A

Surname ____________________

Other Names ____________________

Centre Number ____________________

Candidate Number ____________________

Candidate Signature ____________________

I declare this is my own work.

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

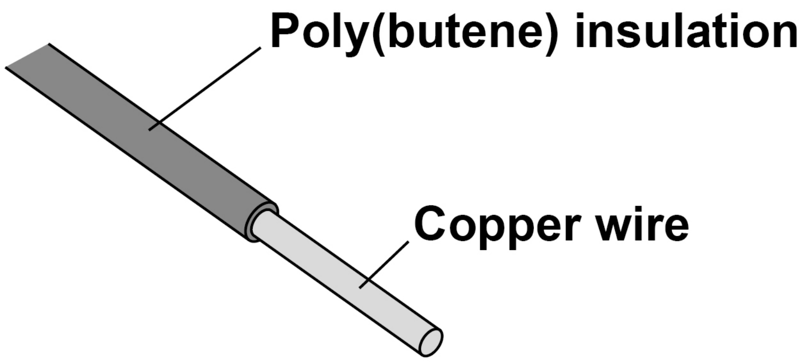
0 1

This question is about copper wire and copper compounds.

Copper is used to make electrical wires.

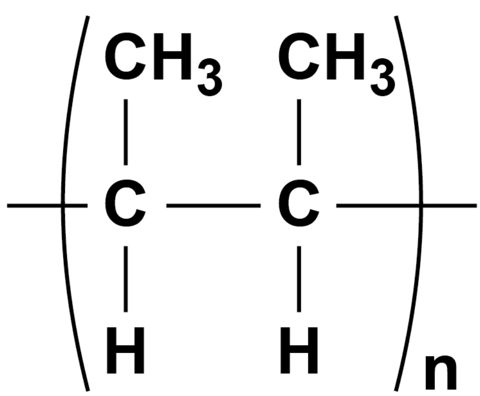
FIGURE 1 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

FIGURE 1



0 1 . 1

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



Poly(butene) is produced from the monomer butene.

Complete FIGURE 2 to show the displayed structural formula of butene. [2 marks]

FIGURE 2

CH_3 CH_3

C C

H H

[Turn over]

Copper can be obtained by recycling scrap copper wire.

0 1 . 2

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

0 1 . 3

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

0 1 . 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 1 . 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 1 . 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 ____

____

____

[Turn over]

11

0 2

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

The word equation for the reaction is:

hydrated cobalt chloride $\rightleftharpoons$
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.

TABLE 1 shows the results.

TABLE 1

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 2 . 1

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

Mass of empty test tube = ____________________ g

[Turn over]

0 2 . 2

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

0 2 . 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 2 . 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

0 2 . 5

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

8

0 3

This question is about life cycle assessments (LCAs).

0 3 . 1

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

TABLE 2, on page 16, shows information about milk bottles of equal volume.

[Turn over]

TABLE 2

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

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 2, on the opposite page. [6 marks]

[Turn over]

0 3 . 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.

Use the equation:

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

[3 marks]

____

____

____

____

____

____

Mass = ______________________ g

[Turn over]

9

0 4

This question is about the fractions obtained from crude oil.

0 4 . 1

Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

TABLE 3 shows the boiling point range of these fractions.

TABLE 3

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation. [4 marks]

[Turn over]

0 4 . 2

Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which TWO are useful materials produced from this feedstock? [2 marks]

Tick (✓) TWO boxes.

- [ ] **Alloys**
- [ ] **Ceramics**
- [ ] **Detergents**
- [ ] **Fertilisers**
- [ ] **Solvents**

Another fraction obtained from crude oil is petrol.

0 4 . 3

Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation. [2 marks]

C_9H_{20} + __________ $\rightarrow$ __________ + __________

[Turn over]

0 4 . 4

Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines. [2 marks]

0 4 . 5

TABLE 4 shows information about two more fractions obtained from crude oil.

TABLE 4

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction. [2 marks]

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

0 4 . 6

Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process. [3 marks]

Name of process ______________________________

____

Conditions ______________________________

____

____

____

0 4 . 7

Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would BOTH turn bromine water colourless? [1 mark]

Tick (✓) ONE box.

- [ ] C_7H_{14} and C_8H_{16}
- [ ] C_7H_{14} and C_8H_{18}
- [ ] C_7H_{16} and C_8H_{16}
- [ ] C_7H_{16} and C_8H_{18}

[Turn over]

16

0 5

This question is about water.

0 5 . 1

Sewage is waste water.

Sewage contains organic matter.

Describe how sewage is treated to remove organic matter. [4 marks]

[Turn over]

Sea water and ground water are treated to make them potable.

TABLE 5 shows information about the composition and treatment of sea water and of ground water.

TABLE 5

	SEA WATER	GROUND WATER
Concentration of sodium ions and chloride ions before PROCESS 1	Na^+ : 0.5 mol/dm^3 Cl^- : 0.5 mol/dm^3	Na^+ : 0.001 mol/dm^3 Cl^- : 0.001 mol/dm^3
PROCESS 1	Reverse osmosis	Filtration
Concentration of sodium ions and chloride ions after PROCESS 1	X	Na^+ : 0.001 mol/dm^3 Cl^- : 0.001 mol/dm^3
PROCESS 2	Add ozone	Expose to ultraviolet light

05.2

Sea water is desalinated during PROCESS 1.

Which pair of concentrations could represent X in TABLE 5? [1 mark]

Tick (✓) ONE box.

- [ ] Na^+ : 0.003 mol/dm^3 Cl^- : 0.003 mol/dm^3
- [ ] Na^+ : 0.003 mol/dm^3 Cl^- : 0.5 mol/dm^3
- [ ] Na^+ : 0.5 mol/dm^3 Cl^- : 0.003 mol/dm^3
- [ ] Na^+ : 0.5 mol/dm^3 Cl^- : 0.5 mol/dm^3

[Turn over]

REPEAT OF TABLE 5

	SEA WATER	GROUND WATER
Concentration of sodium ions and chloride ions before PROCESS 1	Na^+ : 0.5 mol/dm^3 Cl^- : 0.5 mol/dm^3	Na^+ : 0.001 mol/dm^3 Cl^- : 0.001 mol/dm^3
PROCESS 1	Reverse osmosis	Filtration
Concentration of sodium ions and chloride ions after PROCESS 1	X	Na^+ : 0.001 mol/dm^3 Cl^- : 0.001 mol/dm^3
PROCESS 2	Add ozone	Expose to ultraviolet light

0 5 . 3

Explain why the concentrations of sodium ions and of chloride ions in the ground water in TABLE 5 are unchanged by PROCESS 1. [2 marks]

05.4

Explain why the ground water in TABLE 5 requires PROCESS 2 before the water is safe to drink. [2 marks]

0 5 . 5

After treatment the ground water in TABLE 5, on page 32, is sold by a company as pure water.

The ground water in TABLE 5 is not chemically pure because the water contains sodium ions and chloride ions.

Suggest what the company means by 'pure'. [1 mark]

0 5 . 6

Chlorine is also used to treat some ground water.

Describe the test for chlorine gas.

Give the result of the test. [2 marks]

Test ____

____

____

Result ____

____

____

[Turn over]

12

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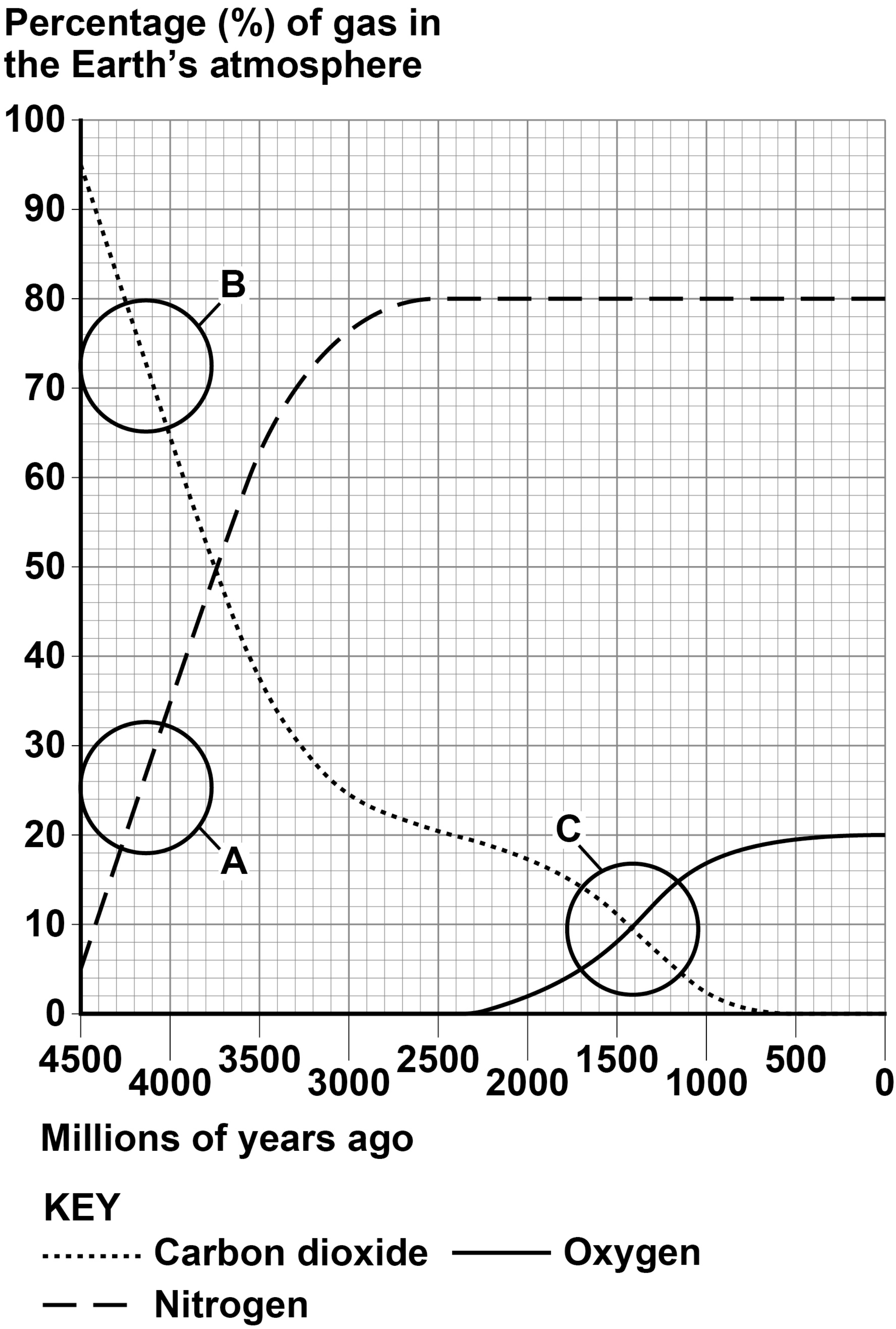
0 6

This question is about the chemistry of the Earth's atmosphere.

FIGURE 3, on page 38, shows how the percentages of gases in the Earth's atmosphere may have changed since the atmosphere was formed.

[Turn over]

FIGURE 3


Percentage (%) of gas in the Earth's atmosphere
100
90
80
70
60
50
40
30
20
10
0
B
A
C
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Millions of years ago
KEY
Carbon dioxide
Oxygen
Nitrogen

0 6 . 1

Explain the change in the percentage of gas in the region labelled A on FIGURE 3. [2 marks]

[Turn over]

0 6 . 2

Explain the change in the percentage of gas in the region labelled B on FIGURE 3, on page 38. [2 marks]

0 6 . 3

Compare the changes in the percentages of gases in the region labelled C on FIGURE 3. [2 marks]

0 6 . 4

What process caused the changes in the percentages of gases in the region labelled C on FIGURE 3? [1 mark]

[Turn over]

0 6 . 5

Natural gas is a fossil fuel.

Describe how deposits of natural gas were formed.
[3 marks]

10

0 7

Ammonia is produced in the Haber process.

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

The equation for the reaction is:

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

0 7 . 1

Give the sources of the nitrogen and of the hydrogen used in the Haber process. [2 marks]

Nitrogen ______________________________

Hydrogen ______________________________

0 7 . 2

How does the equation for the reaction show that the atom economy of the forward reaction is 100%? [1 mark]

____

____

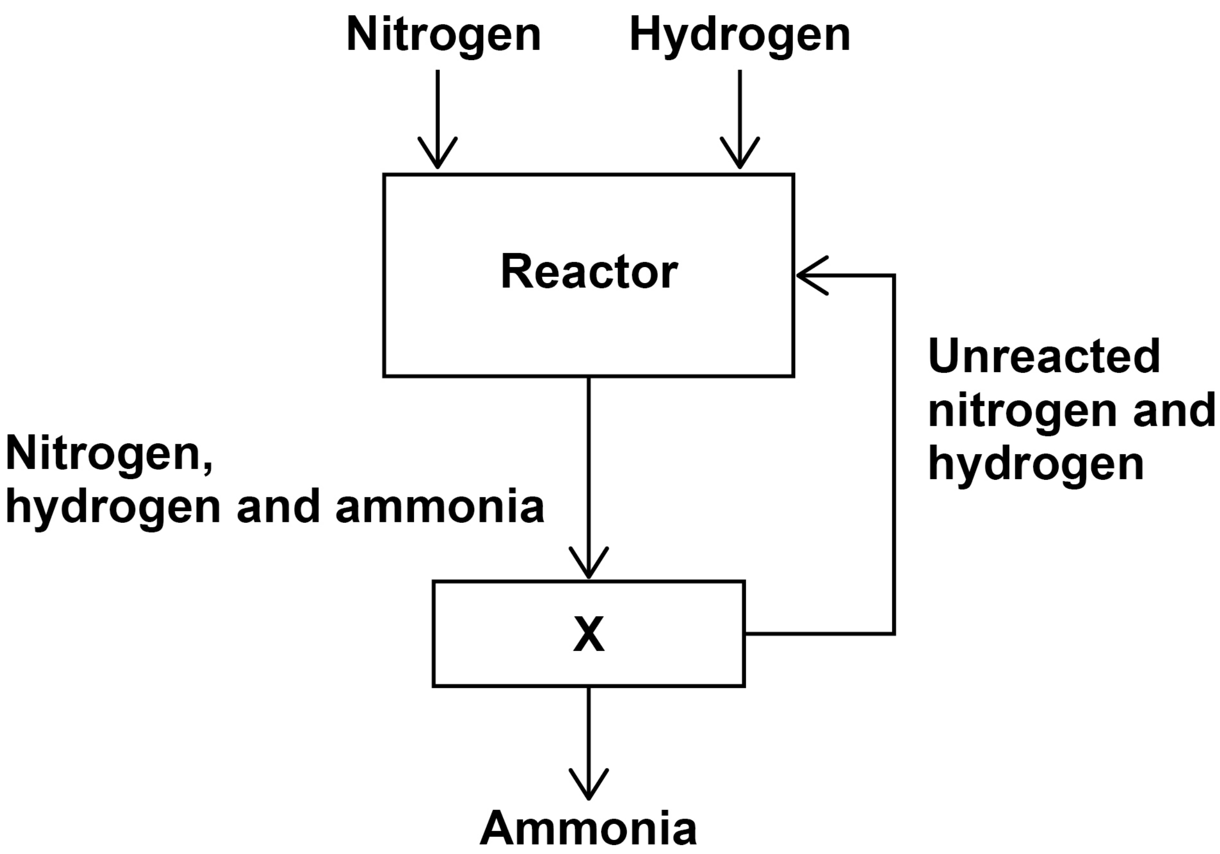
____

[Turn over]

0 7 . 3

FIGURE 4 represents the Haber process.

FIGURE 4



Explain how the ammonia produced is separated from the unreacted nitrogen and hydrogen in X. [2 marks]

[Turn over]

The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres.

TABLE 6 shows the percentage yield of ammonia produced at 450 °C using different pressures.

TABLE 6

Pressure in atmospheres	Percentage (%) yield of ammonia
60	9
120	18
180	25
240	31
300	36
360	40
420	43

0 7 . 4

Complete FIGURE 5, on the opposite page.

The first two points have been plotted.

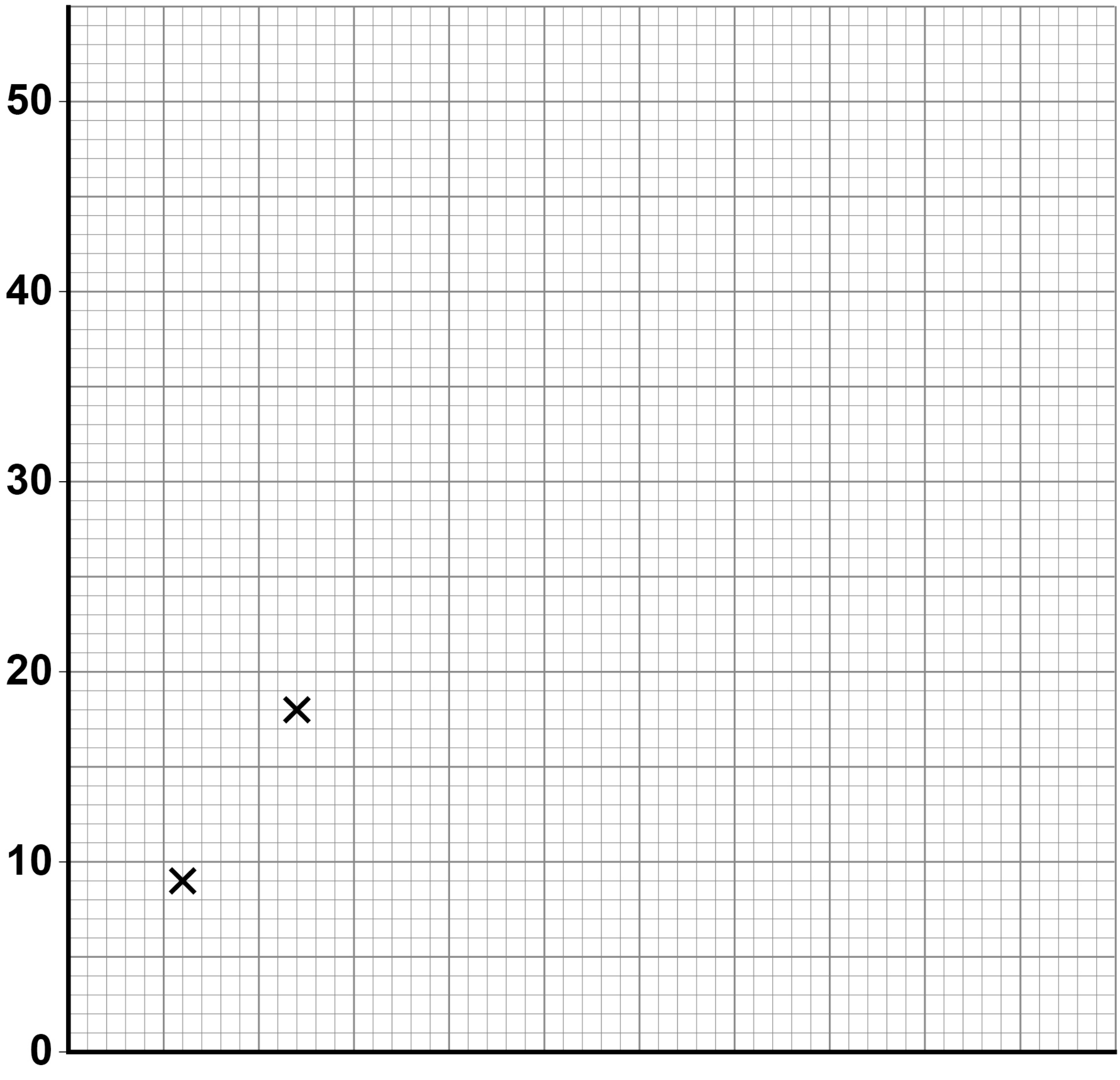
You should:

- use a suitable scale for the *x*-axis
- plot the remaining data from TABLE 6
- draw a line of best fit.

[4 marks]

FIGURE 5

**Percentage (%)
yield of ammonia**



Pressure in atmospheres

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0 7 . 5

Determine the percentage yield of ammonia at 450 °C and 500 atmospheres.

Show your working on FIGURE 5, on page 47. [2 marks]

Percentage yield = __________________________ %

[Turn over]

07.6

The equation for the production of ammonia in the Haber process is:

$N_2(g) \quad + \quad 3\,H_2(g) \quad \rightleftharpoons \quad 2\,NH_3(g)$

The forward reaction is exothermic.

The conditions used are:

- a temperature of 450 °C
- a pressure of 200 atmospheres
- the presence of an iron catalyst.

Explain why these conditions are chosen for economical production of ammonia in the Haber process.

You should include references to the rate of reaction and the position of equilibrium. [6 marks]

[Turn over]

17

0 8

This question is about the reaction between sodium thiosulfate solution and hydrochloric acid.

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

The equation for the reaction is:

$Na_2S_2O_3(aq) + 2\,HCl(aq) \rightarrow$

$2\,NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$

0 8 . 1

Sulfur is produced in the reaction.

Why does the mixture become cloudy? [1 mark]

____

____

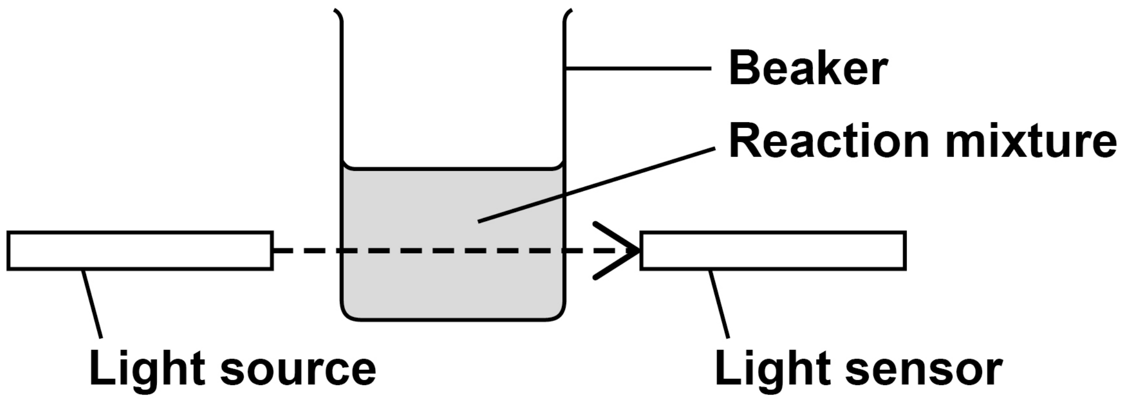
____

[Turn over]

A student investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

FIGURE 6 shows the apparatus used.

FIGURE 6



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 0.10 mol/dm^3 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.
5. Repeat steps 1 to 4 using 0.20 mol/dm^3 sodium thiosulfate solution.

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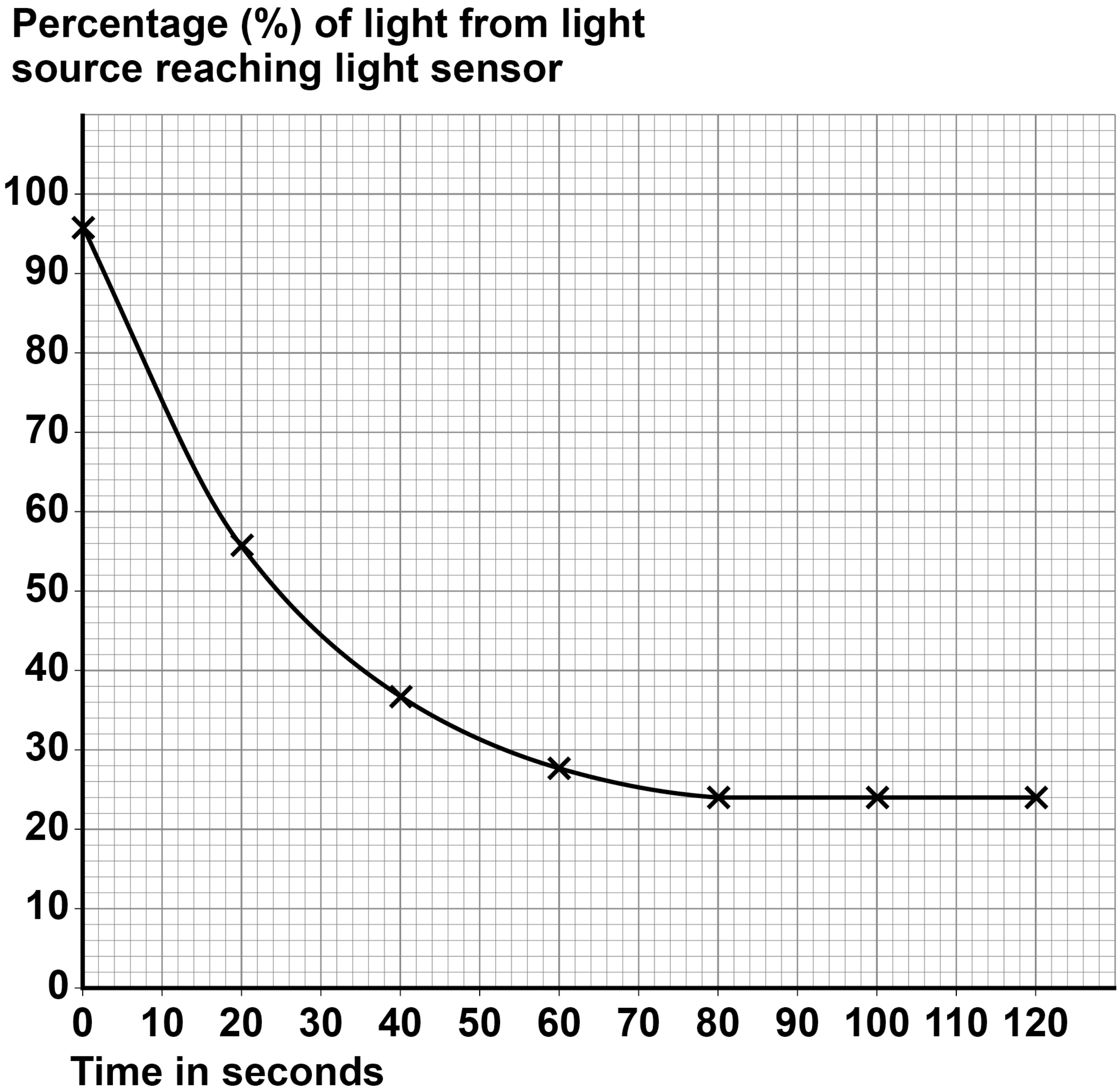
[Turn over]

FIGURE 7 shows the results for 0.10 mol/dm^3 sodium thiosulfate solution.

FIGURE 7



0 8 . 2

The percentage of light reaching the light sensor decreases by 1% when 7.1×10^{-5} moles of sulfur is produced.

Determine the rate of reaction in mol/s for the production of sulfur at 30 seconds.

You should draw a tangent on FIGURE 7. [5 marks]

[Turn over]

Rate = ______________________________ mol/s

0 8 . 3

Explain why the rate of reaction changes between 0 and 60 seconds.

Answer in terms of concentration.

Use FIGURE 7, on page 56. [2 marks]

[Turn over]

FIGURE 8 is a repeat of FIGURE 7.

FIGURE 8

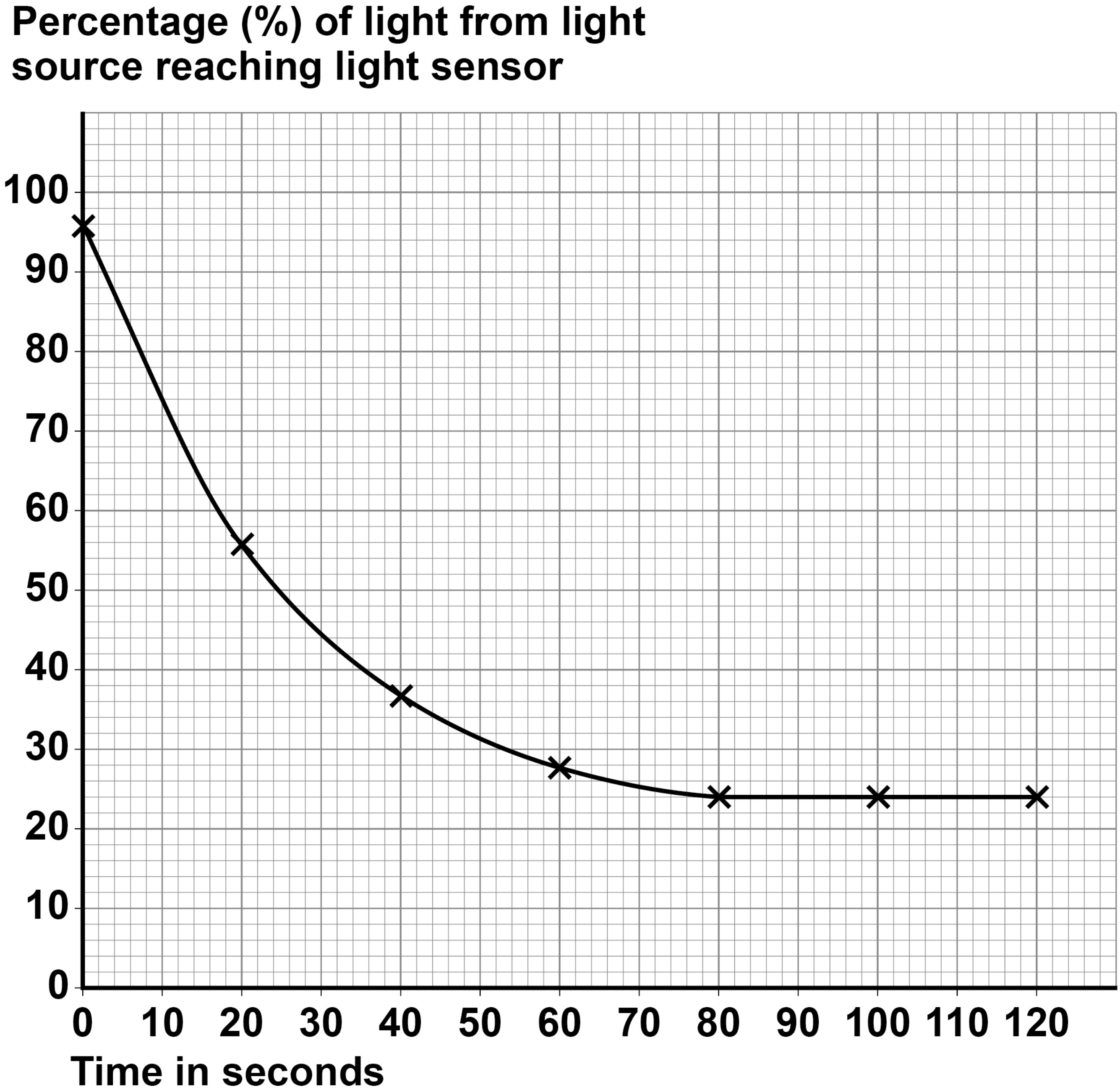


FIGURE 8 shows the results for 0.10 mol/dm^3 sodium thiosulfate solution.

Sodium thiosulfate solution was in excess in the investigation.

0 8 . 4

The line of best fit on FIGURE 8 is horizontal between 80 and 120 seconds because the reaction stopped.

Why did the reaction stop? [1 mark]

____

____

____

0 8 . 5

Sketch a line on FIGURE 8, on the opposite page to show the results you would predict for 0.20 mol/dm^3 sodium thiosulfate solution. [2 marks]

[Turn over]

The same student did the investigation again the next day.

The student found that the same method produced different results for the percentage of light reaching the light sensor.

0 8 . 6

How could the student improve the method so that the same percentages of light reached the light sensor?
[1 mark]

Tick (✓) ONE box.

- [ ] Record the percentage of light every 10 seconds.
- [ ] Stop light from other sources reaching the light sensor.
- [ ] Use a larger volume of sodium thiosulfate solution.
- [ ] Use a more sensitive light sensor.

0 8 . 7

The student improved the method so that similar results were obtained on different days.

What name is given to similar results obtained on different days under the same conditions by the same student? [1 mark]

Tick (✓) ONE box.

☐ **Anomalous**

☐ **Precise**

☐ **Repeatable**

☐ **Reproducible**

[Turn over]

FIGURE 9, on the opposite page, shows the volumes of:

- **sodium thiosulfate solution of concentration 0.10 mol/dm^3**
- **hydrochloric acid of concentration 0.05 mol/dm^3**

which completely react to produce different masses of sulfur.

0 8 . 8

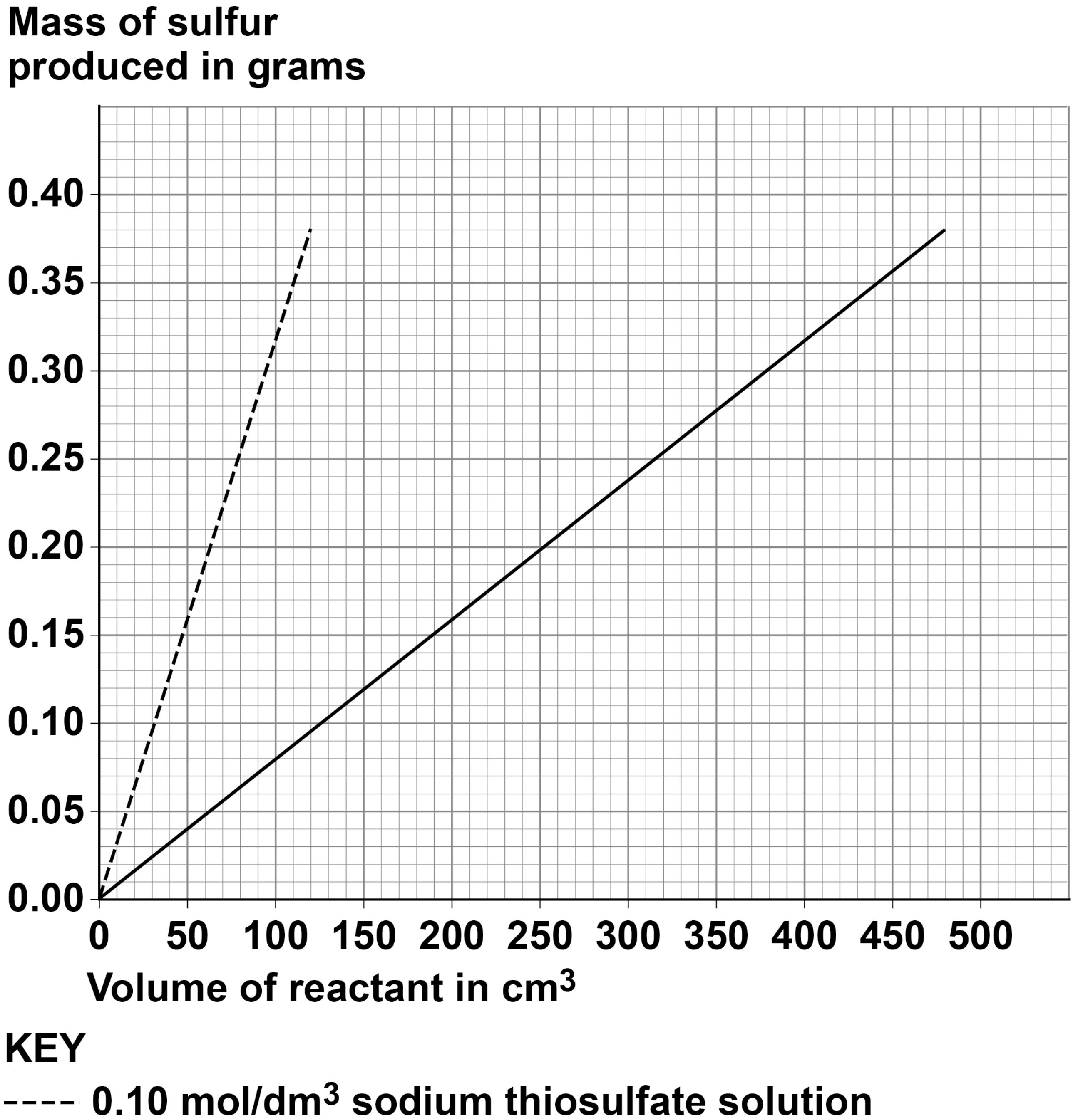
Which expression represents the relationship between the volume (V) of sodium thiosulfate solution used and the mass (m) of sulfur produced?

Use FIGURE 9. [1 mark]

Tick (✓) ONE box.

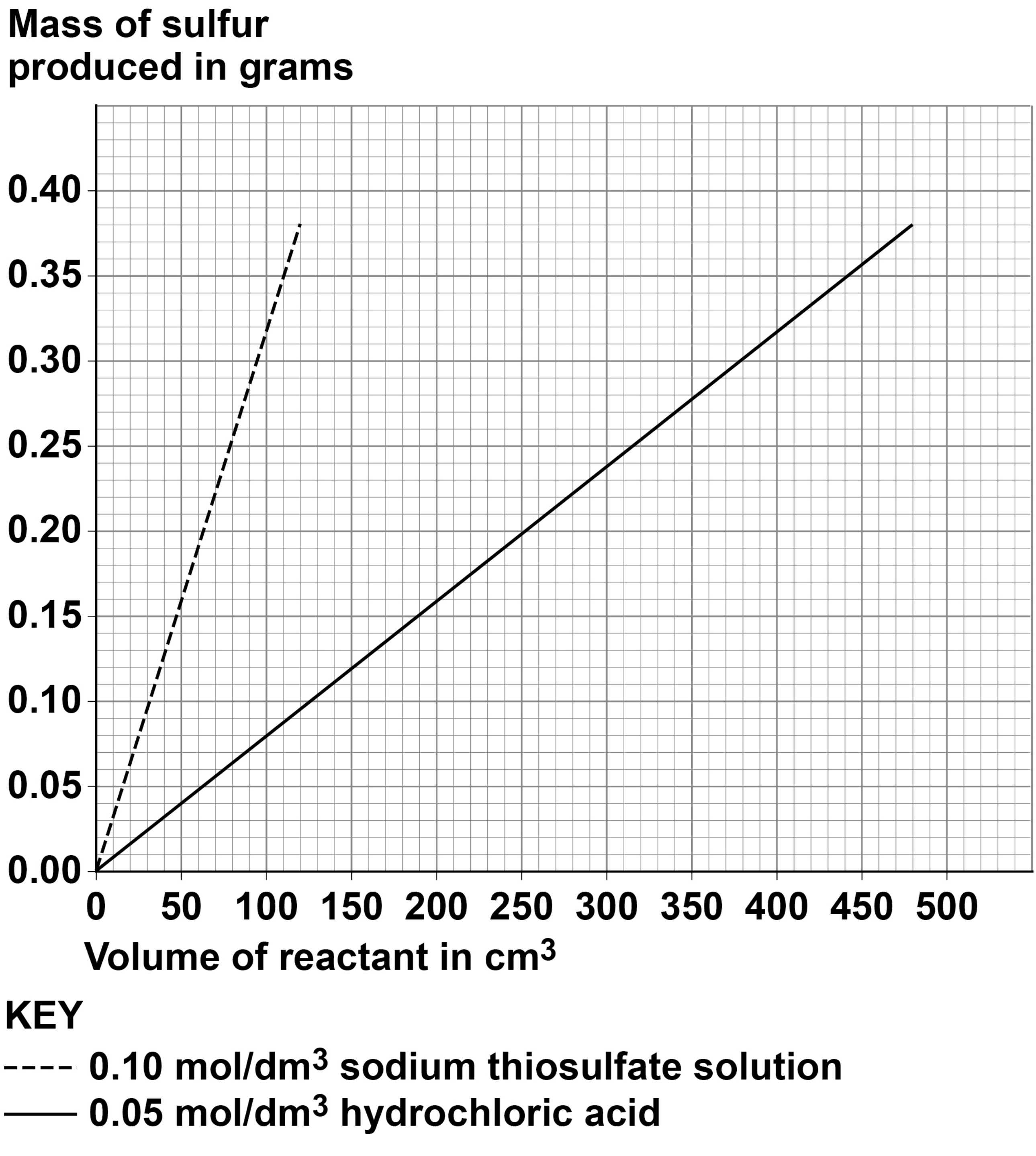
- [ ] **$V \propto m$**
- [ ] **$V \sim m$**
- [ ] **$V \ll m$**
- [ ] **$V = m$**

FIGURE 9



[Turn over]

REPEAT OF FIGURE 9



0 8 . 9

Determine the simplest whole number ratio of the volumes of

sodium thiosulfate solution : hydrochloric acid

which completely react with each other.

Use FIGURE 9. [3 marks]

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____

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____

____

____

Simplest whole number ratio = ___________ : ___________

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	
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7	
8	
TOTAL	

IB/M/NC/Jun22/8462/2H/E4