A

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE

CHEMISTRY

F

Foundation Tier Paper 2

8462/2F

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]

JUN228462 2F 01

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 water.

A student investigated pure water.

The student measured:

- **the boiling point of pure water**
- **the pH of pure water.**

0 1 . 1

Complete the sentences.

Choose answers from the list. [2 marks]

- **0**
- **4**
- **7**
- **10**
- **25**
- **100**

Pure water has a boiling point of _____ °C.

Pure water has a pH of _____ .

[Turn over]

0 1 . 2

What could the student use to measure the pH of pure water? [1 mark]

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[Turn over]

A different student investigated sea water.

Sea water contains dissolved solids.

This is the method used.

1. **Measure a 50 cm^3 sample of the sea water.**
2. **Heat the sample until all the water has evaporated.**
3. **Measure the mass of solid that remains.**
4. **Repeat steps 1 to 3 three more times.**

0 1 . 3

Which TWO pieces of equipment were needed in this investigation? [2 marks]

Tick (✓) TWO boxes.

- ☐ **Balance**
- ☐ **Measuring cylinder**
- ☐ **Ruler**
- ☐ **Thermometer**
- ☐ **Timer**

[Turn over]

0 1 . 4

TABLE 1 shows the results.

TABLE 1

Sea water sample	Mass of solid that remained in grams
1	1.73
2	1.70
3	1.75
4	1.78

Calculate the mean mass of solid that remained. [2 marks]

Mean mass = _____ g

0 1 . 5

A 50 cm^3 sample of sea water from a different source contained 1.50 g of dissolved solids.

Calculate the mass of dissolved solids in 1000 cm^3 of this sea water. [2 marks]

Mass = _____ g

Sodium chloride is a dissolved solid in sea water.

Sodium chloride contains sodium ions and chloride ions.

0 1 . 6

Complete the sentence.

Choose the answer from the list. [1 mark]

- **crimson**
- **lilac**
- **yellow**

The student tested sea water for sodium ions using a flame test.

The colour of the flame was

_____ .

0 1 . 7

Complete the sentence.

Choose the answer from the list. [1 mark]

- **brown**
- **green**
- **white**

The student tested sea water for chloride ions by adding nitric acid and silver nitrate solution.

The colour of the precipitate formed was

_____ .

0 2

This question is about hydrocarbons in crude oil.

0 2 . 1

TABLE 2 shows information about three fractions obtained from crude oil.

TABLE 2

Fraction	Boiling point range in °C
A	200–300
B	100–150
C	Below 30

15

FIGURE 1, on page 17, shows the fractionating column used to separate fractions A, B and C.

The temperature of the fractionating column is:

- **30 °C at the top**
- **400 °C at the bottom.**

Complete FIGURE 1 to show where fractions A, B and C are collected. [1 mark]

[Turn over]

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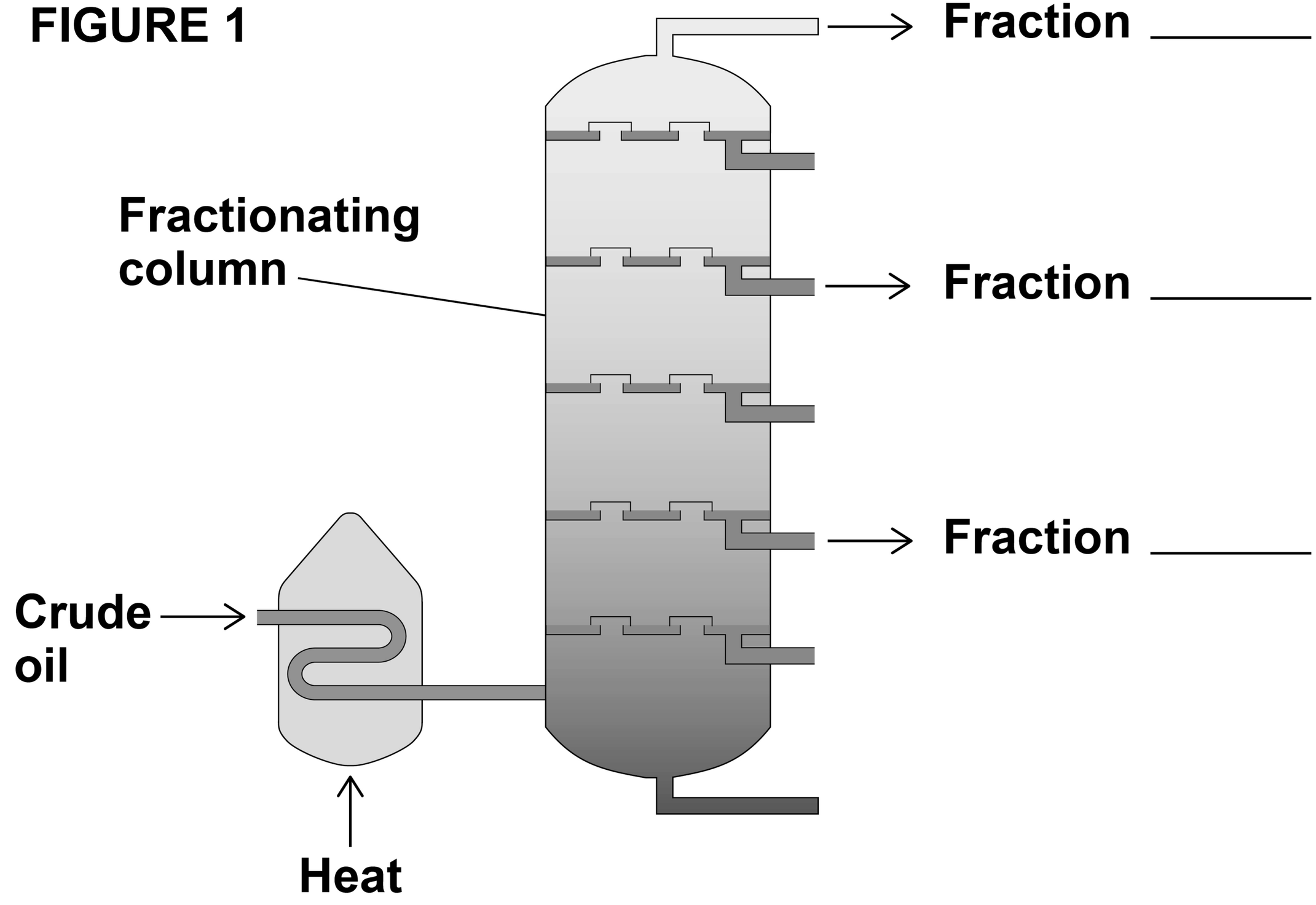
FIGURE 1



[Turn over]

0 2 . 2

TABLE 3 shows information about three fractions obtained from crude oil.

TABLE 3

Fraction	Range of number of carbon atoms in each molecule
Petrol	5–12
Diesel oil	15–19
Heavy fuel oil	20–40

Complete the sentences.

Choose answers from the list. [2 marks]

- **lower**
- **the same**
- **higher**

Compared to petrol, the viscosity of heavy fuel oil is _____ .

Compared to petrol, the flammability of diesel oil is _____ .

[Turn over]

TABLE 4 shows the percentage of two fractions obtained from two different sources of crude oil.

TABLE 4

Source	Percentage (%) of fraction	
	Kerosene	Heavy fuel oil
J	13	30
K	4	44

0 2 . 3

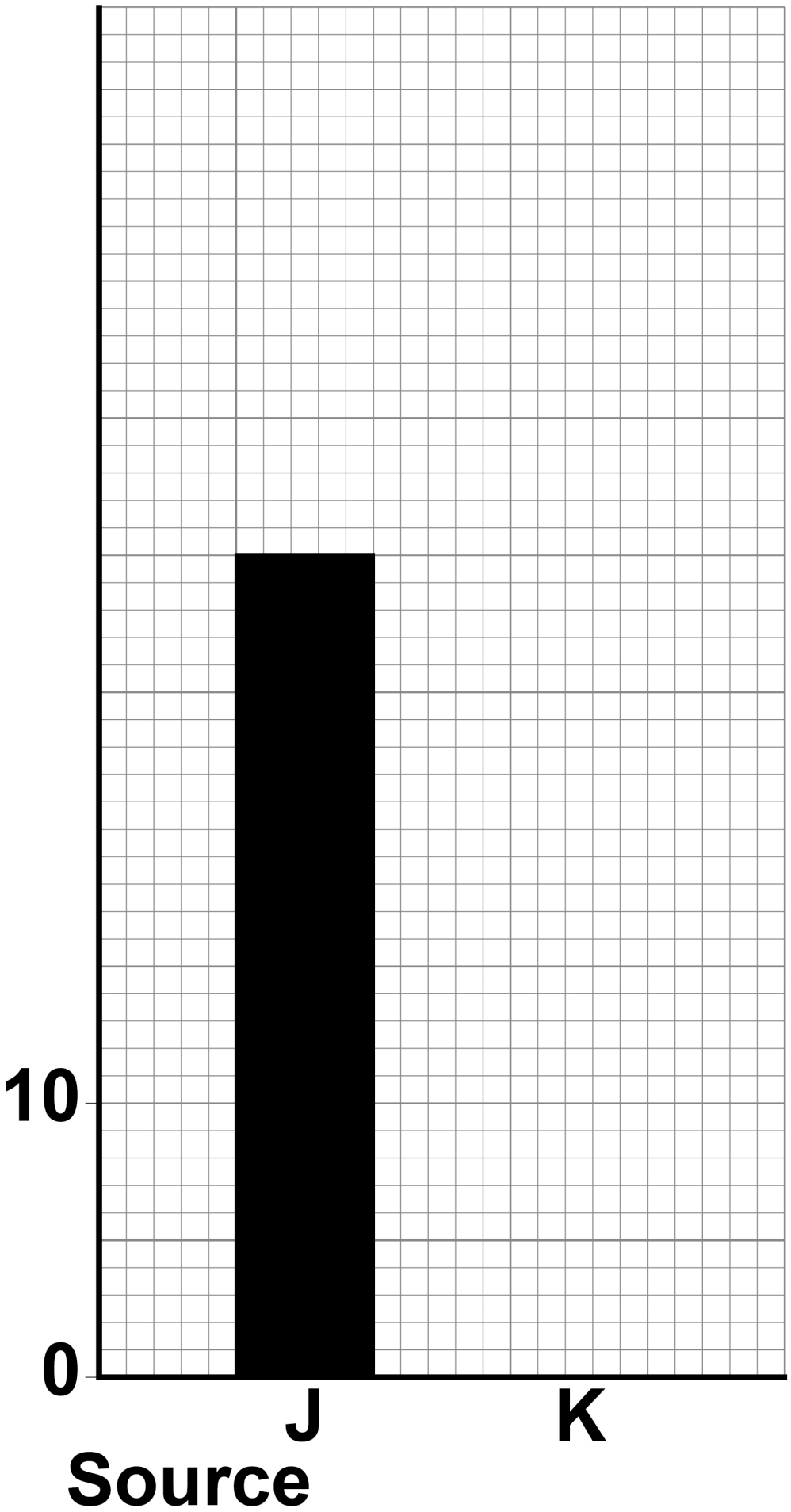
Complete FIGURE 2, on the opposite page.

You should:

- **complete the *y*-axis scale**
- **plot the percentage of the heavy fuel oil fraction obtained from source K.**

Use TABLE 4. [2 marks]

FIGURE 2



[Turn over]

0 2 . 4

Kerosene is in higher demand than heavy fuel oil.

Suggest why crude oil from source J is in higher demand than crude oil from source K.

Use TABLE 4, on page 20. [1 mark]

Large hydrocarbon molecules can be cracked to produce smaller hydrocarbon molecules including alkanes.

0 2 . 5

Which TWO of the following can be used to crack large hydrocarbon molecules? [2 marks]

Tick (✓) TWO boxes.

- ☐ **A catalyst**
- ☐ **A fertiliser**
- ☐ **Air**
- ☐ **Ozone**
- ☐ **Steam**

0 2 . 6

Alkanes have the general formula C_nH_{2n+2}

Complete the formula of the alkane molecule containing 11 carbon atoms.

[1 mark]

$C_{11}H$___

0 2 . 7

C_2H_6 is an alkane.

Which type of bond is found in a C_2H_6 molecule? [1 mark]

Tick (✓) ONE box.

- ☐ **A double bond between two carbon atoms.**
- ☐ **A double bond between two hydrogen atoms.**
- ☐ **A single bond between two carbon atoms.**
- ☐ **A single bond between two hydrogen atoms.**

[Turn over]

0 2 . 8

Which TWO substances are produced when alkanes completely combust?
[2 marks]

Tick (✓) TWO boxes.

- ☐ **Carbon**
- ☐ **Carbon dioxide**
- ☐ **Carbon monoxide**
- ☐ **Hydrogen**
- ☐ **Water**

12

0 3

This question is about the Earth's atmosphere.

TABLE 5, on page 28, shows:

- **the estimated percentages of gases in the Earth's early atmosphere**
- **the percentages of gases in the Earth's atmosphere today.**

[Turn over]

TABLE 5

Gas	Estimated percentage (%) in the Earth's early atmosphere	Percentage (%) in the Earth's atmosphere today
Nitrogen	1.8	X
Oxygen	0.2	20.95
Carbon dioxide	96.0	0.04
Other gases	2.0	0.92

28

0 3 . 1

Calculate value X in TABLE 5, on the opposite page.
[1 mark]

_____

_____

_____

X = _____ **%**

0 3 . 2

Which TWO other gases may have been in the Earth's early atmosphere? [2 marks]

Tick (✓) TWO boxes, on the opposite page.

- [ ] **Ammonia**
- [ ] **Coal**
- [ ] **Limestone**
- [ ] **Methane**
- [ ] **Poly(ethene)**

[Turn over]

Algae and plants increased the percentage of oxygen in the Earth's atmosphere.

The same process in algae and plants decreased the percentage of carbon dioxide in the Earth's atmosphere.

0 3 . 3

Which process in algae and plants increased the percentage of oxygen in the Earth's atmosphere? [1 mark]

Tick (✓) ONE box, on the opposite page.

- ☐ Fermentation
- ☐ Photosynthesis
- ☐ Rusting
- ☐ Sedimentation

[Turn over]

0 3 . 4

Which TWO other processes decreased the percentage of carbon dioxide in the Earth's atmosphere? [2 marks]

Tick (✓) TWO boxes.

- ☐ **Burning fossil fuels**
- ☐ **Dissolving carbon dioxide in oceans**
- ☐ **Eruption of volcanoes**
- ☐ **Evolution of animals**
- ☐ **Formation of sedimentary rocks**

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[Turn over]

FIGURE 3, on the opposite page, shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.

0 3 . 5

When was the percentage of oxygen in the Earth's atmosphere 8%?

Use FIGURE 3. [1 mark]

_____ millions of years ago

0 3 . 6

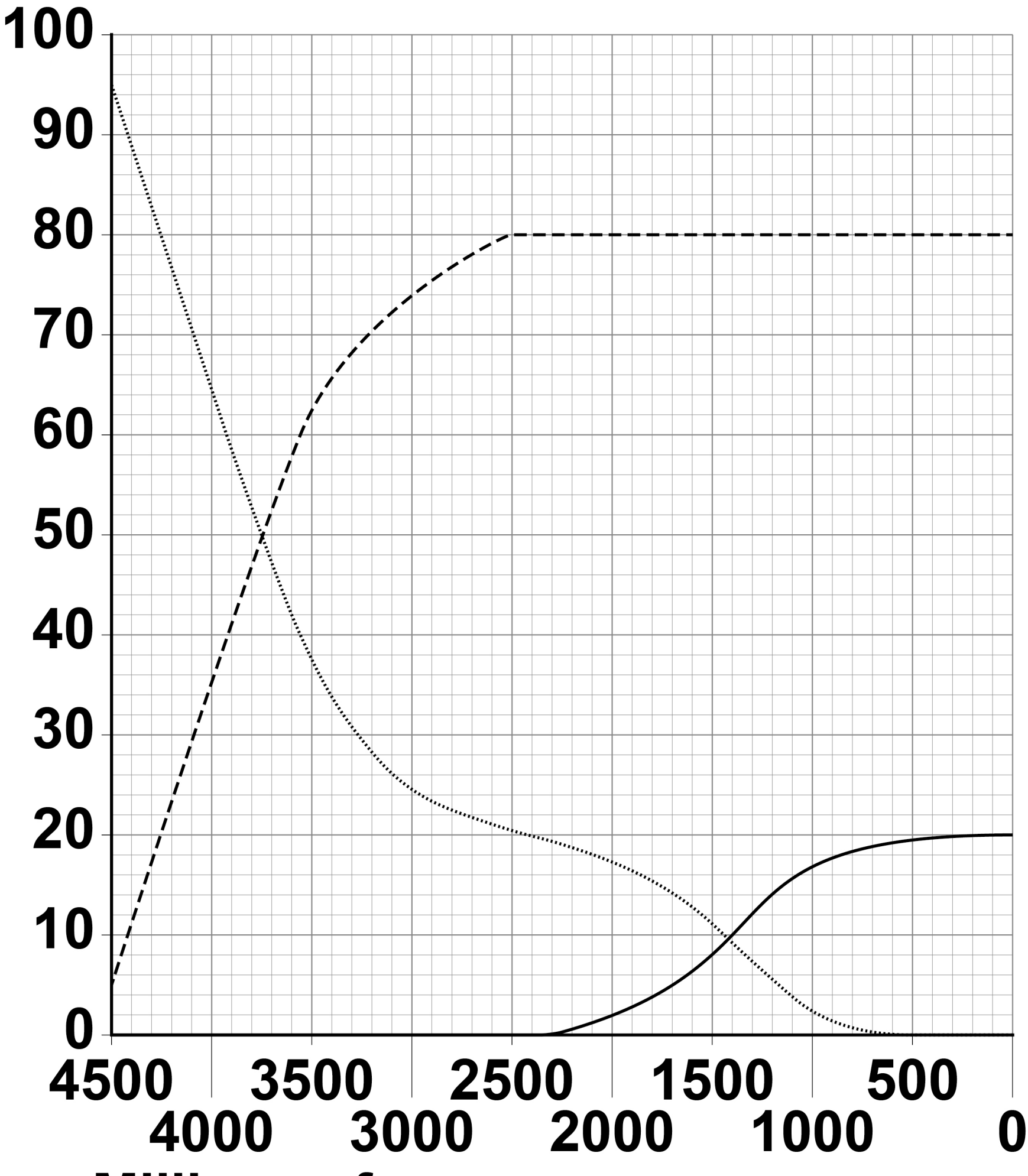
When did the percentage of nitrogen in the Earth's atmosphere become constant?

Use FIGURE 3. [1 mark]

_____ millions of years ago

FIGURE 3

Percentage (%) of gas in the Earth's atmosphere



[Turn over]

0 3 . 7

Crude oil was formed from an ancient biomass as the Earth's atmosphere evolved.

What did this ancient biomass mainly consist of? [1 mark]

Tick (✓) ONE box.

- ☐ **Limestone**
- ☐ **Plankton**
- ☐ **Sand**

0 3 . 8

Most of the percentages of the gases in FIGURE 3, on page 37, are estimated values.

Why have scientists used estimated values for the percentages of the gases in FIGURE 3? [1 mark]

10

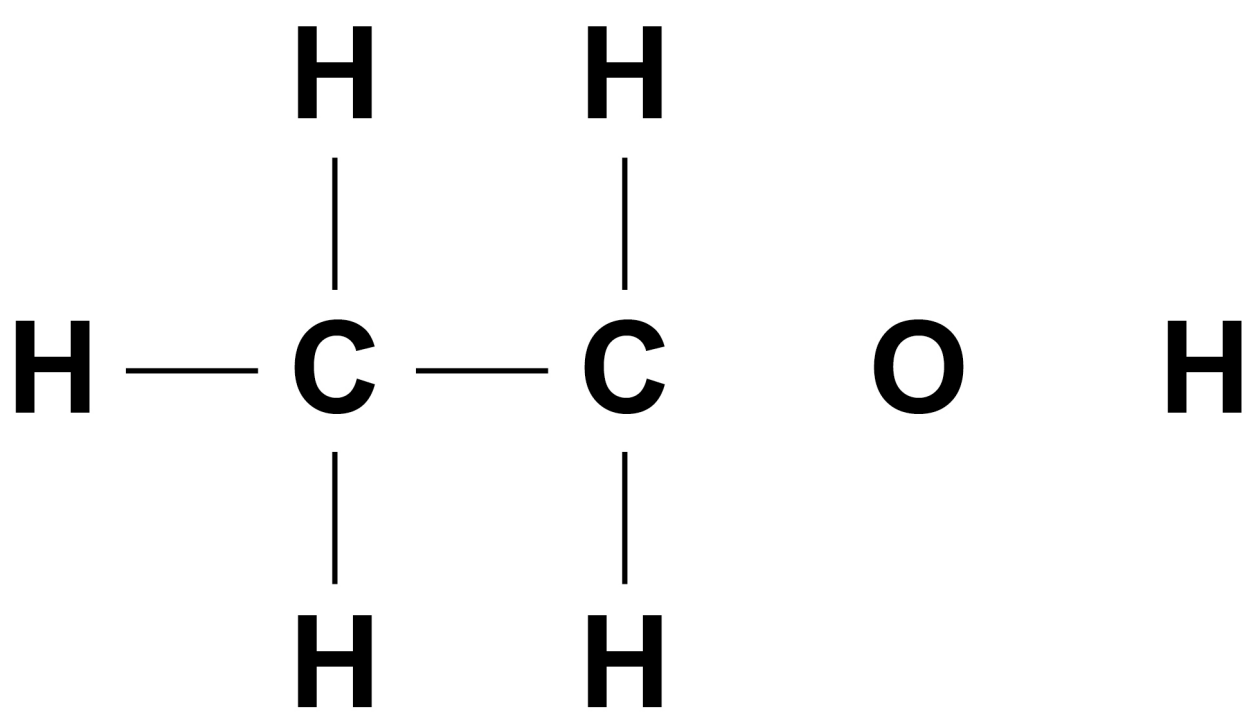
0 4

This question is about ethanol.

0 4 . 1

The formula of ethanol is C_2H_5OH

Complete the displayed structural formula of ethanol. [1 mark]



0 4 . 2

Which is ONE use of ethanol? [1 mark]

Tick (✓) ONE box.

- ☐ **As a protective coating on aluminium**
- ☐ **In hand gel to kill microbes**
- ☐ **To test for the presence of hydrogen gas**

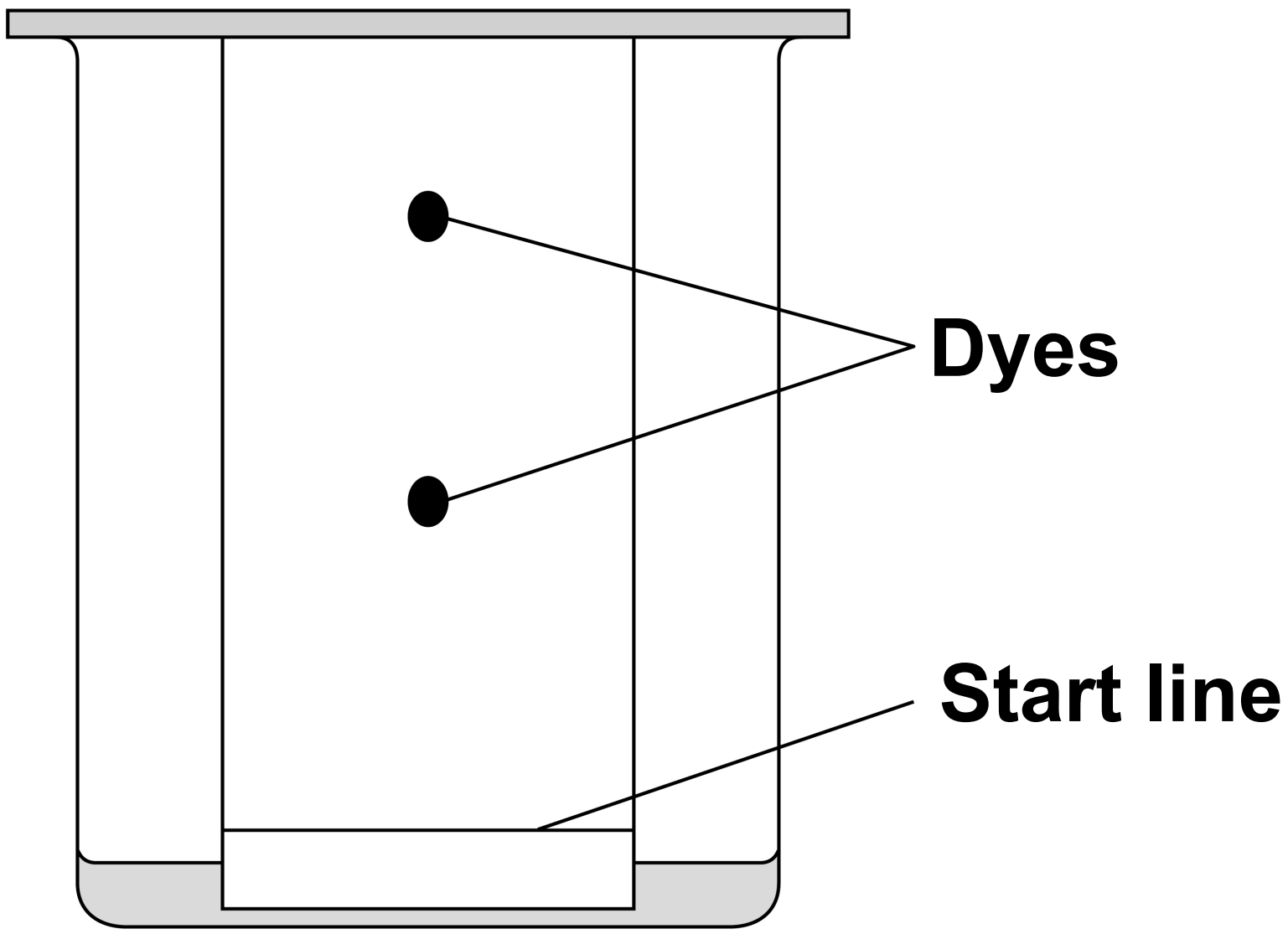
0 4 . 3

Ethanol is used as a solvent in some inks.

A student used paper chromatography to show that an ink contained two different dyes.

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

FIGURE 4



Describe a method the student could have used for the investigation.
[4 marks]

0 4 . 4

Ethanol can be produced from sugar solution by fermentation.

What must be added to sugar solution to produce ethanol? [1 mark]

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[Turn over]

E5 and E10 are types of fuel used in cars.

These fuels contain ethanol and petrol.

TABLE 6 shows information about E5 and E10.

TABLE 6

Fuel	Percentage (%) by mass of ethanol	Percentage (%) by mass of petrol
E5	5	95
E10	10	90

0 4 . 5

Calculate the mass of ethanol in 4.4 kg of E5.

Give your answer in grams.

Use TABLE 6, on the opposite page.
[3 marks]

Mass = _____ g

[Turn over]

REPEAT OF TABLE 6

Fuel	Percentage (%) by mass of ethanol	Percentage (%) by mass of petrol
E5	5	95
E10	10	90

0 4 . 6

The ethanol in E5 and E10 is produced from sugar.

Sugar is produced from plants.

Explain why the production of E10 removes more carbon dioxide from the atmosphere than the production of E5.

Use TABLE 6. [3 marks]

[Turn over]

0 4 . 7

TABLE 7 shows the energy content of ethanol and petrol.

TABLE 7

	Energy content in MJ (megajoules) per kg
Ethanol	30.0
Petrol	46.4

Suggest ONE disadvantage of using E10 instead of E5.

Complete the sentence. [1 mark]

A disadvantage of using E10 is that

_____

_____

14

0 5

Ammonia is produced in the Haber process.

The raw materials for the Haber process are nitrogen and hydrogen.

[Turn over]

0 5 . 1

Draw ONE line from each raw material to the source of that raw material.
[2 marks]

RAW MATERIAL	SOURCE OF RAW MATERIAL
	Air
Nitrogen	Clay
Hydrogen	Limestone
	Natural gas
	Sand

0 5 . 2

What are the states of nitrogen and of hydrogen when used in the Haber process? [1 mark]

Tick (✓) ONE box.

	State of nitrogen	State of hydrogen
☐	Gas	Gas
☐	Gas	Liquid
☐	Liquid	Gas
☐	Liquid	Liquid

0 5 . 3

The word equation for the production of ammonia is:

nitrogen + hydrogen ⇌ ammonia

The atom economy of the reaction is 100%.

How does the word equation show that the atom economy is 100%? [1 mark]

Tick (✓) ONE box.

☐ **The reaction is reversible.**

☐ **There are two reactants.**

☐ **There is one product.**

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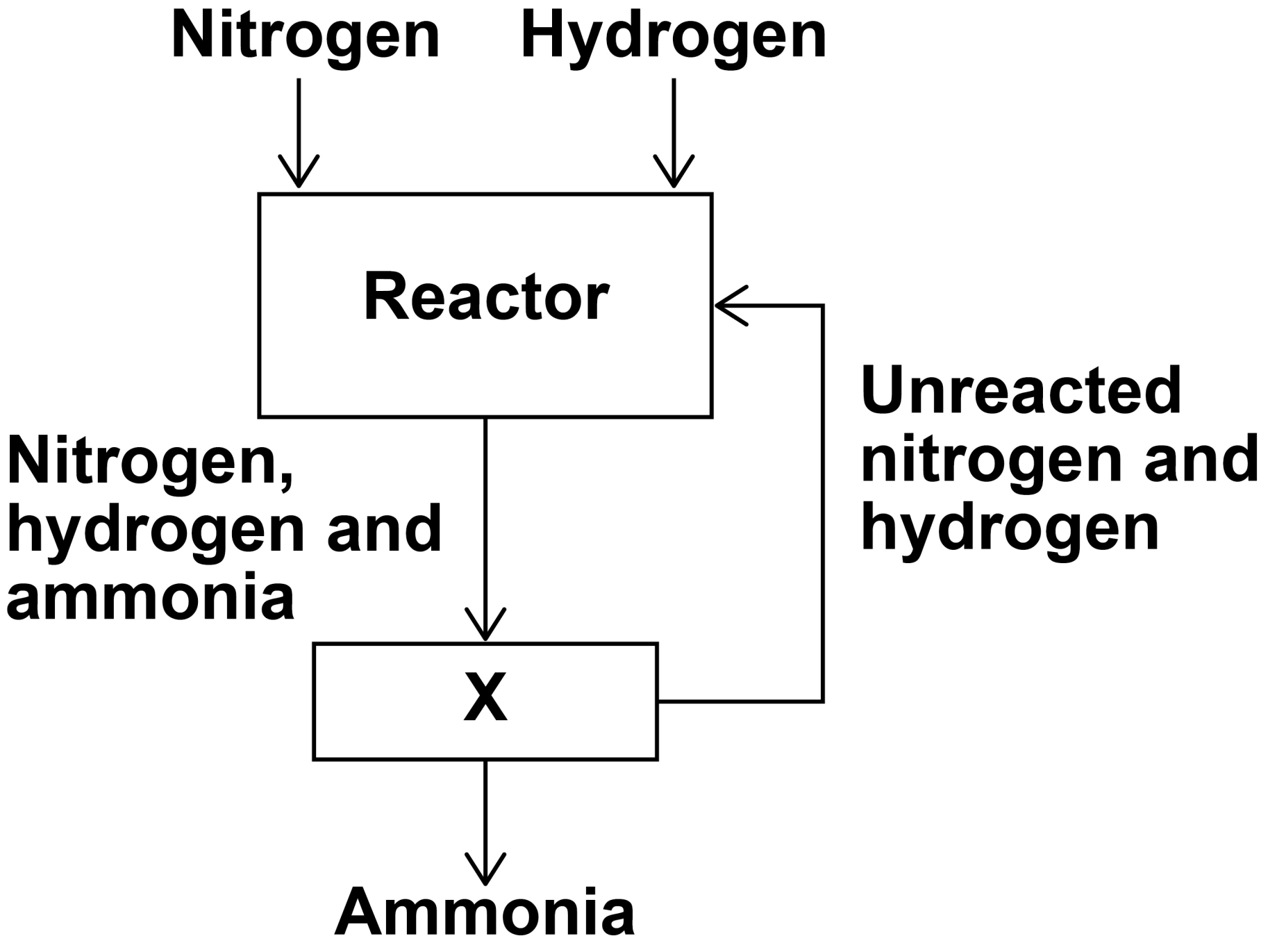
[Turn over]

0 5 . 4

FIGURE 5 represents the Haber process.

FIGURE 5



A mixture of nitrogen, hydrogen and ammonia enters X.

Complete the sentences.

Choose answers from the list. [2 marks]

- **evaporated**
- **filtered**
- **liquefied**
- **recycled**

In X, the mixture is cooled.

The ammonia can be removed from X because the ammonia is _____ .

The unreacted nitrogen and hydrogen are _____ .

[Turn over]

TABLE 8 shows the percentage yield of ammonia at different pressures.

TABLE 8

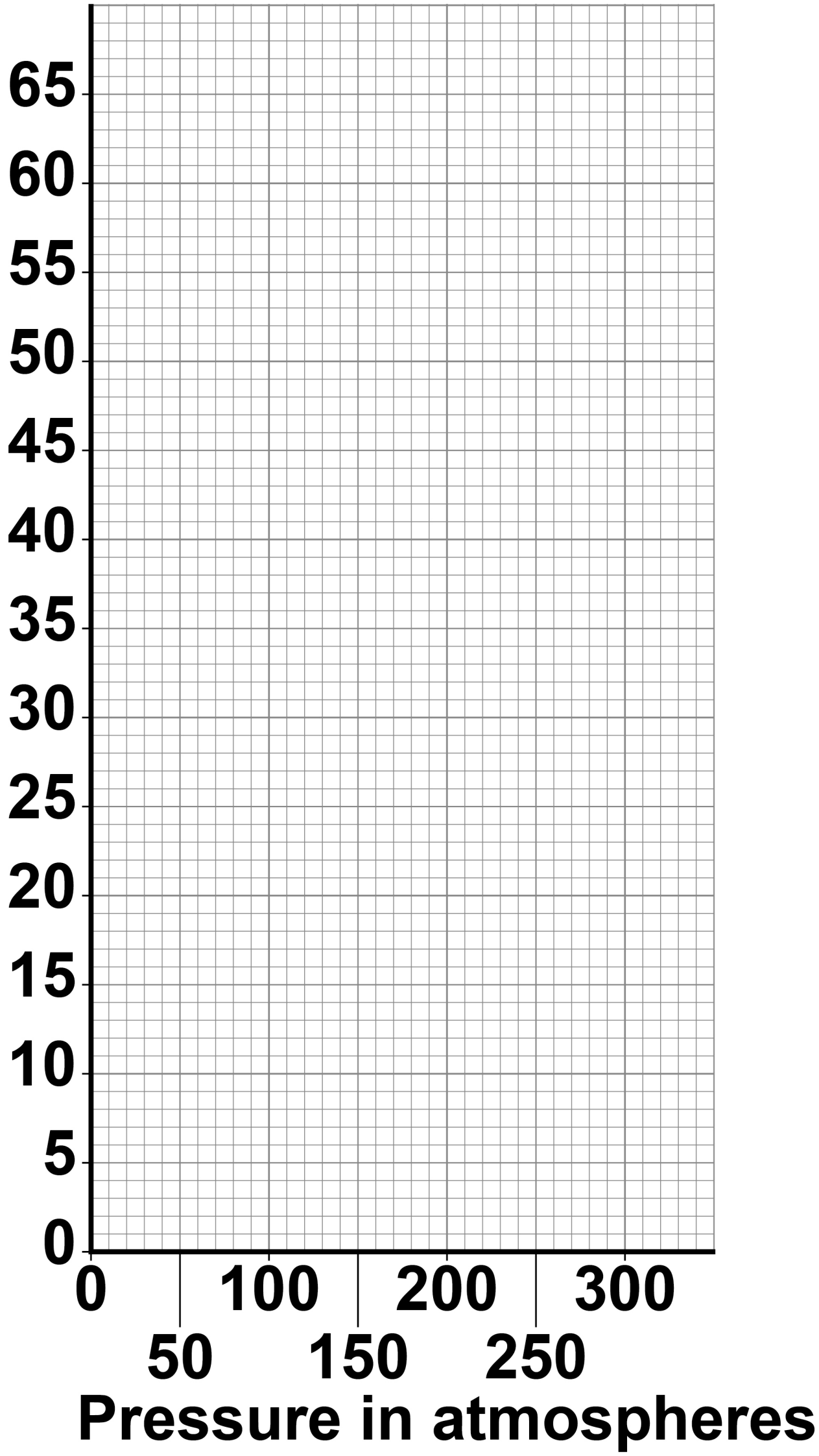
Pressure in atmospheres	Percentage (%) yield of ammonia
50	20
100	33
150	44
200	52
250	59
300	64

0 5 . 5

Plot the data from TABLE 8 on FIGURE 6, on the opposite page.

Draw a line of best fit. [3 marks]

FIGURE 6



[Turn over]

REPEAT OF TABLE 8

Pressure in atmospheres	Percentage (%) yield of ammonia
50	20
100	33
150	44
200	52
250	59
300	64

0 5 . 6

What is the effect of increasing the pressure on the percentage yield of ammonia?

Use TABLE 8, on the opposite page.

[1 mark]

_____

_____

_____

[Turn over]

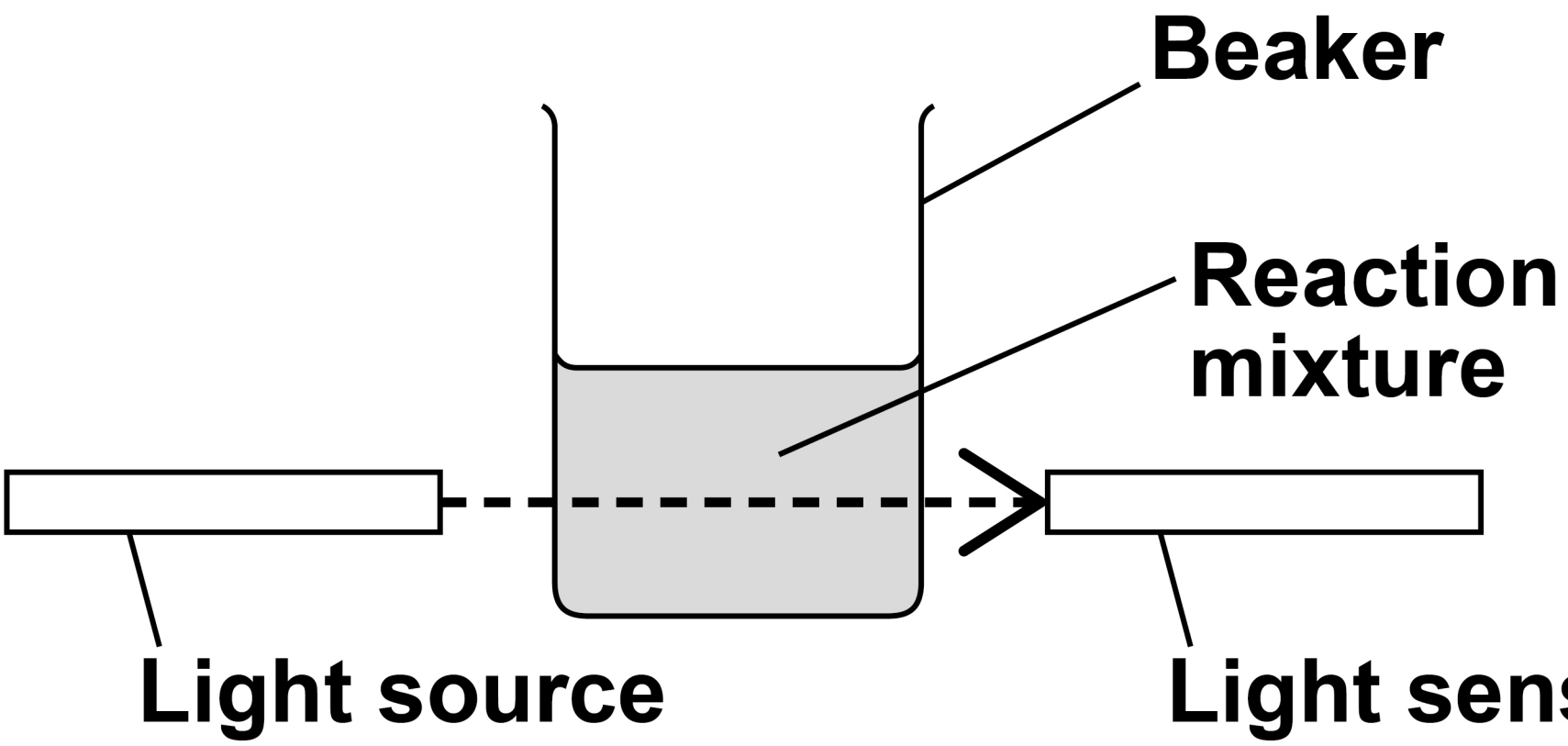
10

0 6

A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

FIGURE 7 shows the apparatus used.

FIGURE 7



When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm^3 of sodium thiosulfate solution into the beaker.
2. Add 10 cm^3 of hydrochloric acid to the sodium thiosulfate solution.
3. Immediately start a timer.
4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

[Turn over]

0 6 . 1

Balance the equation for this reaction.
[1 mark]

$$Na_2S_2O_3 + 2\,HCl \longrightarrow \_\_\_\_\_\ NaCl + H_2O + SO_2 + S$$

0 6 . 2

The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?
[1 mark]

Tick (✓) ONE box.

☐ **(aq)**

☐ **(g)**

☐ **(l)**

☐ **(s)**

[Turn over]

0 6 . 3

The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture? [1 mark]

Tick (✓) ONE box.

- ☐ **A balance**
- ☐ **A cross on a piece of paper**
- ☐ **A gas syringe**
- ☐ **A thermometer**

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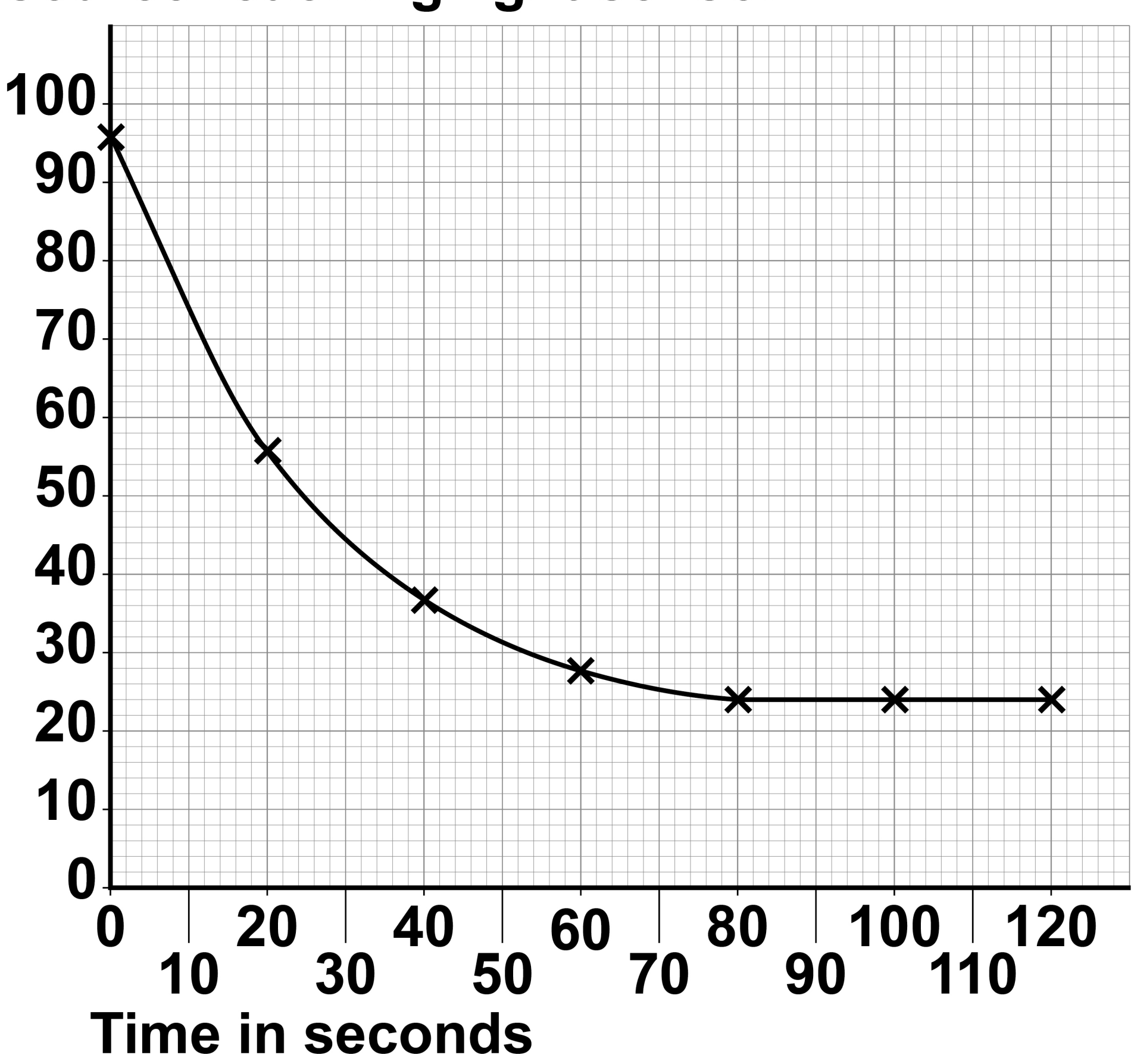
[Turn over]

FIGURE 8 shows the results.

FIGURE 8



0 6 . 4

What happened to the rate of reaction between 40 and 60 seconds?

Use FIGURE 8, on the opposite page.
[1 mark]

☐ **The rate of reaction decreased.**

☐ **The rate of reaction stayed at zero.**

☐ **The rate of reaction increased.**

[Turn over]

0 6 . 5

The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant? [1 mark]

Tick (✓) ONE box.

☐ **No light was reaching the sensor.**

☐ **One of the reactants was used up.**

☐ **The reaction was too vigorous.**

0 6 . 6

The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on FIGURE 8, on page 68?
[1 mark]

Tick (✓) ONE box.

☐ **Initially the line of best fit would be less steep.**

☐ **Initially the line of best fit would be the same steepness.**

☐ **Initially the line of best fit would be steeper.**

[Turn over]

0 6 . 7

The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are TWO effects of using reactants kept in an ice bath rather than at room temperature? [2 marks]

Tick (✓) TWO boxes, on the opposite page.

- ☐ **Fewer reactant particles have the activation energy.**
- ☐ **The reactant particles collide more frequently.**
- ☐ **The reactant particles have more energy.**
- ☐ **The reactant particles move more slowly.**
- ☐ **There are fewer reactant particles in the same volume.**

8

0 7

This question is about fertilisers.

Ammonium nitrate is a fertiliser containing nitrogen.

0 7 . 1

Complete the sentence.

Choose the answer from the list.
[1 mark]

- **hydrochloric acid**
- **nitric acid**
- **sulfuric acid**

Ammonium nitrate is produced by reacting ammonia with _____ .

0 7 . 2

Ammonium nitrate fertiliser is sold in 600 kg bags.

A farmer spreads 40 bags of ammonium nitrate fertiliser on land with an area of 800 000 m^2.

Calculate the mass of ammonium nitrate fertiliser spread per m^2 of land.
[2 marks]

_____

_____

_____

_____

Mass per m^2 = _____ kg/m^2

[Turn over]

0 7 . 3

A scientist works for a company which makes ammonium nitrate fertiliser.

The scientist investigates the effect of different fertilisers on crop growth.

The scientist concludes that the ammonium nitrate fertiliser improves crop growth more than other fertilisers.

Suggest ONE reason why this conclusion might NOT be valid. [1 mark]

A different fertiliser containing nitrogen has the formula $K_2NH_4PO_4$

0 7 . 4

How many atoms of nitrogen are in the formula $K_2NH_4PO_4$? [1 mark]

0 7 . 5

Nitrogen and potassium in the fertiliser $K_2NH_4PO_4$ are important for good crop growth.

Which other element in the fertiliser $K_2NH_4PO_4$ is important for good crop growth? [1 mark]

Tick (✓) ONE box.

- ☐ **Hydrogen**
- ☐ **Oxygen**
- ☐ **Phosphorus**

0 7 . 6

Some fertilisers are mixtures of different compounds in fixed proportions.

What name is given to a mixture of different compounds in fixed proportions? [1 mark]

_____

_____

[Turn over]

7

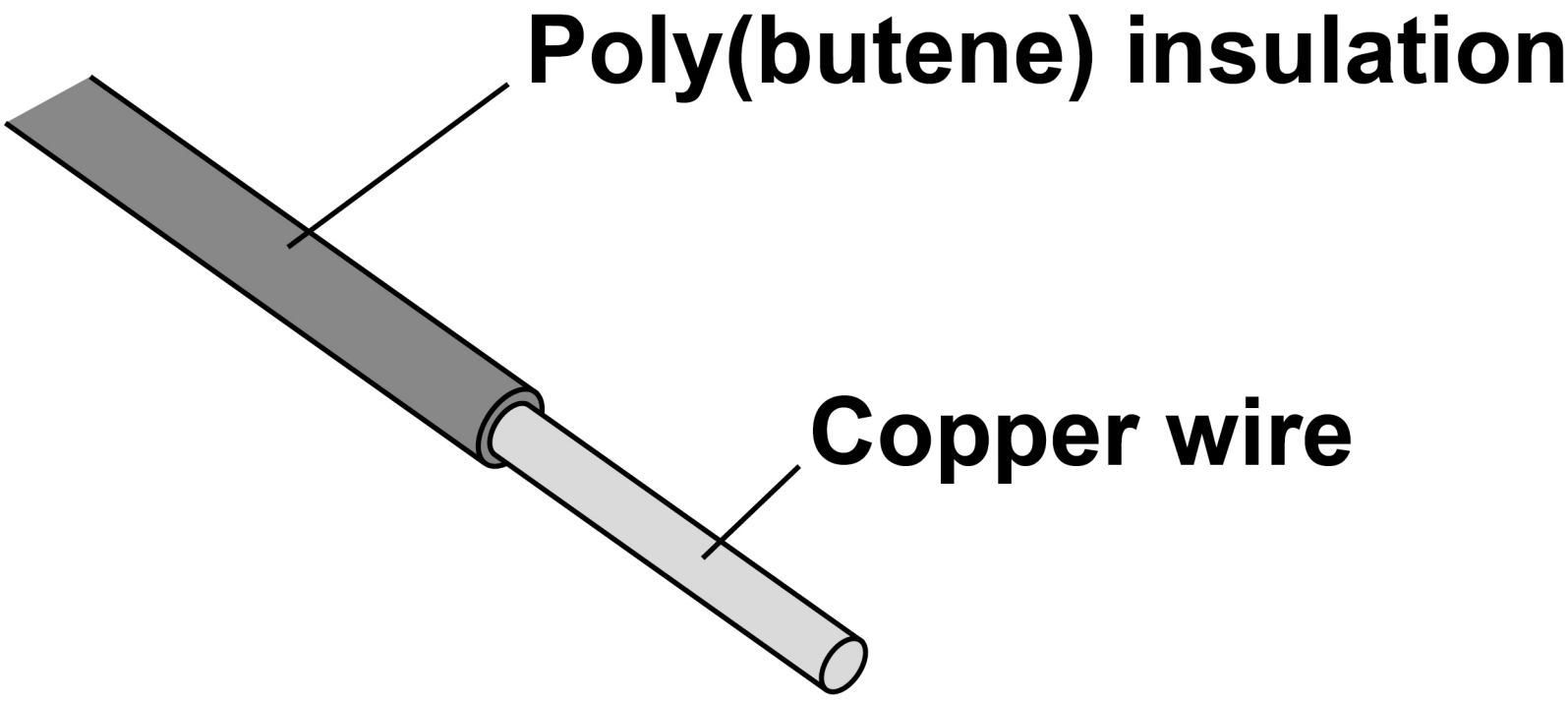
0 8

This question is about copper wire and copper compounds.

Copper is used to make electrical wires.

FIGURE 9 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

FIGURE 9



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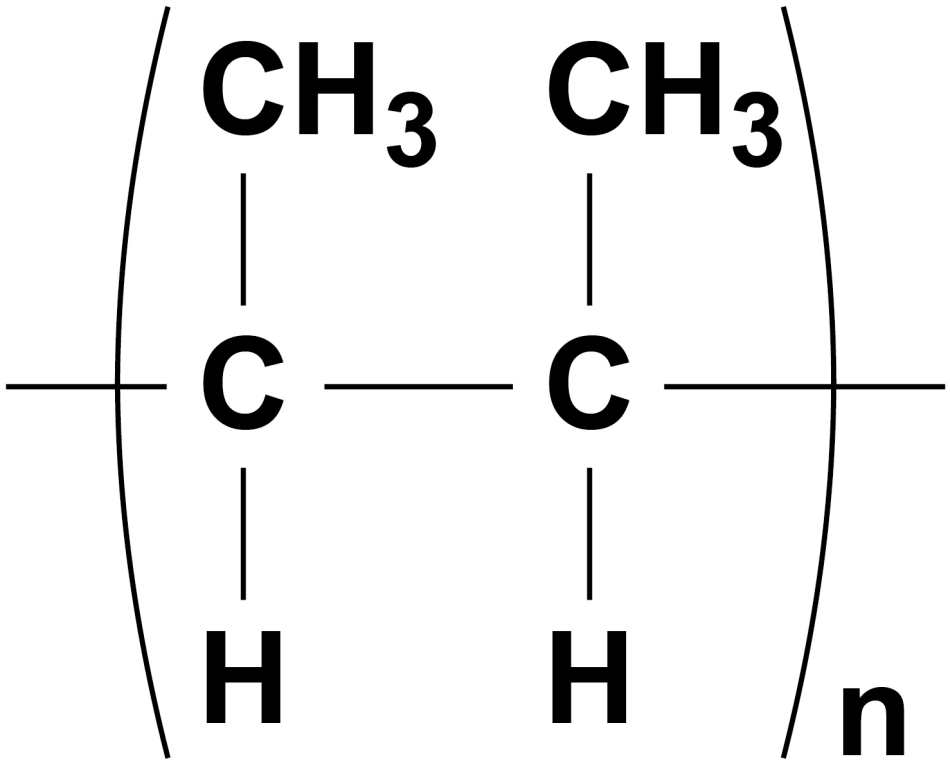
[Turn over]

0 8 . 1

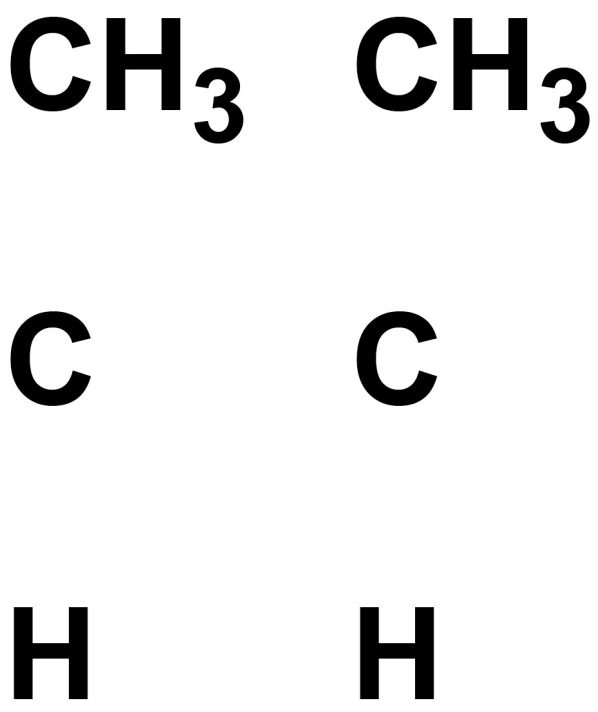
The addition polymer poly(butene) has the displayed structural formula:



Poly(butene) is produced from the monomer butene.

Complete FIGURE 10, on the opposite page, to show the displayed structural formula of butene. [2 marks]

FIGURE 10



[Turn over]

Copper can be obtained by recycling scrap copper wire.

0 8 . 2

Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled. [1 mark]

0 8 . 3

Describe how scrap copper wire can be recycled to make new copper water pipes. [2 marks]

0 8 . 4

Suggest TWO reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.
[2 marks]

1 _____

_____

_____

2 _____

_____

_____

[Turn over]

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 8 . 5

A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test. [2 marks]

Name of solution added _____

Result _____

0 8 . 6

Describe ONE test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test. [2 marks]

Test

Result

0 9

A student investigated the change in mass when hydrated cobalt chloride was heated.

The word equation for the reaction is:

hydrated cobalt chloride ⇌
anhydrous cobalt chloride + water

This is the method used.

1. Add 2.0 g of hydrated cobalt chloride to an empty test tube.
2. Measure the mass of the test tube and contents.
3. Heat the test tube and contents gently for 30 seconds.
4. Allow the test tube and contents to cool.
5. Measure the mass of the test tube and contents.
6. Repeat steps 3 to 5 until the mass of the test tube and contents does not change.

[Turn over]

TABLE 9 shows the results.

TABLE 9

Total heating time in seconds	Mass of test tube and contents in grams
0	26.5
30	26.2
60	25.9
90	25.6
120	25.6

0 9 . 1

Determine the mass of the empty test tube. [1 mark]

Mass of empty test tube = _____ g

0 9 . 2

Explain why the mass of the test tube and contents decreased. [2 marks]

0 9 . 3

Suggest why the test tube and contents were heated until the mass did not change. [1 mark]

Energy is taken in from the surroundings when hydrated cobalt chloride is heated.

0 9 . 4

When 238 g of hydrated cobalt chloride is heated until the mass does not change, 88.1 kJ of energy is taken in.

The student heated 2.00 g of hydrated cobalt chloride until the mass did not change.

Calculate the energy taken in during this reaction.

Give your answer to 3 significant figures.
[3 marks]

Energy taken in (3 significant figures) = _____ kJ

[Turn over]

0 9 . 5

What type of reaction takes place when hydrated cobalt chloride is heated?
[1 mark]

8

1 0

This question is about life cycle assessments (LCAs).

1 0 . 1

Milk bottles can be made from glass or from a polymer.

TABLE 10, on pages 96 and 97, shows information about milk bottles of equal volume.

[Turn over]

TABLE 10

	GLASS	POLYMER
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710

	GLASS	POLYMER
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

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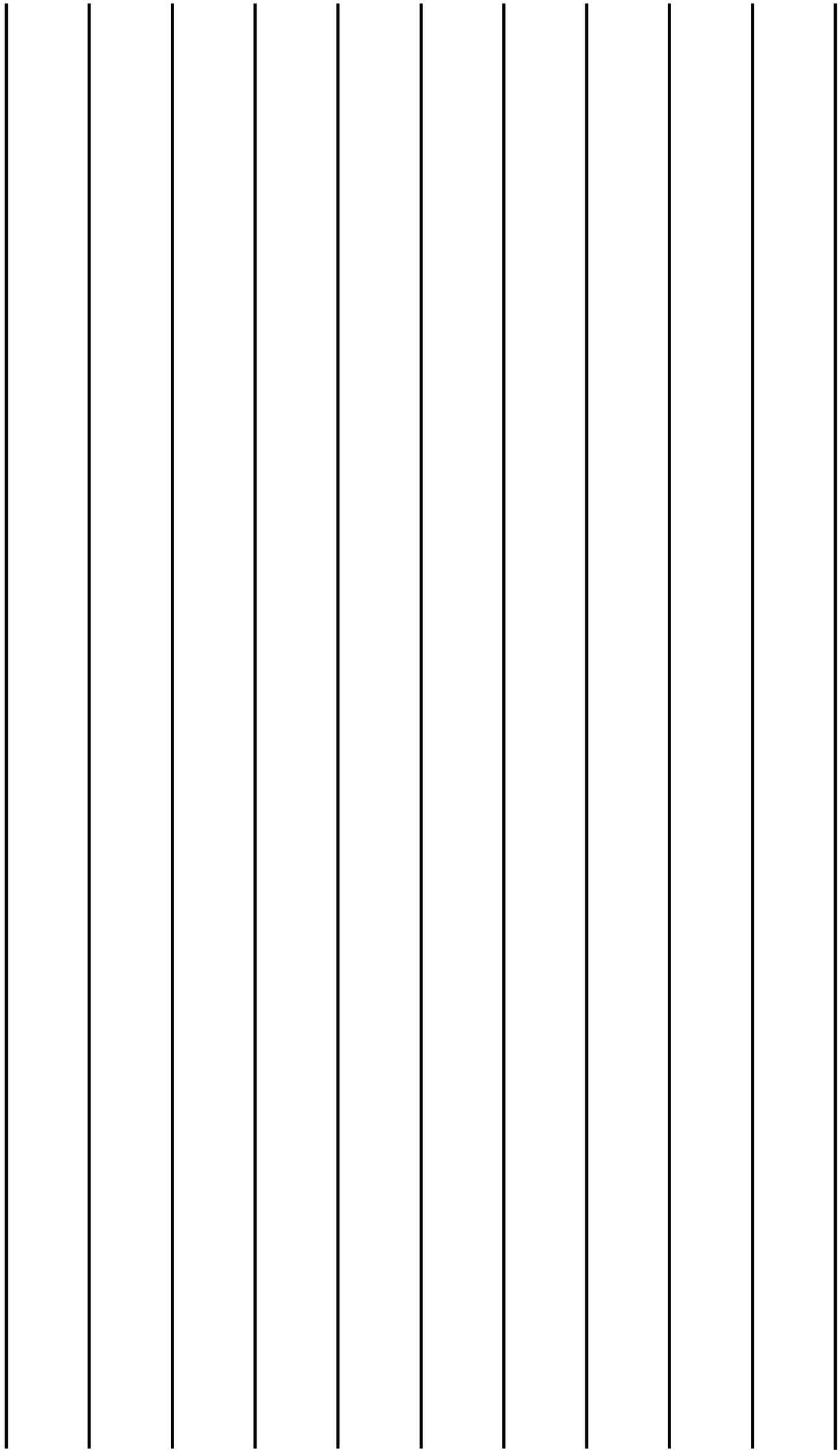
Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use TABLE 10, on pages 96 and 97. [6 marks]

[Turn over]

100



1 0 1

[Turn over]

1 0 . 2

Milk is also sold in cardboard cartons.

A carton is made using 40 cm^3 of cardboard.

The density of the cardboard is 0.40 g/cm^3.

Calculate the mass of the carton, on the opposite page.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[3 marks]

Mass = _____ g

END OF QUESTIONS

9

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
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