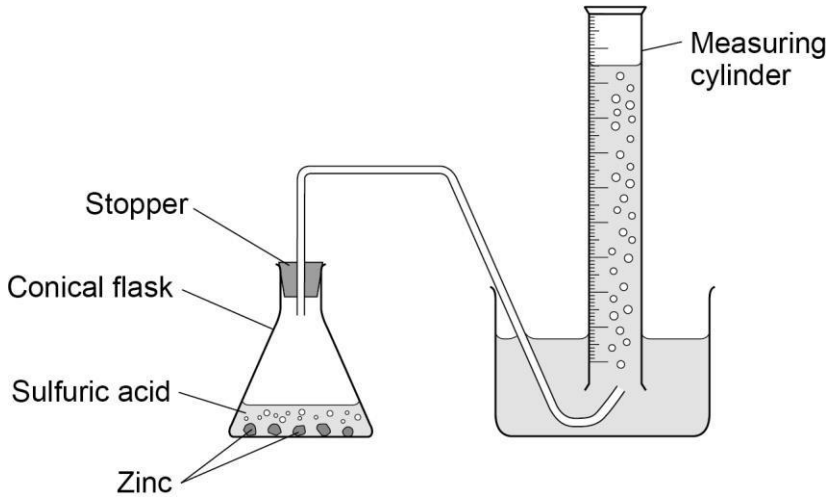
Do not write outside the box

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]

to reduce the escape of gas

Do not write outside the box

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 rate =)
$\frac{0.78 + 0.81 + 0.81}{3}$

0.80 (cm^3/s)

$\frac{0.80}{} = \frac{20}{\text{mean time taken}}$

(mean time taken =) $\frac{20}{0.80}$

= 25 (s)

Mean time taken = 25 (s)

s

Question 8 continues on the next page

Do not write outside the box

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 burning / lit splint

Result burns with a (squeaky) pop sound

10

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

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 =) 39.8 / 29.6 (×1)

= 1.34 (g)

Mass = _____ g

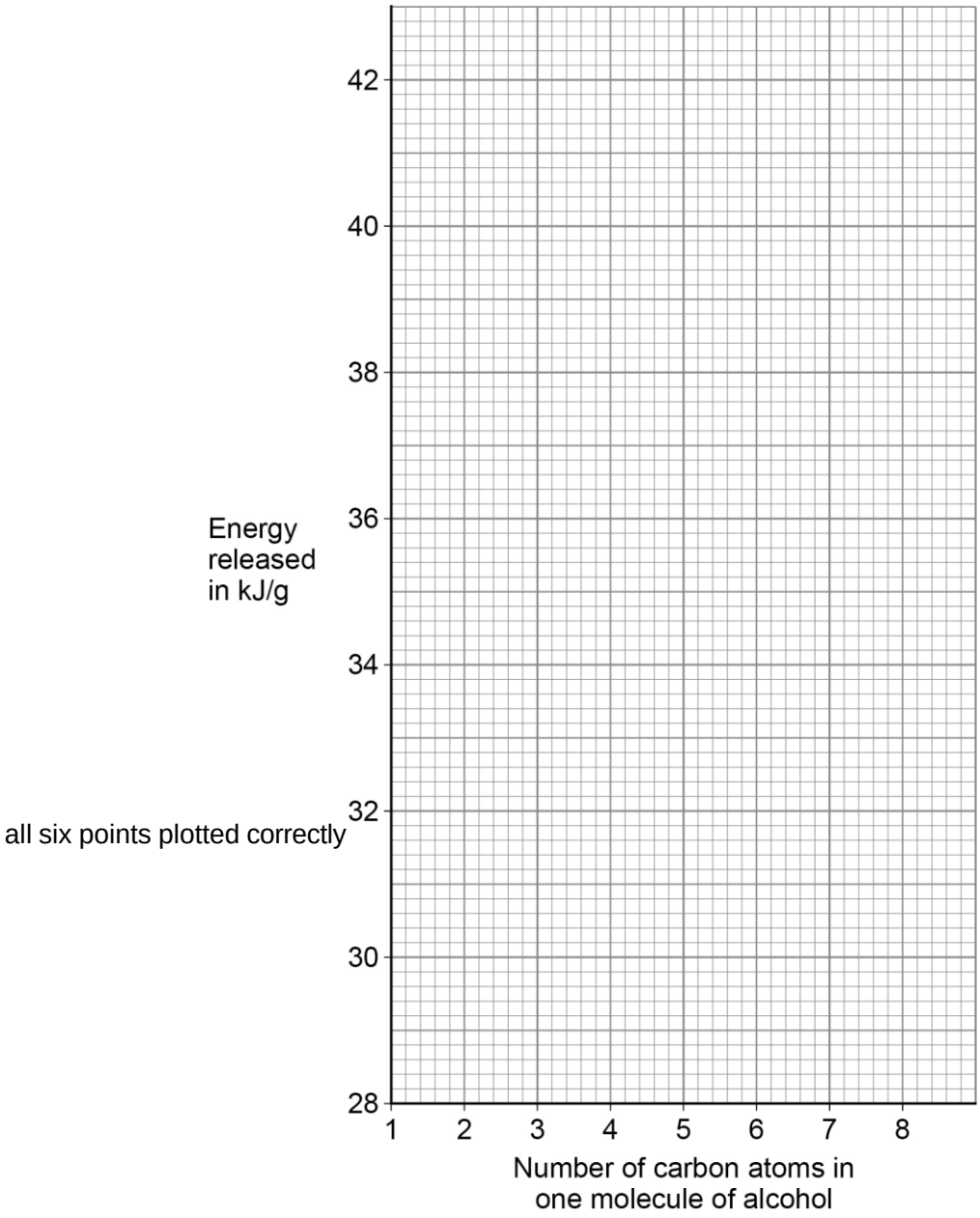
0 9 . 2 The energy released in kJ/g varies with the number of carbon atoms in one molecule of each alcohol.

Plot the data from **Table 8** on **Figure 8**.

[2 marks]

Do not write outside the box

Figure 8



all six points plotted correctly

0 9 . 3 Estimate the energy released in kJ when 1.00 g of octanol ($C_8H_{17}OH$) is burned.

Use **Figure 8**.

[1 mark]

Energy released = 40.6 (kJ) kJ

Turn over ►

Do not write outside the box

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 box.

[1 mark]

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

Limewater is an aqueous solution of calcium hydroxide .

0 9 . 5 Give the result of the test when carbon dioxide is bubbled through limewater.

[1 mark]

milky / cloudy

Do not write outside the box

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 ☐

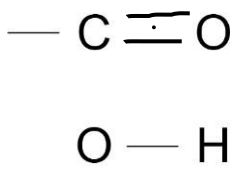
An oxidising agent ☑

Water ☐

0 9 . 7 Ethanoic acid contains the functional group –COOH

Complete the displayed structural formula of this functional group.

[1 mark]



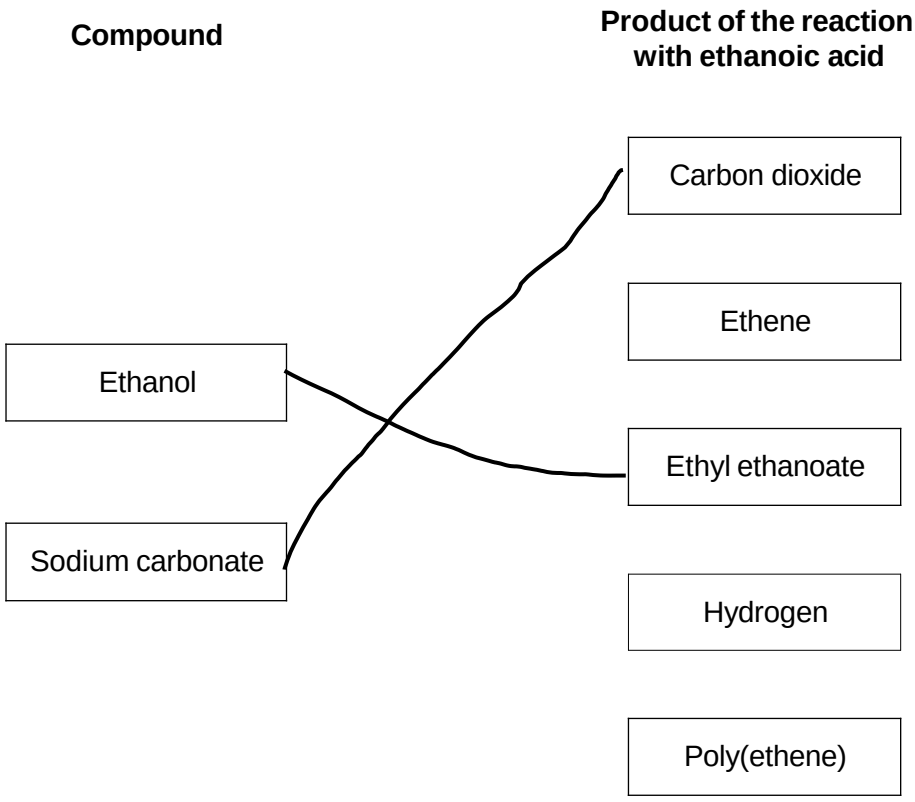
Question 9 continues on the next page

Do not write outside the box

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]



11

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Turn over for the next question

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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]

Level 3: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

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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]

flame emission spectroscopy

1 0 . 3 Give **one** advantage of using this instrumental method instead of a chemical test.

[1 mark]

8

END OF QUESTIONS

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

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