Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE
CHEMISTRY

H

Higher Tier Paper 2

8462/2H

Tuesday 11 June 2024 Morning

Time allowed: 1 hour 45 minutes

[Turn over]

JUN248462 2H 01

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On 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).**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**

[Turn over]

- **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.**

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.**

- **In all calculations, show clearly how you work out your answer.**
- **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

A student investigated an aqueous solution of a salt.

The student identified that the salt solution contained only sodium ions and chloride ions.

0 1 . 1

Describe a test to identify sodium ions.

Give the result of the test. [2 marks]

Test for sodium ions

Result

0 1 . 2

Describe a test to identify chloride ions.

Give the result of the test. [2 marks]

Test for chloride ions _____

_____

_____

Result _____

_____

_____

The student determined the concentration of sodium chloride in the salt solution.

This is the method used.

1. **Weigh an empty evaporating dish.**
2. **Add 25.0 cm^3 of the salt solution into the evaporating dish.**
3. **Heat the evaporating dish and contents.**
4. **Weigh the evaporating dish and contents.**
5. **Repeat steps 3 to 4 until there is no further change in mass.**
6. **Repeat steps 1 to 5 three more times.**

0 1 . 3

Why did the student heat the evaporating dish and contents until the mass did not change? [1 mark]

0 1 . 4

How did the student calculate the mass of solid sodium chloride remaining after steps 1 to 5? [1 mark]

Tick (✓) ONE box.

- ☐ **Mass of 25 cm^3 of salt solution + mass of empty evaporating dish**
- ☐ **Mass of 25 cm^3 of salt solution − mass of empty evaporating dish**
- ☐ **Mass of evaporating dish and dry contents + mass of empty evaporating dish**
- ☐ **Mass of evaporating dish and dry contents − mass of empty evaporating dish**

BLANK PAGE

[Turn over]

0 1 . 5

The student calculated the concentration of sodium chloride in the salt solution.

TABLE 1 shows the results.

TABLE 1

Concentration of sodium chloride in g/dm^3			
TRIAL 1	**TRIAL 2**	**TRIAL 3**	**TRIAL 4**
35.2	**34.6**	**36.4**	**33.8**

The percentage by mass of sodium ions in sodium chloride is 39.3%.

Calculate the mean concentration of sodium ions in the salt solution.
[4 marks]

Mean concentration =

g/dm^3

[Turn over]

10

0 2

This question is about ammonia and nitric acid.

In the Haber process ammonia is produced from nitrogen and hydrogen.

FIGURE 1, on the opposite page, represents the Haber process.

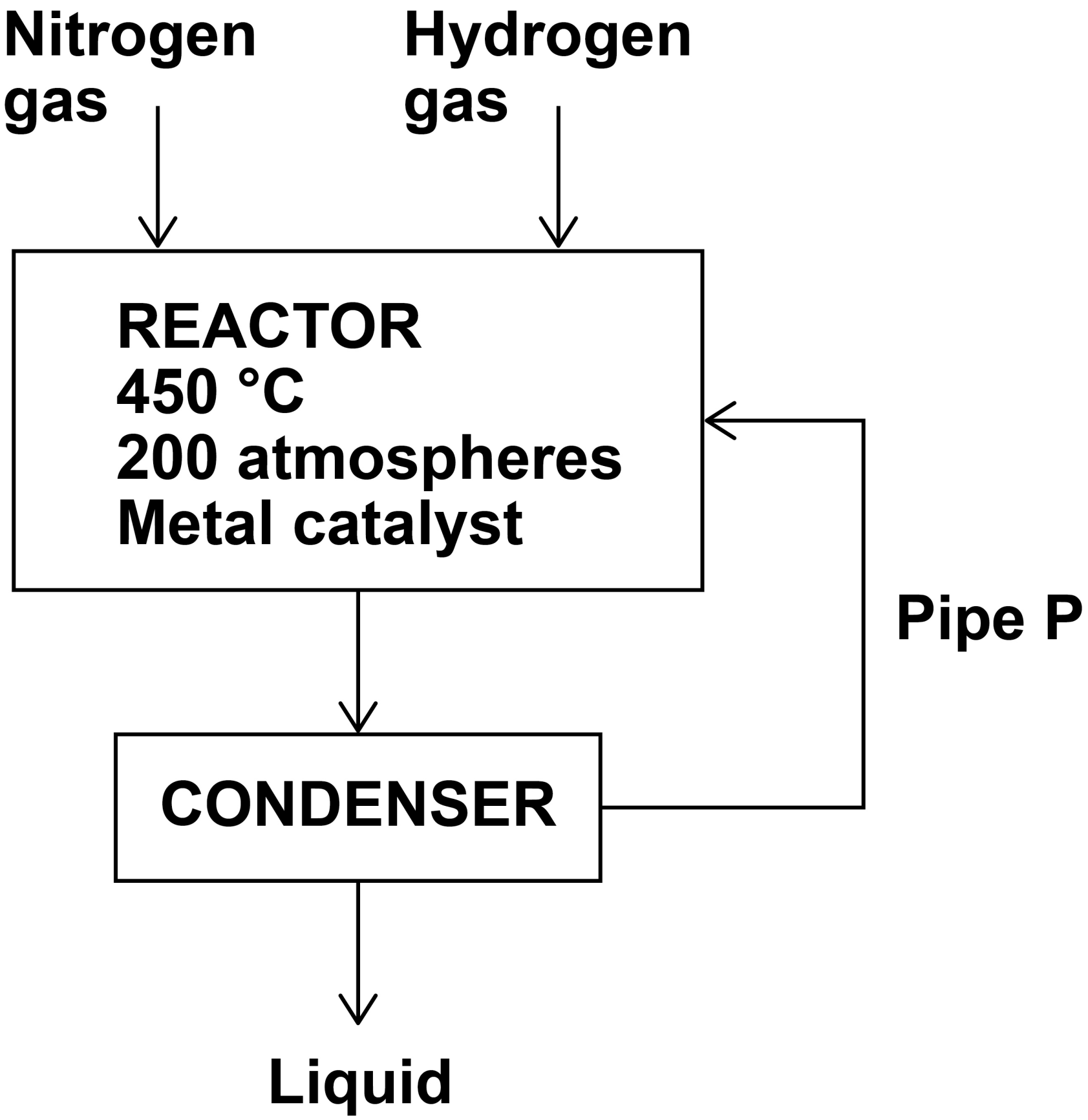
0 2 . 1

Pipe P links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use FIGURE 1. [1 mark]

FIGURE 1



[Turn over]

0 2 . 2

Which metal is used as a catalyst in this reaction? [1 mark]

Nitric acid is produced by reacting ammonia with oxygen.

The word equation for the production of nitric acid is:

ammonia + oxygen ⟶ water + nitric acid

Platinum is a catalyst in this reaction.

0 2 . 3

Describe the test for oxygen gas.

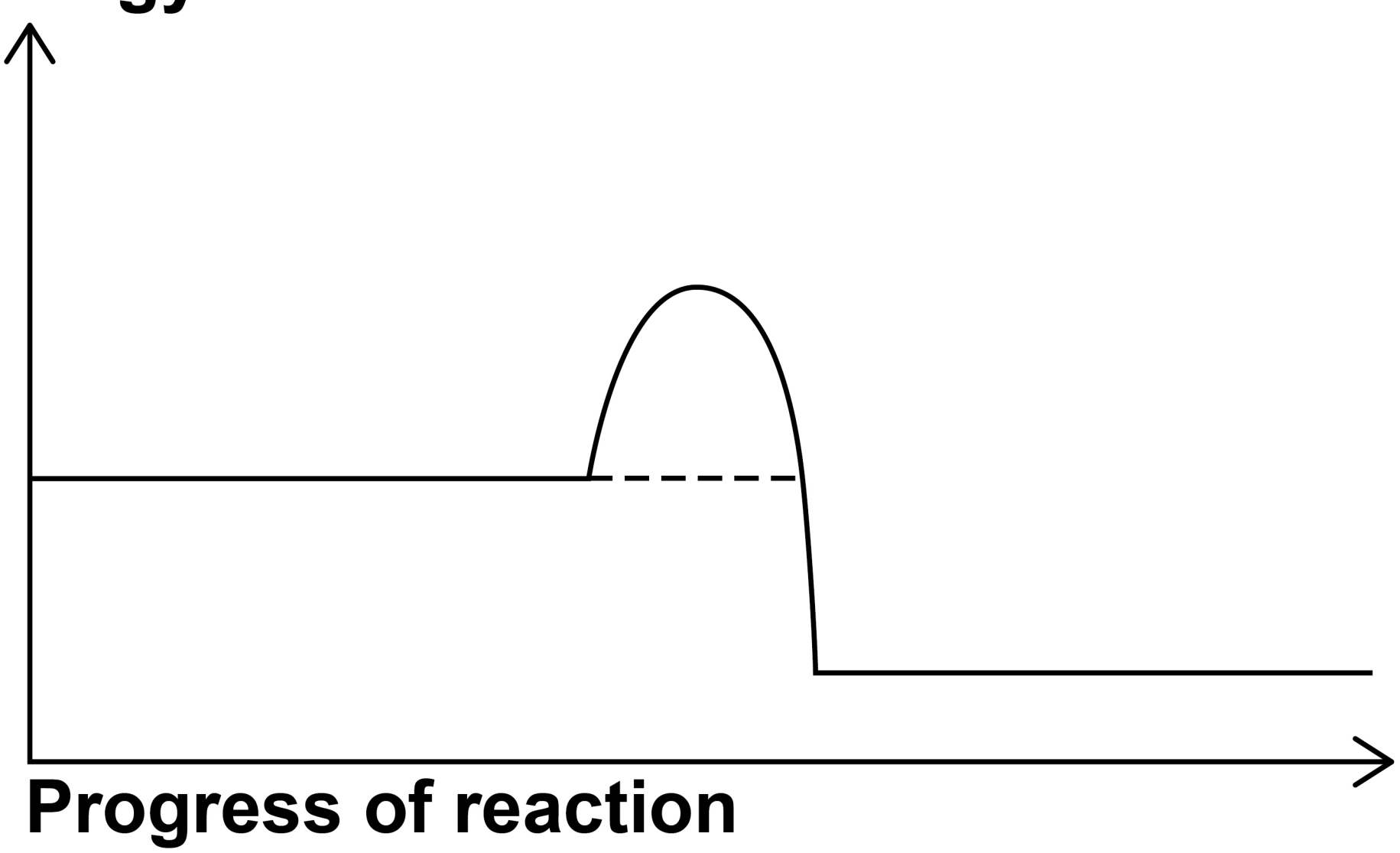
Give the result if oxygen gas is present.
[2 marks]

Test

Result

FIGURE 2 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

FIGURE 2



0 2 . 4

Complete the reaction profile for the catalysed reaction in FIGURE 2.

You should:

- **label the activation energy**
- **label the reactants and products, using the names of the reactants and products.**

[2 marks]

[Turn over]

0 2 . 5

How would FIGURE 2, on page 18, be different if NO catalyst was used?
[1 mark]

Tick (✓) ONE box.

☐ **The final energy level would be higher.**

☐ **The final energy level would be lower.**

☐ **The line would reach a higher peak.**

☐ **The line would reach a lower peak.**

0 2 . 6

Ammonia and nitric acid react to produce the salt, ammonium nitrate.

Ammonium ions and nitrate ions both contain nitrogen.

Suggest ONE use of ammonium nitrate.
[1 mark]

_____

_____

_____

[Turn over]

8

0 3

This question is about water.

0 3 . 1

Hydrogen gas reacts with oxygen gas to produce water.

Water is decomposed into hydrogen gas and oxygen gas using electricity.

Which TWO words, on the opposite page, describe the reaction between hydrogen gas and oxygen gas?
[2 marks]

Tick (✓) TWO boxes.

- ☐ **Alloying**
- ☐ **Combustion**
- ☐ **Corrosion**
- ☐ **Endothermic**
- ☐ **Reversible**

[Turn over]

0 3 . 2

Water molecules break down into hydrogen ions and hydroxide ions.

The equation for the reaction is:

$$H_2O \rightleftharpoons H^+ + OH^-$$

Which sentence describes this reaction at equilibrium? [1 mark]

Tick (✓) ONE box.

- ☐ **Water molecules break down at a higher rate than they reform.**
- ☐ **Water molecules break down and reform at the same rate.**
- ☐ **Water molecules break down at a lower rate than they reform.**

0 3 . 3

Water collected from rivers is used in the home for drinking and flushing toilets.

Water used in the home must be potable.

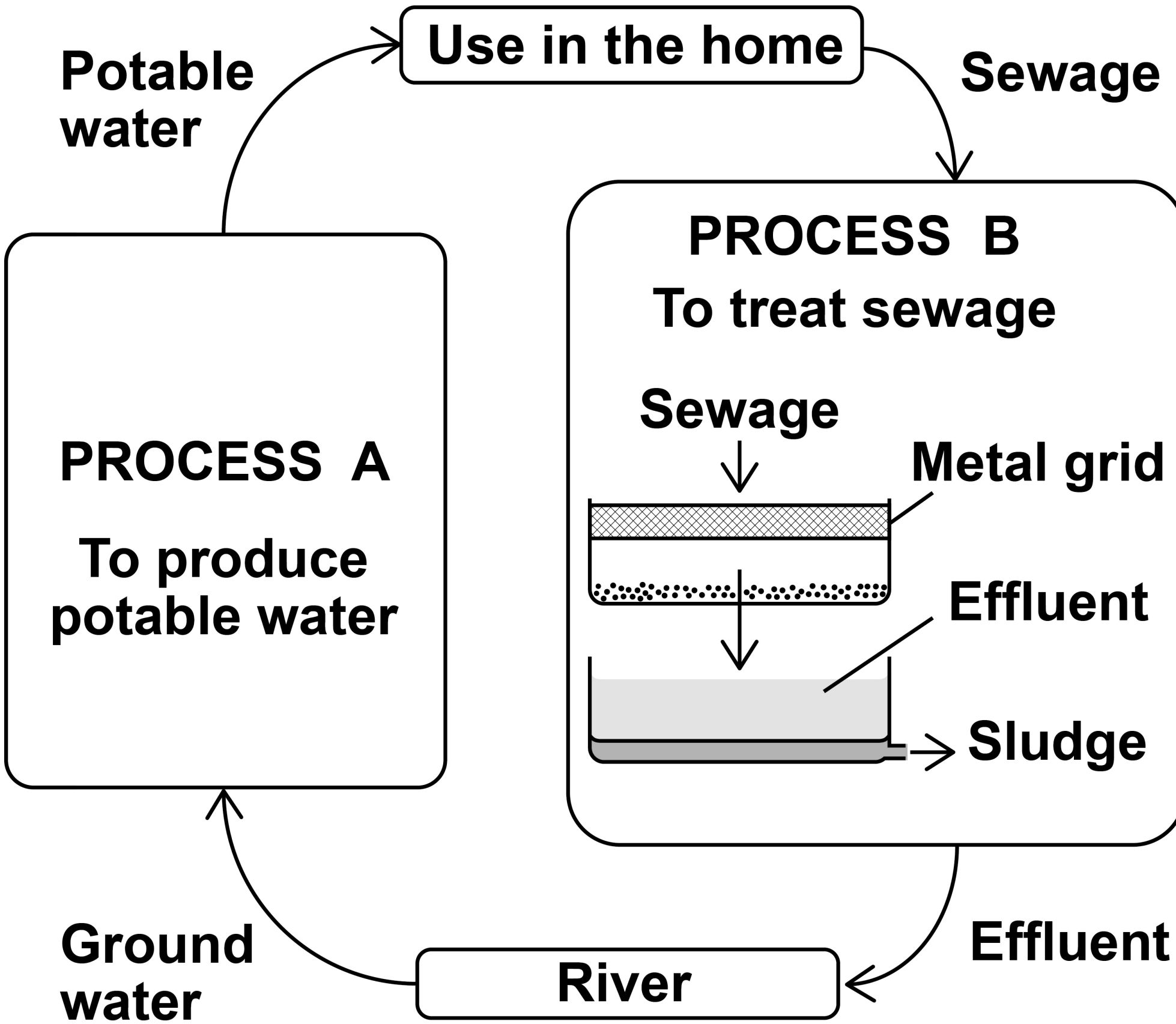
Potable water is safe to drink.

Waste water produced after use in the home is called sewage.

FIGURE 3, on page 26, shows how water is collected from rivers and returned to rivers after use.

[Turn over]

FIGURE 3


Potable water
Use in the home
Sewage
PROCESS A
To produce potable water
PROCESS B
To treat sewage
Sewage
Metal grid
Effluent
Sludge
Ground water
River
Effluent

Explain what happens to water in PROCESS A and in PROCESS B in FIGURE 3.

Do NOT refer to use of water in the home. [6 marks]

9

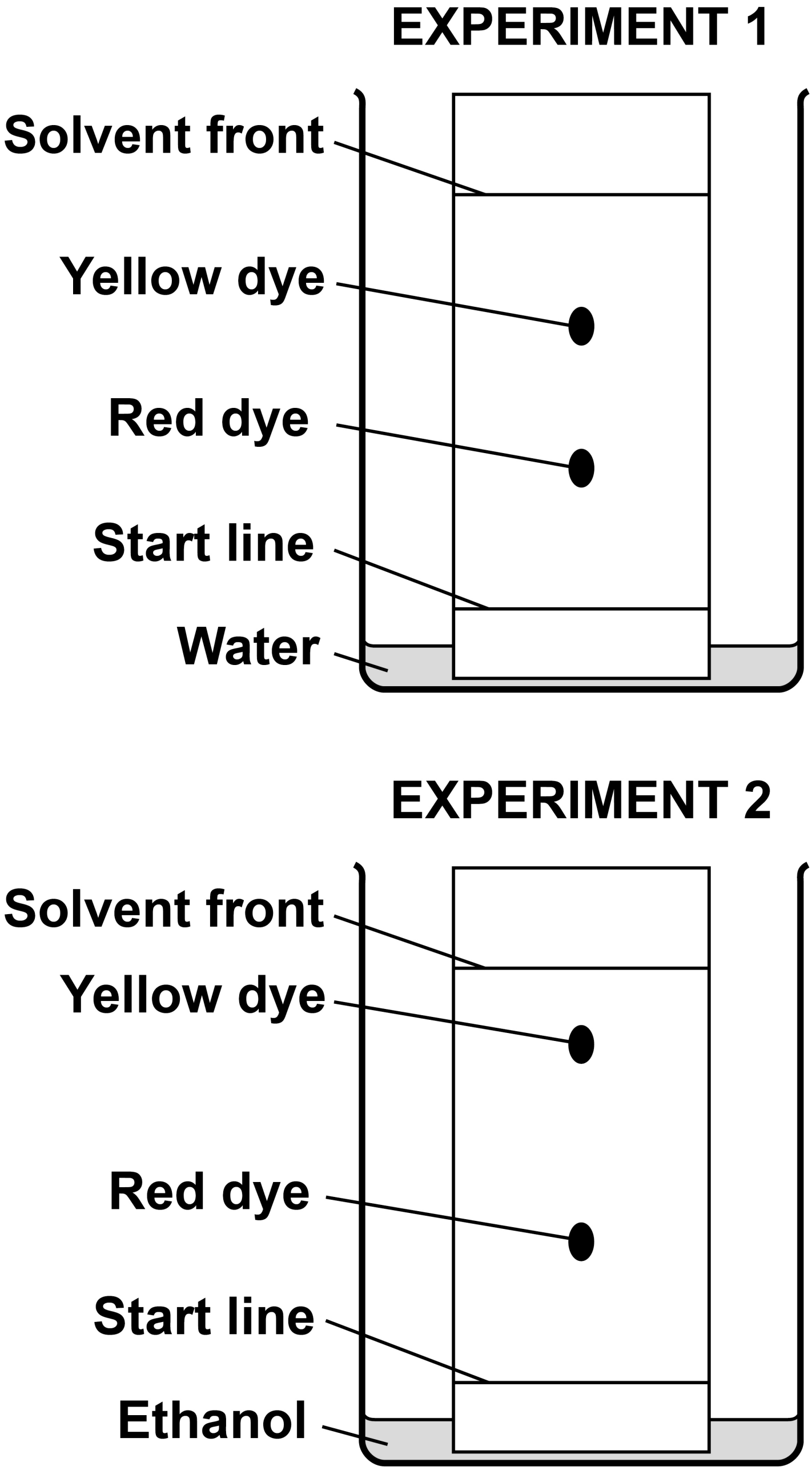
0 4

A student investigated an orange dye (A) using paper chromatography.

FIGURE 4, on page 30, shows the results of Experiment 1 and Experiment 2 using orange dye A.

[Turn over]

FIGURE 4


EXPERIMENT 1
Solvent front
Yellow dye
Red dye
Start line
Water
EXPERIMENT 2
Solvent front
Yellow dye
Red dye
Start line
Ethanol

0 4 . 1

Explain why the yellow dye and red dye travel different distances in Experiment 1.

Refer to forces of attraction between the dyes and the chromatography paper in your answer. [2 marks]

0 4 . 2

The student used the same type of chromatography paper in Experiment 1 and in Experiment 2.

Explain why the yellow dye is in different positions in Experiment 1 and in Experiment 2.

Use FIGURE 4, on page 30. [3 marks]

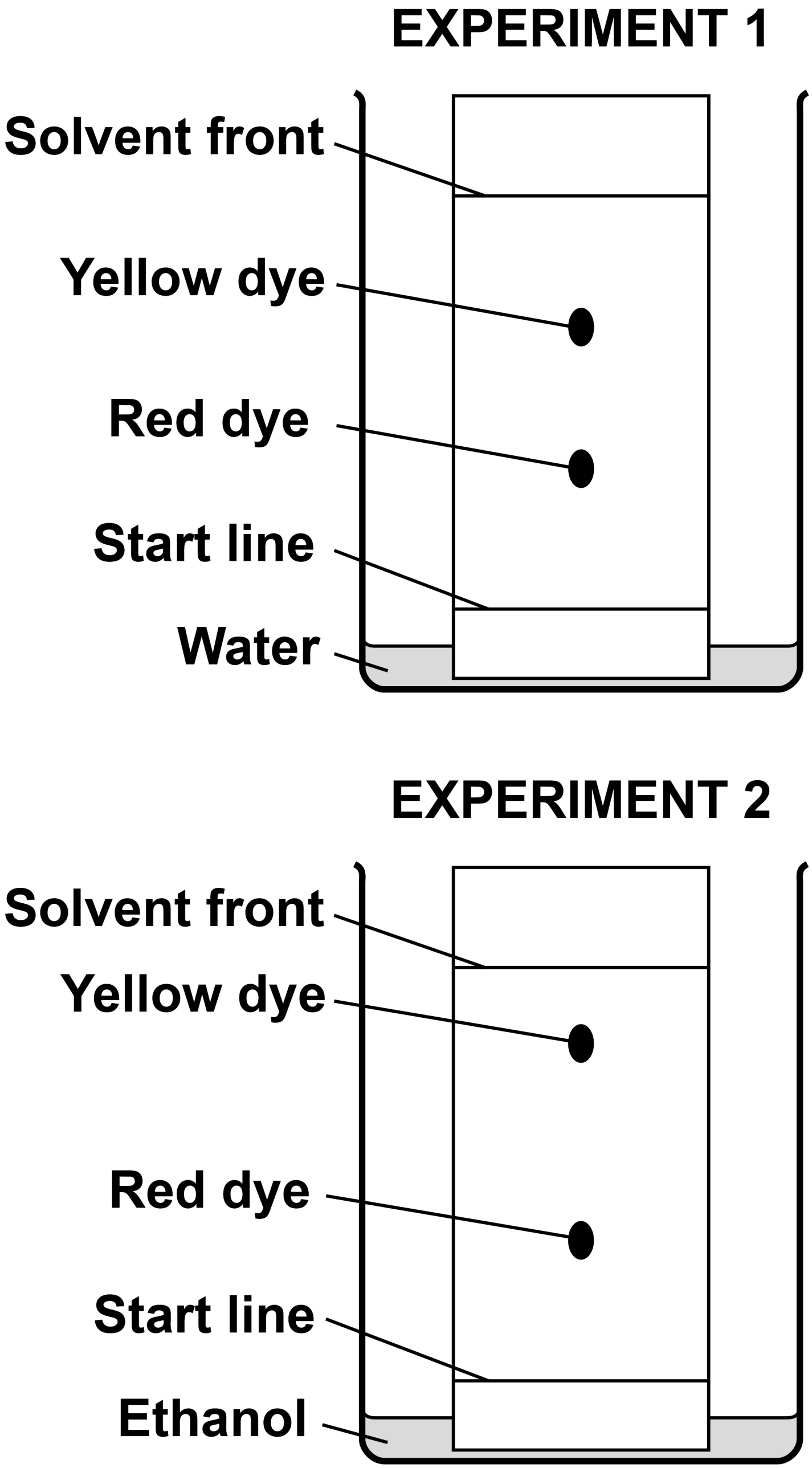
BLANK PAGE

[Turn over]

FIGURE 4 is repeated on the opposite page.

FIGURE 4 shows the results of Experiment 1 and Experiment 2 using orange dye A.

FIGURE 4

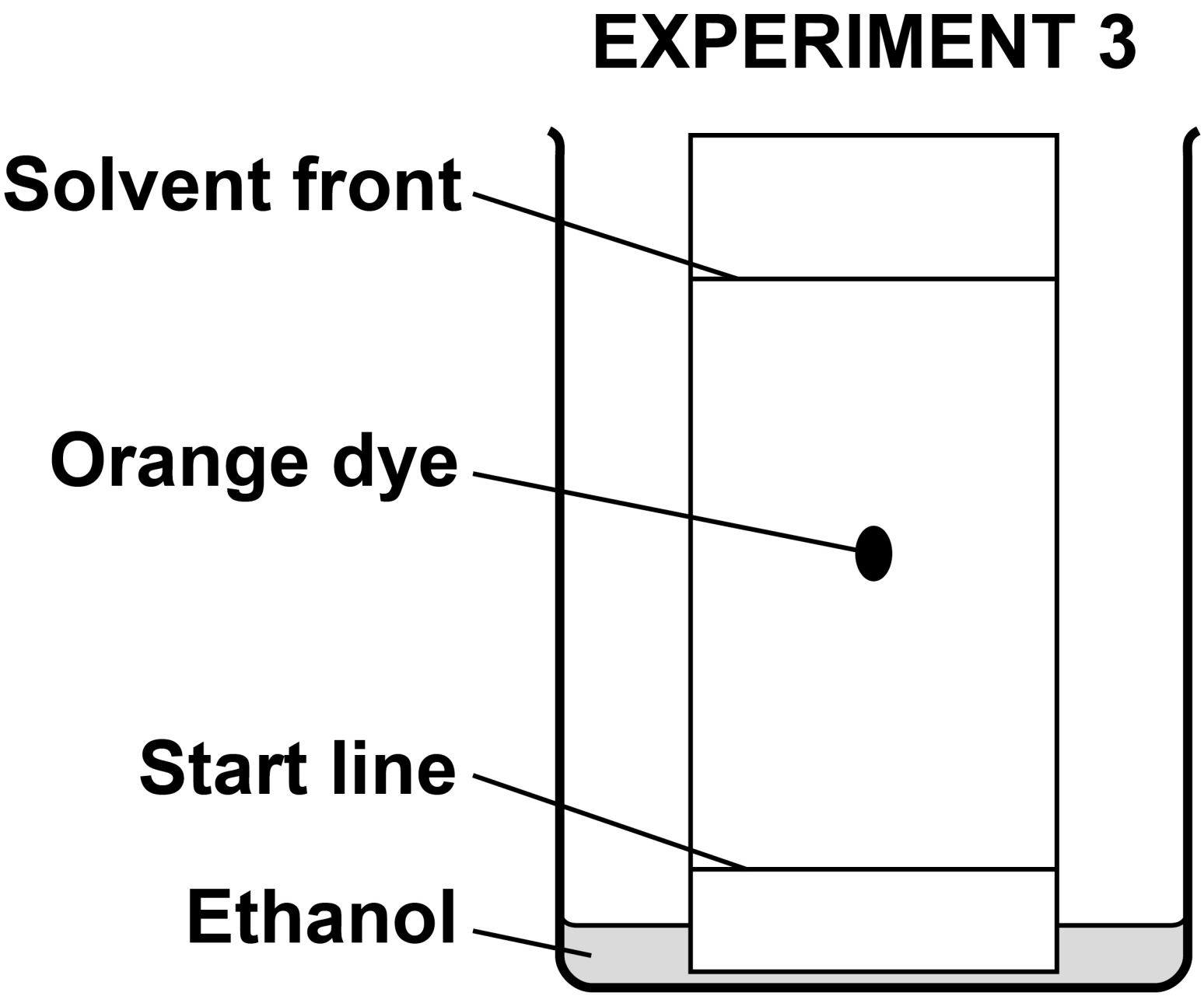


[Turn over]

The student investigated a different orange dye (B).

FIGURE 5 shows the results of Experiment 3 using orange dye B.

FIGURE 5



0 4 . 3

Compare the purity of the orange dyes A and B.

Give reasons for your answer.

Use FIGURE 4 and FIGURE 5, on pages 35 and 36. [2 marks]

0 4 . 4

The student calculated that the R_f value of the orange dye in the experiment shown in FIGURE 5, on page 36, was 0.48

Calculate the distance moved by the solvent front when the orange dye had moved 5.4 cm. [3 marks]

Distance moved by solvent front =

_____ cm

0 4 . 5

Why is the R_f value of a dye NOT affected by how far the solvent front is allowed to travel? [1 mark]

0 4 . 6

Another type of chromatography is called gas chromatography.

Gas chromatography is an instrumental method of chemical analysis.

Scientists tested the orange dyes using gas chromatography.

Suggest TWO advantages of using the instrumental method of gas chromatography rather than paper chromatography. [2 marks]

1 _____

_____

2 _____

_____

_____

13

BLANK PAGE

[Turn over]

0 5

This question is about burning fuels in central heating boilers.

In the future, gas central heating boilers may burn hydrogen rather than natural gas.

TABLE 2, on the opposite page, shows information about these fuels when 1 dm^3 of the fuel is burned in a central heating boiler.

TABLE 2

	FUEL	
	HYDROGEN	NATURAL GAS
Energy released in kJ	11.9	37.1
Mass of carbon dioxide produced in grams	0.00	1.83
Mass of water vapour produced in grams	0.75	1.50
Mass of oxides of nitrogen produced in grams	6.6×10^{-4}	4.9×10^{-4}

0 5 . 1

Explain how oxides of nitrogen are produced when burning fuels. [2 marks]

0 5 . 2

Explain ONE positive impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use TABLE 2, on page 43. [2 marks]

0 5 . 3

Explain ONE negative impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use TABLE 2, on page 43. [2 marks]

0 5 . 4

Air is 20% oxygen.

Calculate the volume of air needed to provide enough oxygen to react with 3.50 dm^3 of hydrogen gas.

The equation for the reaction is

$$2\ H_2 + O_2 \longrightarrow 2\ H_2O$$

[3 marks]

Volume of air = _____ dm^3

0 5 . 5

Central heating boilers can also burn kerosene.

Kerosene is produced from crude oil in a fractionating column using fractional distillation.

In the first step, crude oil is heated and hydrocarbon vapours are formed.

Explain how kerosene is produced from these hydrocarbon vapours. [3 marks]

[Turn over]

0 6

This question is about materials used to make bicycles.

FIGURE 6 shows a bicycle.

FIGURE 6

TABLE 3, on page 52, shows information about two materials used to make bicycle frames.

[Turn over]

TABLE 3

	MATERIAL	
	ALUMINIUM ALLOY	BAMBOO
Raw material	aluminium ore	bamboo plant
Cost of frame in £	250	1500
Strength in arbitrary units	290	193
Mass in kilograms	1.6	2.4
Lifespan in years	6–10	10–15
One method of disposal at end of life	recycled to make new products	burned to produce heat energy

0 6 . 1

Evaluate the use of aluminium alloy and of bamboo for making bicycle frames.

Use TABLE 3. [6 marks]

0 6 . 2

Explain why aluminium alloy bicycle frames do NOT need protection from corrosion. [2 marks]

0 6 . 3

Bicycle chains are made from an alloy of iron.

Bicycle chains rust without protection.

Paint is NOT used to protect bicycle chains from rusting.

Suggest how bicycle chains can be protected from rusting. [1 mark]

0 6 . 4

Bicycle frames can also be made from a composite of carbon fibres embedded in a polymer resin.

What description is given in this composite to:

- **the carbon fibre component**
- **the polymer resin component?**

[2 marks]

Carbon fibre _____

_____

Polymer resin _____

_____

0 7

This question is about sulfuric acid.

0 7 . 1

Sulfuric acid contains sulfate ions.

Describe the test for the presence of sulfate ions in sulfuric acid.

Give the result of the test. [2 marks]

Test _____

_____

_____

Result _____

_____

_____

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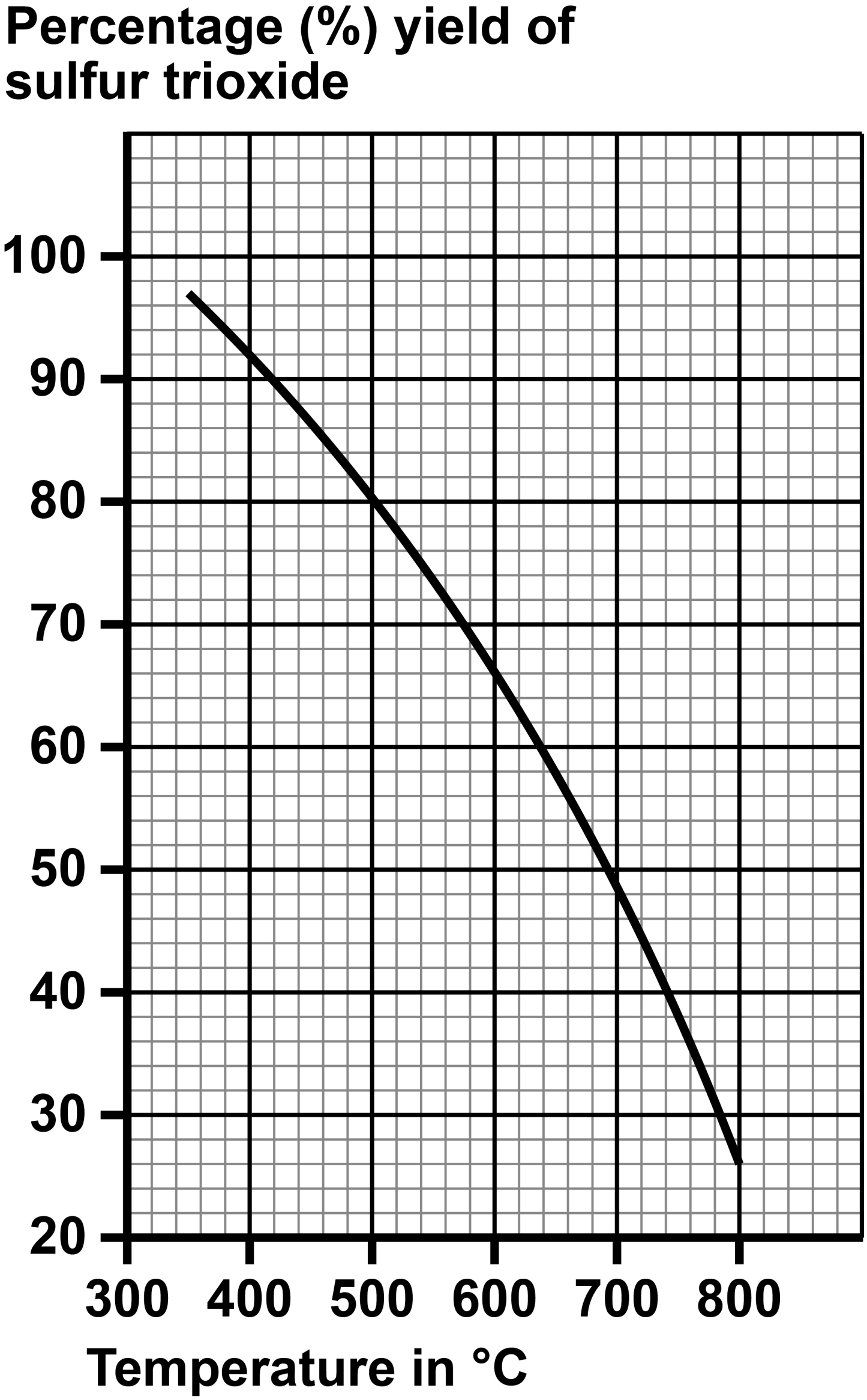
[Turn over]

One stage in the industrial production of sulfuric acid is the reaction of sulfur dioxide with oxygen to produce sulfur trioxide.

This reversible reaction reaches dynamic equilibrium.

FIGURE 7, on the opposite page, shows the percentage yield of sulfur trioxide in this reaction at different temperatures.

FIGURE 7



[Turn over]

0 7 . 2

Which statement, below and on the opposite page, about the forward reaction is correct?

Use FIGURE 7, on page 61. [1 mark]

Tick (✓) ONE box.

☐ **The yield is greater at higher temperatures because the reaction is exothermic.**

☐ **The yield is greater at higher temperatures because the reaction is endothermic.**

☐ **The yield is smaller at higher temperatures because the reaction is exothermic.**

☐ **The yield is smaller at higher temperatures because the reaction is endothermic.**

[Turn over]

The equation for the reaction is:

$$2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$$

0 7 . 3

Explain why the percentage yield of sulfur trioxide in this reaction is greater if the pressure is higher. [2 marks]

0 7 . 4

In industry, the reaction is done at 450 °C and atmospheric pressure.

Under these conditions the yield of sulfur trioxide is 86%.

Suggest TWO reasons why a higher pressure is NOT used. [2 marks]

1 _____

_____

_____

2 _____

_____

[Turn over]

0 7 . 5

This reaction uses a catalyst to increase the rate of the reaction.

The catalyst is a metal oxide.

Which is the most likely metal in the metal oxide catalyst?

Use the periodic table. [1 mark]

Tick (✓) ONE box.

- ☐ **Aluminium (Al)**
- ☐ **Barium (Ba)**
- ☐ **Potassium (K)**
- ☐ **Vanadium (V)**

8

BLANK PAGE

[Turn over]

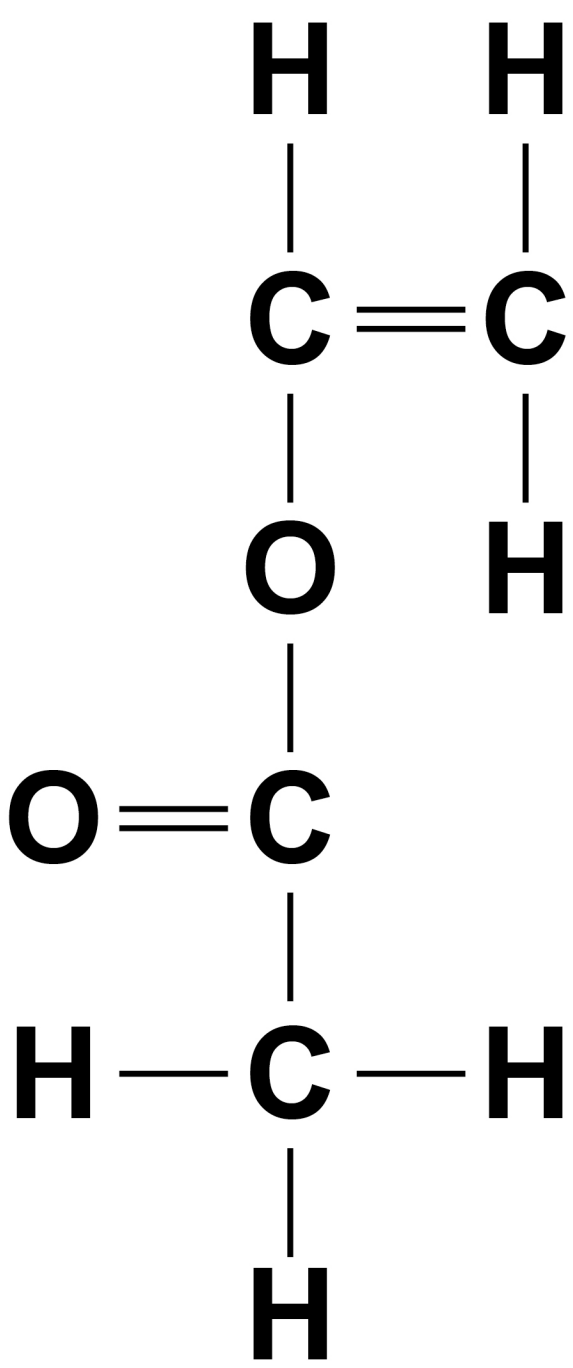
0 8

This question is about monomers and polymers.

Compound A has an alkene functional group and an ester functional group.

FIGURE 8, on the opposite page, represents a molecule of compound A.

FIGURE 8



0 8 . 1

Draw a circle around the alkene functional group on FIGURE 8. [1 mark]

[Turn over]

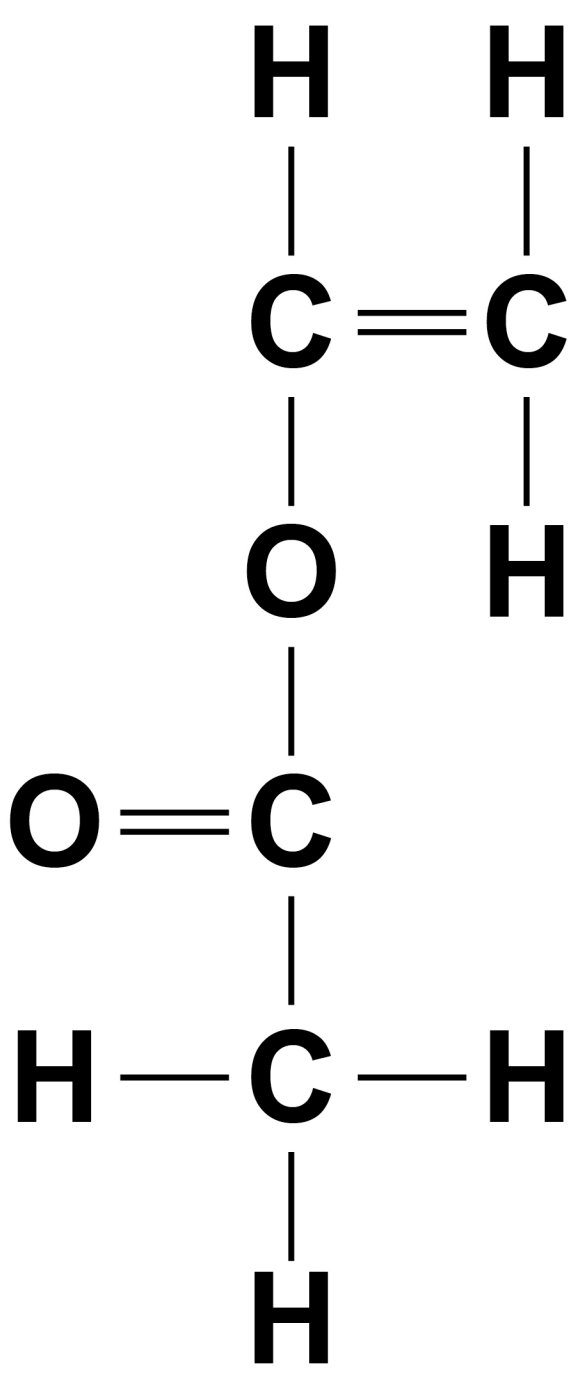
0 8 . 2

Describe what will be seen when compound A is shaken with bromine water. [2 marks]

0 8 . 3

FIGURE 9, on the opposite page, is a repeat of FIGURE 8.

FIGURE 9



Draw a circle around the ester functional group on FIGURE 9. [1 mark]

[Turn over]

0 8 . 4

Compound A has the formula $C_4H_6O_2$

Compound A is flammable.

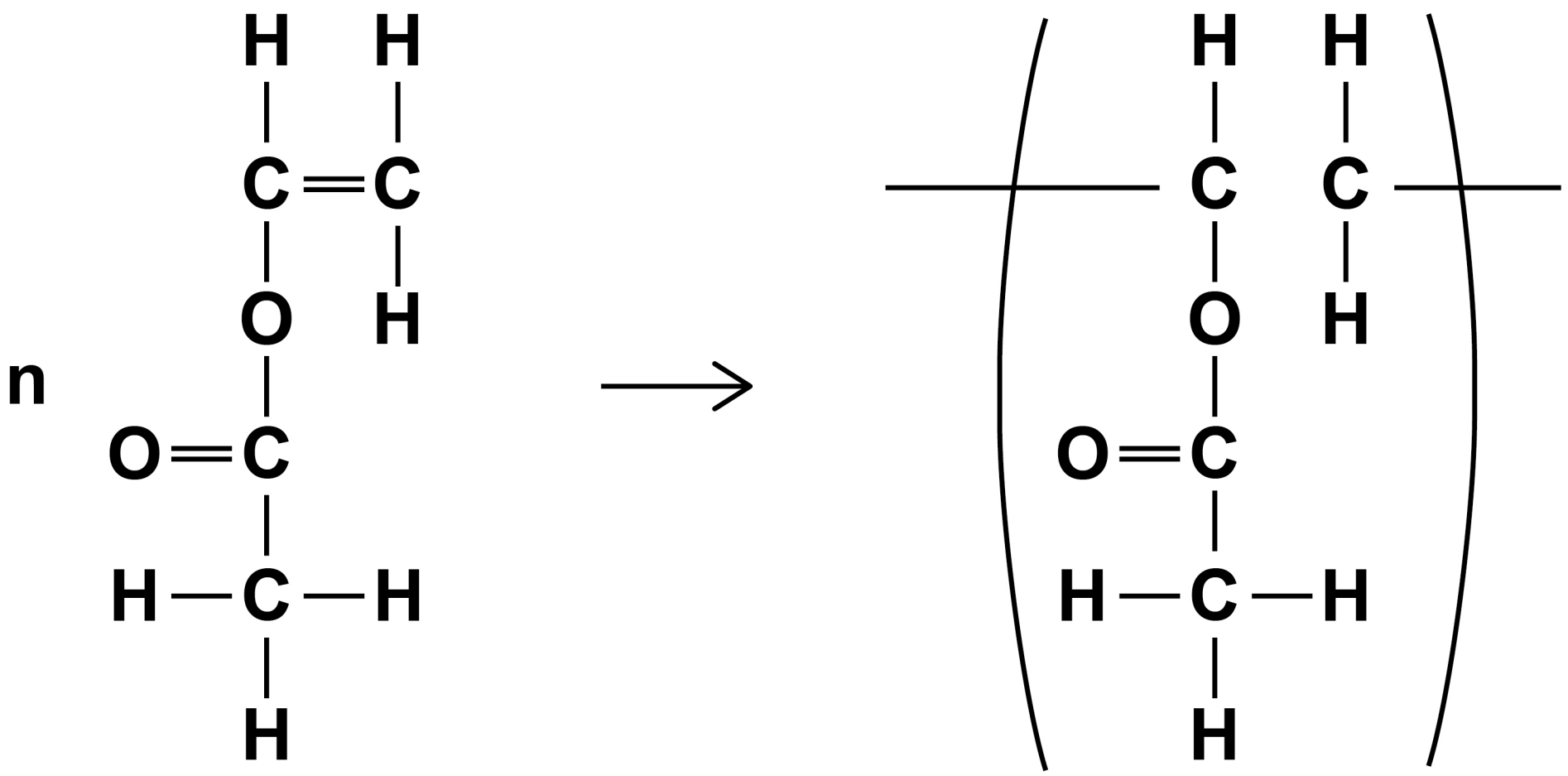
Write a balanced equation for the complete combustion of compound A.
[3 marks]

_____ + _____ → _____ + _____

0 8 . 5

Many molecules of compound A join together to form polymer B.

Complete the displayed formula equation which represents this reaction. [2 marks]



[Turn over]

0 8 . 6

What type of polymer is polymer B?
[1 mark]

Tick (✓) ONE box.

- ☐ **Addition polymer**
- ☐ **Condensation polymer**
- ☐ **DNA**
- ☐ **Protein**

Polymer B is a polymer which melts when heated.

0 8 . 7

What word is used to describe polymers which melt when heated? [1 mark]

[Turn over]

0 8 . 8

Explain why some polymers do NOT melt when heated. [2 marks]

13

0 9

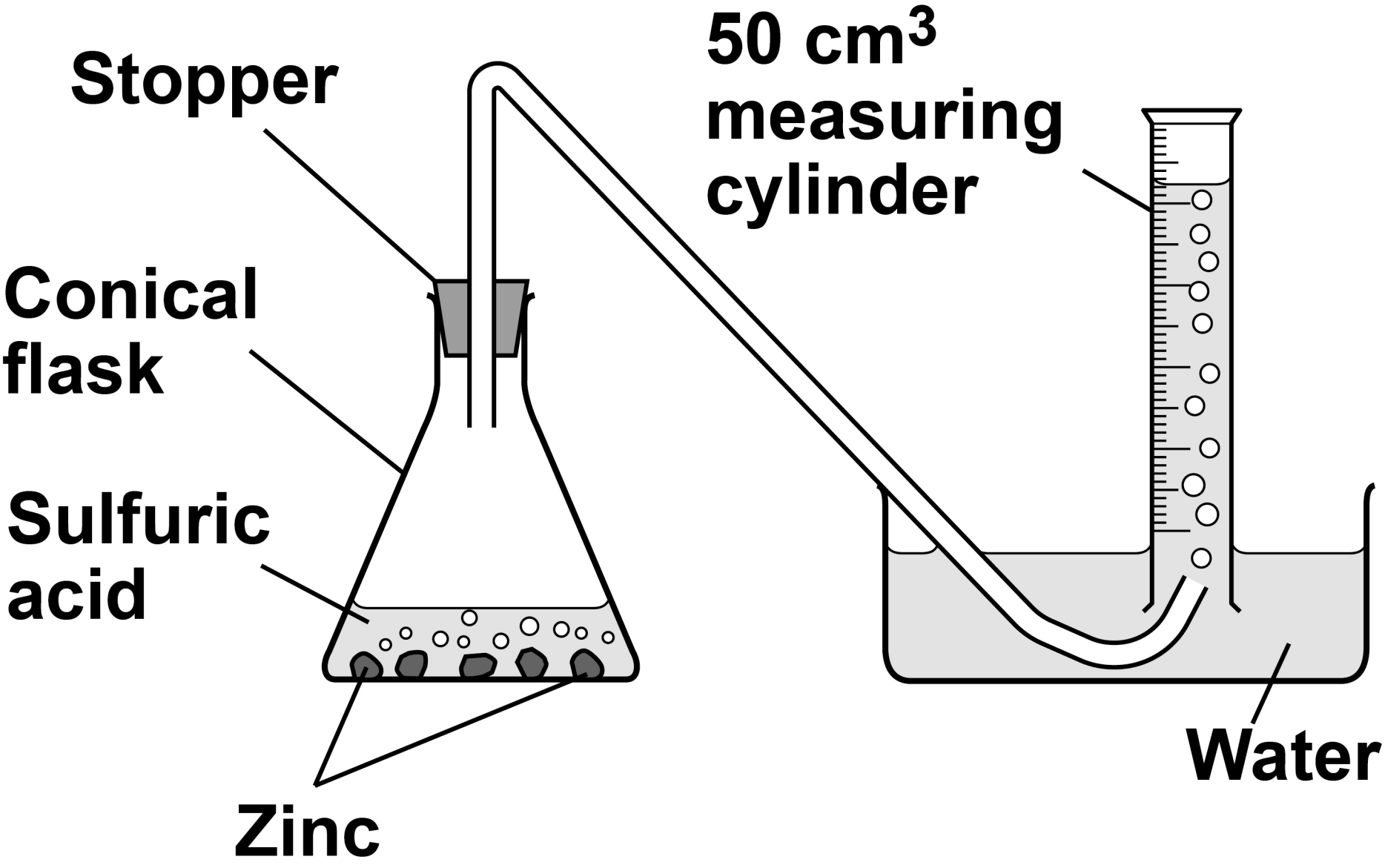
A student investigated the rate of the reaction between zinc and sulfuric acid.

The equation for the reaction is

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

FIGURE 10, on page 78, shows the apparatus.

FIGURE 10



This is the method used.

1. **Pour 50 cm^3 of sulfuric acid into the conical flask.**
2. **Add excess zinc to the conical flask.**
3. **Insert the stopper and start a timer.**

4. Measure the volume of hydrogen collected in the 50 cm^3 measuring cylinder every 20 seconds for 180 seconds.

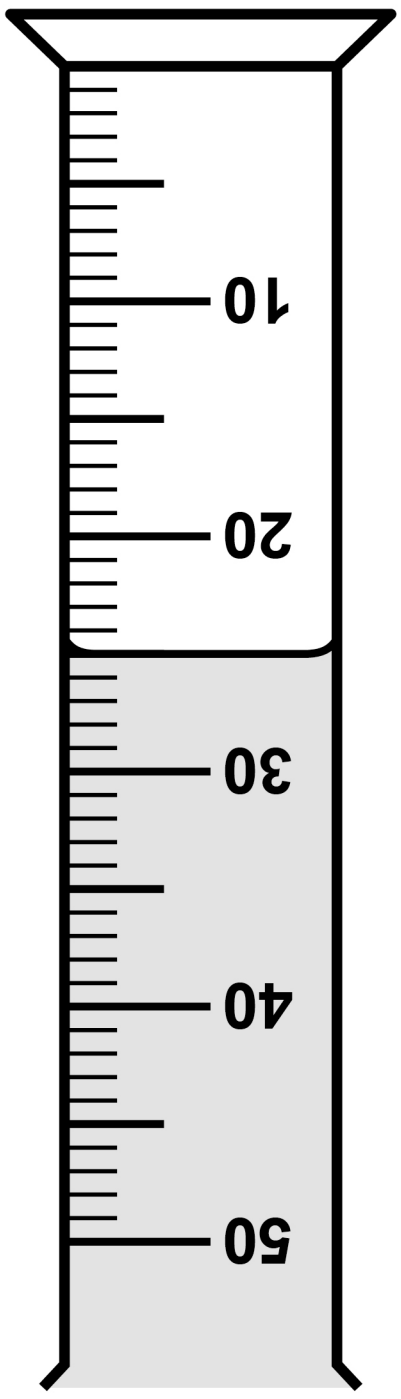
0 9 . 1

Explain why the volume of hydrogen collected in the 50 cm^3 measuring cylinder is less than the volume of hydrogen produced. [2 marks]

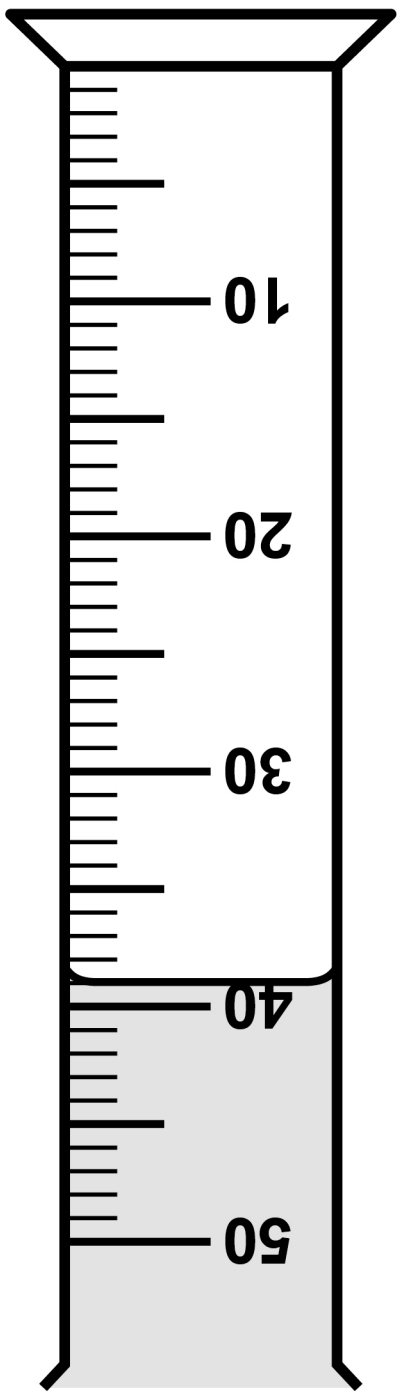
FIGURE 11 shows the volumes of hydrogen collected in the 50 cm^3 measuring cylinder after 40 seconds and after 100 seconds.

FIGURE 11

40 seconds



100 seconds



0 9 . 2

Determine the number of moles of hydrogen collected between 40 seconds and 100 seconds.

The volume of one mole of any gas at room temperature and pressure is 24 dm^3. [4 marks]

Moles of hydrogen = _____

A different student investigated how the concentration of sulfuric acid affected the rate of the reaction.

0 9 . 3

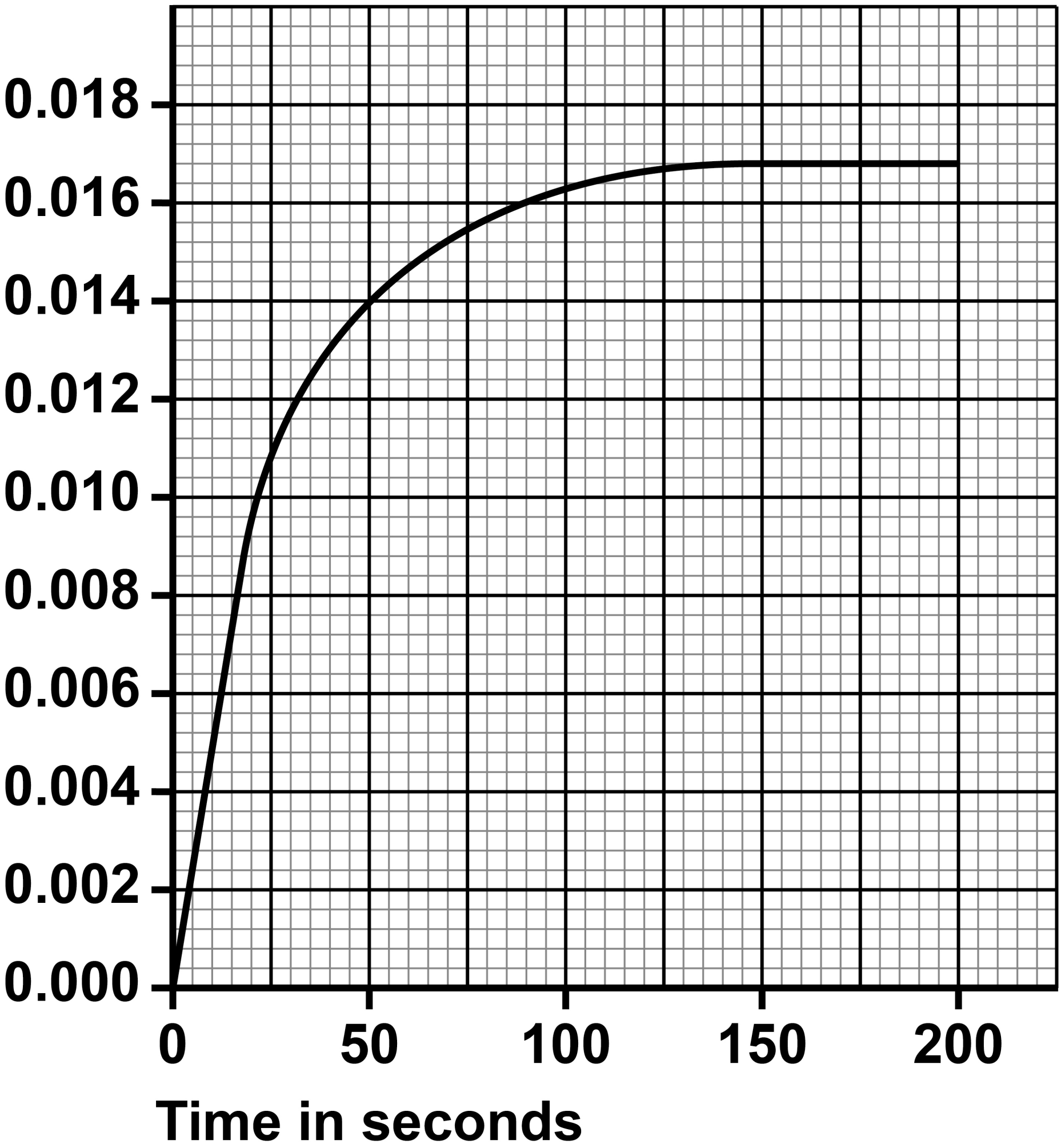
The student did a different experiment using sulfuric acid of concentration 0.40 mol/dm^3.

The student calculated the number of moles of hydrogen collected after every 20 seconds.

FIGURE 12, on page 84, shows the results.

[Turn over]

FIGURE 12


Moles of hydrogen collected
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
50
100
150
200
Time in seconds

Determine the rate of reaction at 45 seconds.

You should draw a tangent on FIGURE 12.

Give your answer in standard form.

[5 marks]

Rate of reaction (in standard form) =

mol/s

BLANK PAGE

[Turn over]

0 9 . 4

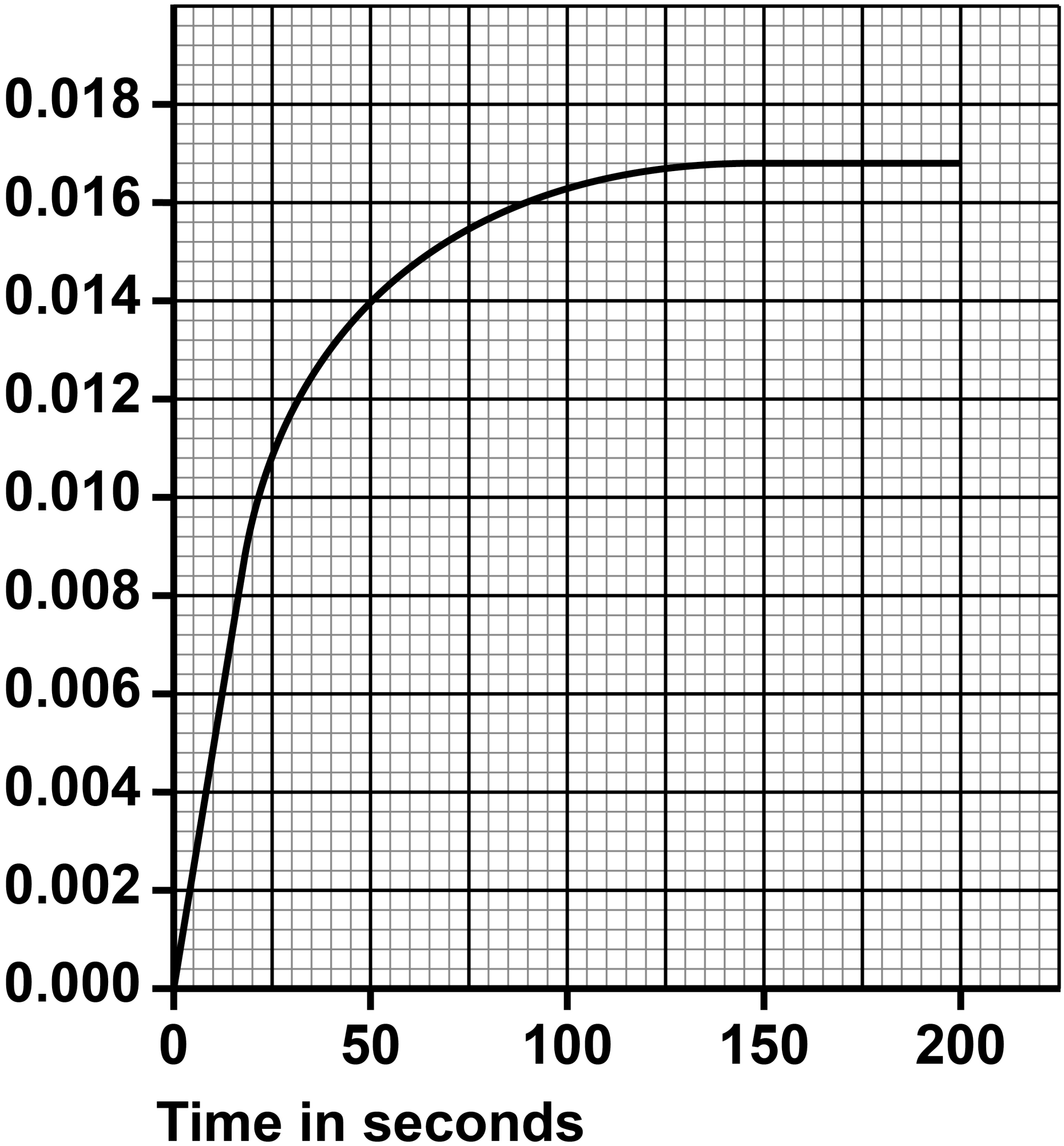
FIGURE 13, on the opposite page, shows the results for 0.40 mol/dm^3 sulfuric acid.

The student repeated the experiment using 0.20 mol/dm^3 sulfuric acid instead of 0.40 mol/dm^3 sulfuric acid.

Excess zinc was used in each experiment.

Sketch a line on FIGURE 13 to show the results you would expect. [2 marks]

FIGURE 13



[Turn over]

0 9 . 5

Explain how increasing the temperature would affect the rate of reaction between zinc and sulfuric acid. [3 marks]

END OF QUESTIONS

16

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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TOTAL	