A

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE

COMBINED SCIENCE: TRILOGY

Higher Tier

Chemistry Paper 2H

H

8464/C/2H

Tuesday 13 June 2023 Morning

Time allowed: 1 hour 15 minutes

[Turn over]

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At the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

MATERIALS

For this paper you must have:

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

[Turn over]

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided.**
- **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 70.**
- **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

The combustion of fuels is a source of atmospheric pollutants.

0 1 . 1

Methane is a fuel.

Balance the equation for the combustion of methane. [1 mark]

$CH_4 +$ _____ $O_2 \longrightarrow CO_2 +$ _____ H_2O

0 1 . 2

Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

TABLE 1, on the opposite page, shows properties of petrol and of diesel.

TABLE 1

	PETROL	DIESEL
Range of number of carbon atoms in a hydrocarbon molecule	4 to 12	12 to 20
Range of boiling points in °C	40 to 205	250 to 350

Compare the properties of petrol and diesel.

Use TABLE 1. [2 marks]

0 1 . 3

The gases released when a fuel is burned in car engines may include:

- **oxides of nitrogen**
- **carbon monoxide**
- **water vapour.**

Which chemical element do all these gases contain? [1 mark]

Tick (✓) ONE box.

☐ **Carbon**

☐ **Hydrogen**

☐ **Nitrogen**

☐ **Oxygen**

0 1 . 4

When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?
[1 mark]

0 1 . 5

When diesel burns, particulates may be produced.

What environmental effect do particulates from burning diesel cause?

[1 mark]

0 1 . 6

Carbon monoxide may be produced when diesel burns.

Give ONE reason why carbon monoxide is difficult to detect. [1 mark]

_____

_____

_____

[Turn over]

0 1 . 7

Explain why water vapour and NOT liquid water is produced when diesel burns.
[2 marks]

0 1 . 8

Sulfur is a common impurity in diesel.

Explain why this causes an environmental problem. [3 marks]

0 2

Chromatography is used to separate mixtures.

Chromatography involves a mobile phase and one other phase.

0 2 . 1

What is the other phase in chromatography? [1 mark]

Tick (✓) ONE box.

- ☐ **Moving phase**
- ☐ **Recycled phase**
- ☐ **Stationary phase**
- ☐ **Viscous phase**

0 2 . 2

Why do the substances in the mixture separate in the mobile phase? [1 mark]

_____

_____

0 2 . 3

How many spots will be produced on the chromatogram of a pure compound? [1 mark]

Number of spots = _____

[Turn over]

0 2 . 4

In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the R_f value for the blue colour. [2 marks]

Rf value =

0 2 . 5

Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- **separate the colours in black ink**
- **identify the colours from their R_f values.**

[6 marks]

0 3

Crude oil is a mixture of many different compounds.

0 3 . 1

Give TWO reasons why crude oil is NOT a formulation. [2 marks]

1 _____

_____

_____

2 _____

_____

[Turn over]

0 3 . 2

Describe how crude oil is separated into fractions. [4 marks]

0 3 . 3

The fractions from crude oil contain alkanes.

Explain why alkanes are cracked.
[2 marks]

Cracking produces a mixture of products.

0 3 . 4

An equation for cracking decane ($C_{10}H_{22}$) is:

$$C_{10}H_{22}(l) \longrightarrow C_{10}H_{20}(l) + H_2(g)$$

Describe a test to identify the gas produced in the reaction. [2 marks]

Test

Result

0 3 . 5

Alkenes are produced in cracking.

The general formula for the homologous series of alkenes is C_nH_{2n}

Which formula represents an alkene? [1 mark]

Tick (✓) ONE box.

☐ C_2H_2

☐ C_2H_4

☐ C_2H_6

☐ C_3H_8

[Turn over]

11

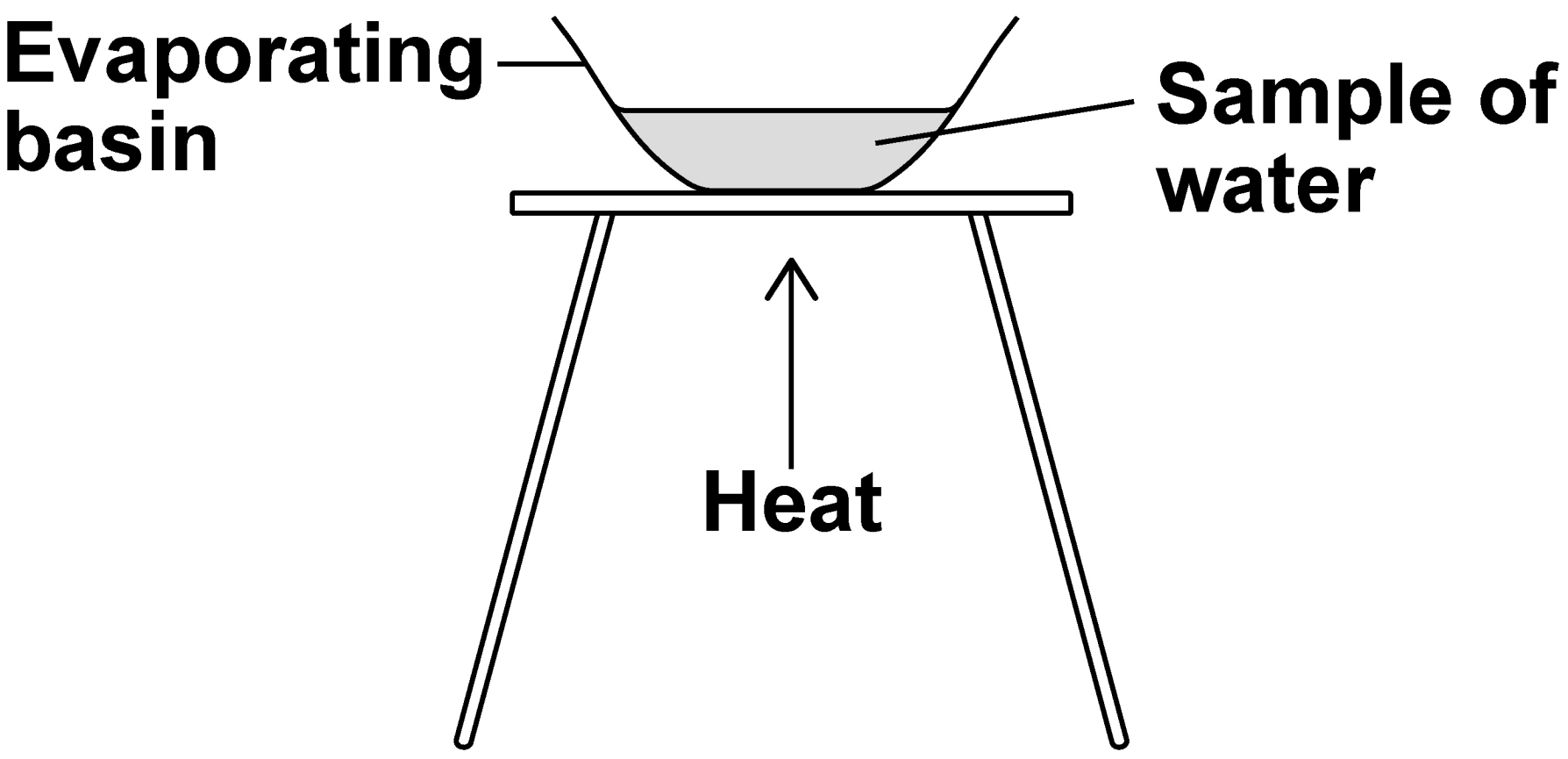
0 4

Some types of water contain dissolved substances.

A student investigated the mass of dissolved solids in distilled water and in sea water.

FIGURE 1 shows the apparatus.

FIGURE 1



This is the method used.

1. Weigh an evaporating basin.
2. Add 20 cm^3 of distilled water to the evaporating basin.
3. Weigh the evaporating basin and the water sample.
4. Heat the water sample for 2 minutes.
5. Weigh the evaporating basin and contents.
6. Repeat steps 1 to 5 two more times.
7. Repeat steps 1 to 6 with sea water.

[Turn over]

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0 4 . 1

The method used by the student did NOT give valid results.

Describe ONE improvement the student could make to obtain valid results.

[1 mark]

_____

_____

_____

[Turn over]

A different student used a method which gave valid results.

0 4 . 2

TABLE 2 shows the results.

TABLE 2

	Mass of dissolved solids in grams			
Type of water	**TEST 1**	**TEST 2**	**TEST 3**	**MEAN**
Distilled water	**0.00**	**0.00**	**0.00**	**0.00**
Sea water	**0.30**	**X**	**0.26**	**0.29**

Calculate the value X for the mass of dissolved solids in sea water in TEST 2. [2 marks]

_____

_____

_____

Mass X = _____ g

[Turn over]

0 4 . 3

The student concludes that distilled water is pure.

Describe a test to confirm that distilled water is pure. [2 marks]

Test _____

_____

_____

Result _____

_____

_____

Tap water is potable.

A stage in the production of potable water is sterilising.

A gas is used to sterilise water.

The equation for the reaction is:

$$Cl_2(g) + H_2O(l) \rightleftharpoons HOCl(aq) + HCl(aq)$$

0 4 . 4

What is meant by the symbol $\rightleftharpoons$?

[1 mark]

0 4 . 5

The reaction is at equilibrium.

The reaction is exothermic.

What happens to the equilibrium position when the temperature is increased?
[1 mark]

Tick (✓) ONE box.

☐ **Shifts towards the left-hand side**

☐ **Stays in the same place**

☐ **Shifts towards the right-hand side**

0 4 . 6

Describe a test to identify the gas used to sterilise water. [2 marks]

Test _____

_____

Result _____

_____

_____

[Turn over]

0 4 . 7

Another stage in the production of potable water is filtering.

Explain why potable water contains dissolved solids after filtering. [2 marks]

0 5

An increase of greenhouse gases in the Earth's atmosphere is causing global warming.

Global warming is causing global climate change.

0 5 . 1

Give ONE effect of global climate change. [1 mark]

_____

_____

0 5 . 2

Explain how greenhouse gases cause global warming. [4 marks]

0 5 . 3

Explain how planting trees reduces global warming. [3 marks]

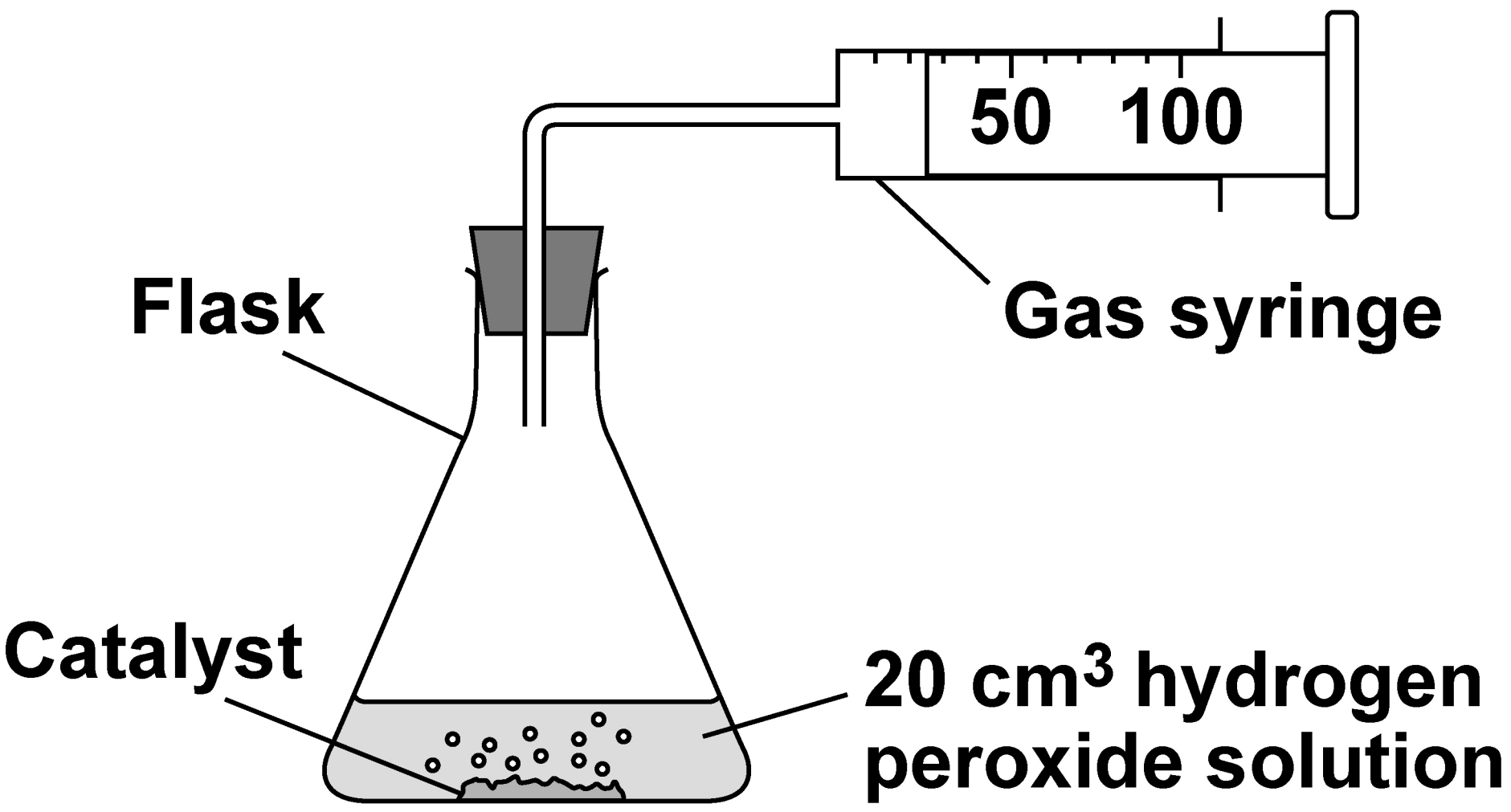
0 6

A student investigated the rate of decomposition of hydrogen peroxide using three different catalysts:

- **manganese dioxide**
- **copper oxide**
- **zinc oxide.**

FIGURE 2 shows the apparatus.

FIGURE 2



This is the method used.

1. **Measure 20 cm^3 of hydrogen peroxide solution into a flask.**
2. **Add 0.5 g of manganese dioxide catalyst to the flask.**
3. **Attach a gas syringe to the flask.**
4. **Measure the volume of oxygen produced every 30 seconds for 180 seconds.**
5. **Repeat steps 1 to 4 two more times.**
6. **Repeat steps 1 to 5 using copper oxide catalyst.**
7. **Repeat steps 1 to 5 using zinc oxide catalyst.**

[Turn over]

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0 6 . 1

The equation for the decomposition of hydrogen peroxide is:

$$2\,H_2O_2 \longrightarrow 2\,H_2O + O_2$$

Describe a test to identify the gas produced in the reaction. [2 marks]

Test _____

_____

_____

Result _____

_____

[Turn over]

0 6 . 2

Using 10 cm^3 of hydrogen peroxide solution gives less accurate results than using 20 cm^3 of hydrogen peroxide solution of the same concentration.

Explain why. [2 marks]

0 6 . 3

Suggest ONE possible source of systematic error in the investigation.
[1 mark]

TABLE 3 shows the results for manganese dioxide catalyst.

TABLE 3

Time in seconds	0	30	60	90	120	150	180
Volume of gas in cm^3	0	22	38	41	54	58	60

FIGURE 3, on the opposite page, shows a graph of the results with copper oxide catalyst and with zinc oxide catalyst.

0 6 . 4

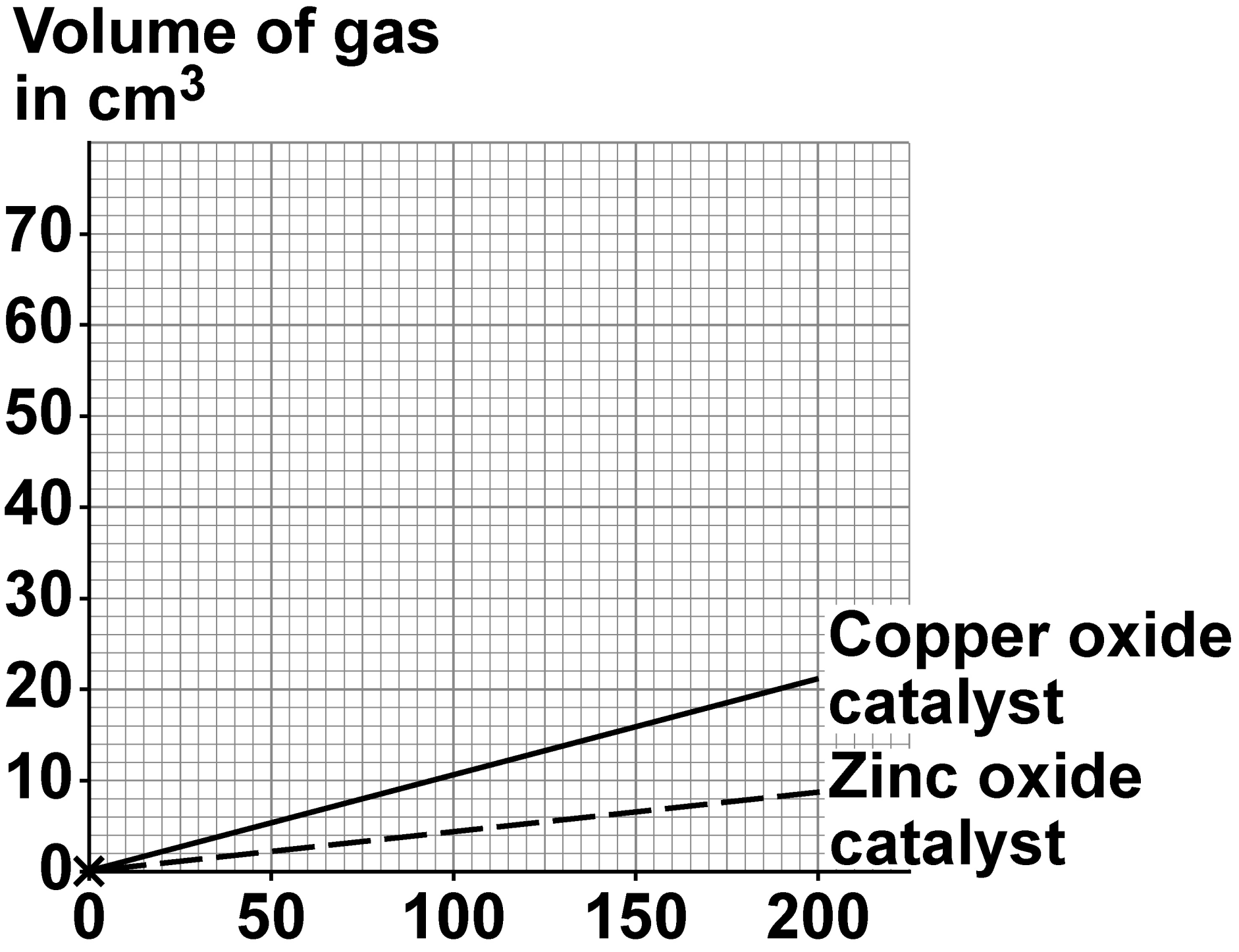
Complete FIGURE 3.

You should:

- **plot the data from TABLE 3**
- **draw a line of best fit.**

The first point has been plotted for you.
[3 marks]

FIGURE 3



[Turn over]

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0 6 . 5

Which catalyst gives the fastest RATE of reaction?

Give ONE reason for your answer.

Use the completed FIGURE 3, on page 45. [2 marks]

Catalyst _____

_____

Reason _____

_____

_____

[Turn over]

0 6 . 6

The rate of reaction is NOT dependent on the volume of hydrogen peroxide solution.

Explain why. [2 marks]

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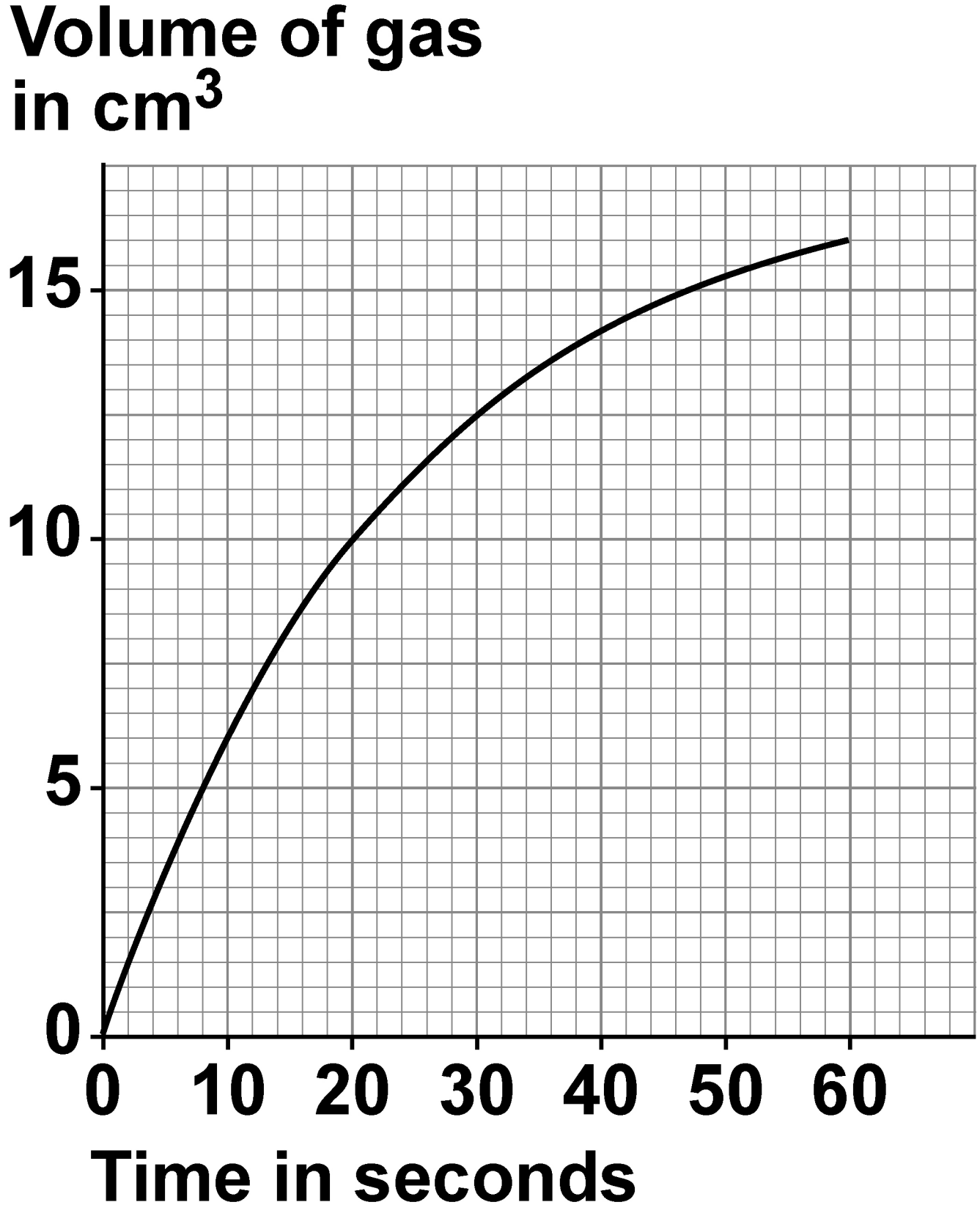
[Turn over]

0 6 . 7

FIGURE 4 shows the results from a different investigation.

FIGURE 4



Determine the rate of reaction at 20 seconds.

Show your working on FIGURE 4, on the opposite page.

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

Rate (3 significant figures) =

_____ cm^3/s

END OF QUESTIONS

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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.

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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