AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier Paper 4 Physical Sciences

Tuesday 11 June 2024 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- the Physics Equations Sheet (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.

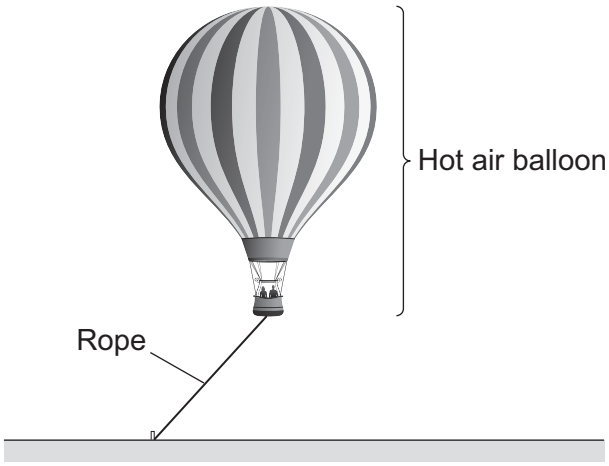
For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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.

0 1 **Figure 1** shows a floating hot air balloon attached to the ground by a rope.

The hot air balloon is stationary.

Figure 1

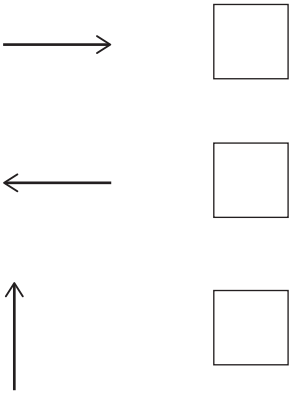


0 1 . 1 The wind is exerting a force on the hot air balloon in **Figure 1**.

Which arrow shows the direction of the force of the wind in **Figure 1**?

[1 mark]

Tick (✓) **one** box.



Do not write outside the box

0 1 . 2 Which force causes the hot air balloon to float?

[1 mark]

Tick (✓) **one** box.

Air resistance ☐

Gravity ☐

Upthrust ☐

0 1 . 3 The hot air balloon in **Figure 1** is stationary.

What is the resultant force on the balloon?

[1 mark]

Tick (✓) **one** box.

The resultant force is the tension in the rope. ☐

The resultant force is the weight. ☐

The resultant force is zero. ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 The mass of the hot air balloon is 350 kg.

Calculate the weight of the hot air balloon.

gravitational field strength = 9.8 N/kg

Use the equation:

weight = mass × gravitational field strength

[2 marks]

_____

_____

_____

Weight = _____ N

Do not write outside the box

0 1 . 5 The hot air balloon exerts a force of 200 N on the rope.

The force causes the rope to stretch by 1.60 m.

The rope behaves like a spring.

Calculate the spring constant of the rope.

Use the equation:

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

Choose the unit from the box.

m	**N**	**m/N**	**N/m**

[3 marks]

Spring constant = _____ Unit _____

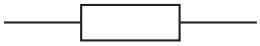
8

Turn over for the next question

Do not write outside the box

0 2 A hairdryer contains a heating element and a motor.

The motor is connected to a fan.

The symbol for the heating element is 

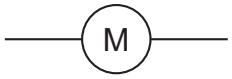
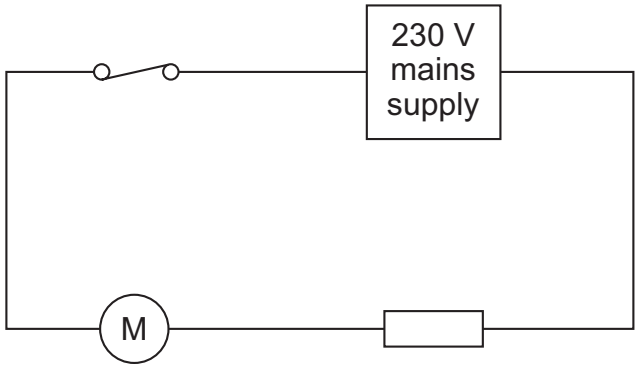
The symbol for the motor is 

Figure 2 shows part of the electrical circuit inside the hairdryer.

Figure 2



0 2 . 1 How does the current in the motor compare with the current in the heating element?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

The current is greater in the motor. ☐

The current in both components is the same. ☐

The current is less in the motor. ☐

Reason _____

_____

Do not write outside the box

0 2 . 2 The potential difference across the motor is 20 V.

What is the potential difference across the heating element?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

20 V ☐ 50 V ☐ 210 V ☐ 230 V ☐

Reason _____

_____

0 2 . 3 The hairdryer transfers 460 000 J of energy in 250 seconds.

Calculate the power of the hairdryer.

Use the equation:

$$\text{power} = \frac{\text{energy transferred}}{\text{time}}$$

[2 marks]

_____

_____

_____

Power = _____ W

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 The current in the hairdryer is 8.0 A.

Calculate the time taken for 1200 C of charge to flow past a point in the hairdryer circuit.

Use the equation:

$$\text{time} = \frac{\text{charge flow}}{\text{current}}$$

[2 marks]

Time = _____ s

0 2 . 5 The hairdryer is connected to the mains electricity supply.

What is the **frequency** of the UK mains electricity supply?

[1 mark]

Tick (✓) **one** box.

50 Hz ☐ 60 Hz ☐ 100 Hz ☐ 230 Hz ☐

9

Do not write outside the box

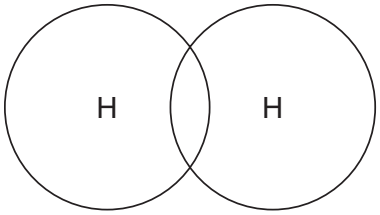
0 3 This question is about reactions involving gases.

0 3 . 1 Hydrogen gas consists of hydrogen molecules.

A hydrogen atom has one electron.

Complete the dot and cross diagram for a hydrogen molecule (H_2).

[1 mark]



Hydrogen (H_2) reacts with chlorine (Cl_2) to produce hydrogen chloride (HCl).

0 3 . 2 Balance the equation for the reaction.

[1 mark]

$$H_2 + Cl_2 \longrightarrow \_\_\_HCl$$

0 3 . 3 0.8 g of hydrogen reacts with chlorine to produce 29.2 g of hydrogen chloride.

Calculate the mass of chlorine that reacts.

[1 mark]

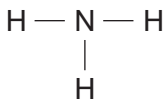
Mass = _____ g

Turn over ▶

Hydrogen reacts with nitrogen to produce ammonia.

Figure 3 represents a molecule of ammonia.

Figure 3



0 3 . 4 What is represented by — in **Figure 3**?

[1 mark]

_____

0 3 . 5 What is the formula of ammonia?

Use **Figure 3**.

[1 mark]

_____

Do not write outside the box

Ammonia reacts with hydrogen chloride to produce ammonium chloride.

The reaction is reversible.

0 3 . 6 Write the word equation for the reaction.

Include the symbol for a reversible reaction.

[2 marks]

_____ + _____ _____

0 3 . 7 Which condition needs to be changed so that the direction of the reaction is reversed?

[1 mark]

_____

8

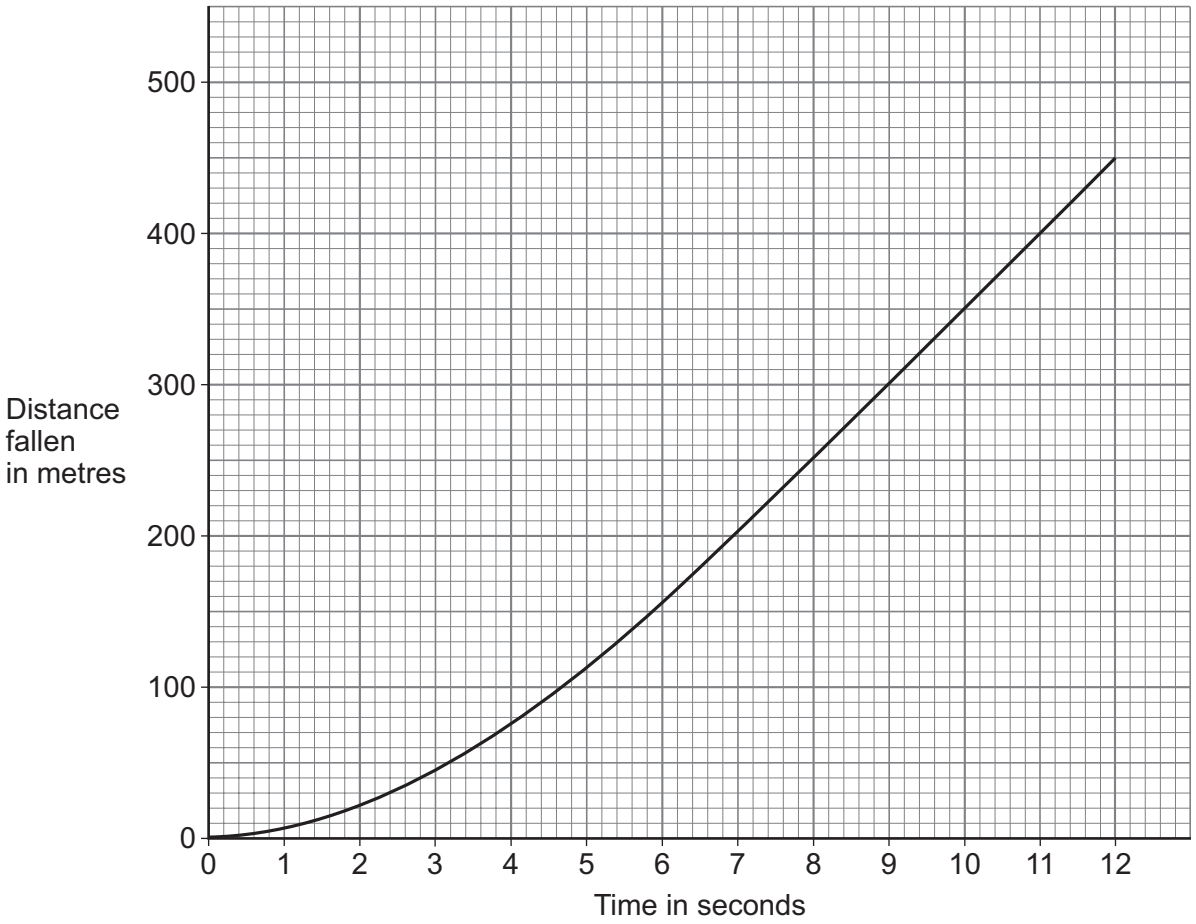
Turn over for the next question

Do not write outside the box

0 4 A skydiver jumped out of a helicopter.

Figure 4 shows a distance–time graph for the first 12 seconds of the skydiver's fall.

Figure 4



0 4 . 1 How does **Figure 4** show that the speed of the skydiver increased between 1 second and 6 seconds?

[1 mark]

Tick (✓) **one** box.

The gradient decreases ☐

The gradient stays the same ☐

The gradient increases ☐

Do not write outside the box

0 4 . 2 What happened to the speed of the skydiver between 8 seconds and 12 seconds?

Use **Figure 4**.

[1 mark]

Tick (✓) **one** box.

The speed decreased ☐

The speed stayed the same ☐

The speed increased ☐

0 4 . 3 Determine the mean speed of the skydiver between 0 seconds and 12 seconds.

Use **Figure 4** and the equation:

$$\text{mean speed} = \frac{\text{total distance}}{\text{total time}}$$

[3 marks]

Mean speed = _____ m/s

Question 4 continues on the next page

Do not write outside the box

The forces acting on the skydiver during the fall were weight and air resistance.

0 4 . 4 What happened to the weight of the skydiver during the fall?

[1 mark]

Tick (✓) **one** box.

Weight decreased ☐

Weight stayed the same ☐

Weight increased ☐

0 4 . 5 What happened to the air resistance acting on the skydiver as the speed of the skydiver increased?

[1 mark]

Tick (✓) **one** box.

Air resistance decreased ☐

Air resistance stayed the same ☐

Air resistance increased ☐

Do not write outside the box

0 4 . 6 The skydiver reached terminal velocity.

How did the forces acting on the skydiver compare at terminal velocity?

[1 mark]

Tick (✓) **one** box.

Weight > air resistance ☐

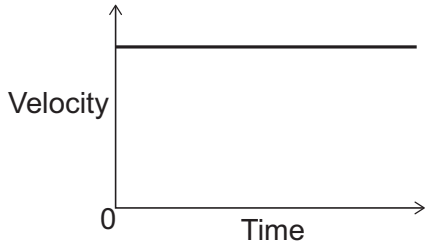
Weight = air resistance ☐

Weight < air resistance ☐

0 4 . 7 Which of the following shows the velocity–time graph for the skydiver falling at terminal velocity?

[1 mark]

Tick (✓) **one** box.



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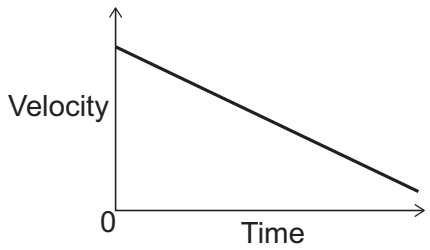

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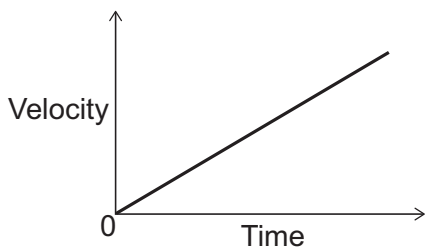


☐

Do not write outside the box

0 4 . 8 The skydiver decelerated when the parachute opened.

The initial resultant force on the skydiver was 960 N.

The mass of the skydiver was 64 kg.

Calculate the initial deceleration of the skydiver.

Use the equation:

$$\text{deceleration} = \frac{\text{resultant force}}{\text{mass}}$$

Choose the unit from the box.

m/s	**m/s^2**	**s/m^2**

[3 marks]

Deceleration = _____ Unit _____

12

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 5 Excess hydrochloric acid in the stomach can cause pain. The excess hydrochloric acid can be neutralised by a calcium carbonate tablet.

A student investigated how the pH changed when a calcium carbonate tablet was added to hydrochloric acid.

This is the method used.

1. Add 10 cm^3 of hydrochloric acid to a beaker.
2. Measure the pH of the hydrochloric acid using an indicator.
3. Add a calcium carbonate tablet to the hydrochloric acid.
4. Time for 3 minutes.
5. Measure the pH of the mixture using an indicator.

0 5 . 1 Which **two** of the following pieces of equipment are needed in this method?

[2 marks]

Tick (✓) **two** boxes.

- Measuring cylinder ☐
- Newtonmeter ☐
- Ruler ☐
- Stop clock ☐
- Thermometer ☐

0 5 . 2 Name an indicator used to measure pH.

[1 mark]

_____

Do not write outside the box

0 5 . 3 Name a piece of equipment that gives a more accurate pH value than an indicator.

[1 mark]

_____

0 5 . 4 The word equation for the reaction is:

calcium carbonate + hydrochloric acid ⟶ calcium chloride + water + carbon dioxide

Why is fizzing seen during the reaction?

[1 mark]

_____

_____

0 5 . 5 Give **one** safety precaution the student should have taken.

[1 mark]

_____

_____

0 5 . 6 What is the pH of a neutral solution?

[1 mark]

Tick (✓) **one** box.

1 ☐ 4 ☐ 7 ☐ 10 ☐

Question 5 continues on the next page

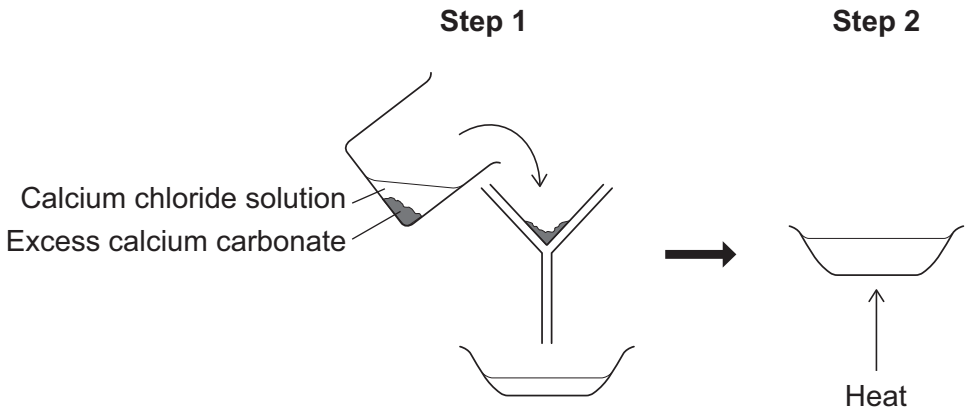
Do not write outside the box

0 5 . 7 A student reacted hydrochloric acid with excess calcium carbonate.

A solution of calcium chloride was produced.

Figure 5 shows the method used to produce calcium chloride crystals from the reaction mixture.

Figure 5



Describe the method shown in **Figure 5** to produce calcium chloride crystals from the reaction mixture.

Include the equipment used.

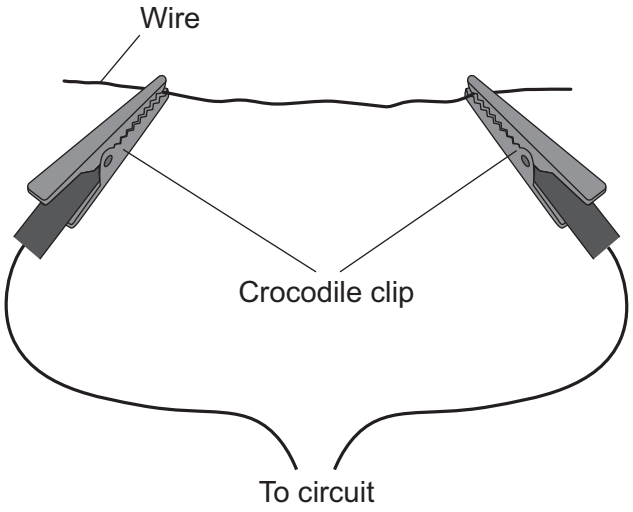
[4 marks]

11

0 6 A student investigated how the resistance of a wire varies with the length of the wire.

Figure 6 shows how the student connected the wire to a circuit.

Figure 6



0 6 . 1 Which piece of equipment should the student use to measure the length of wire between the crocodile clips?

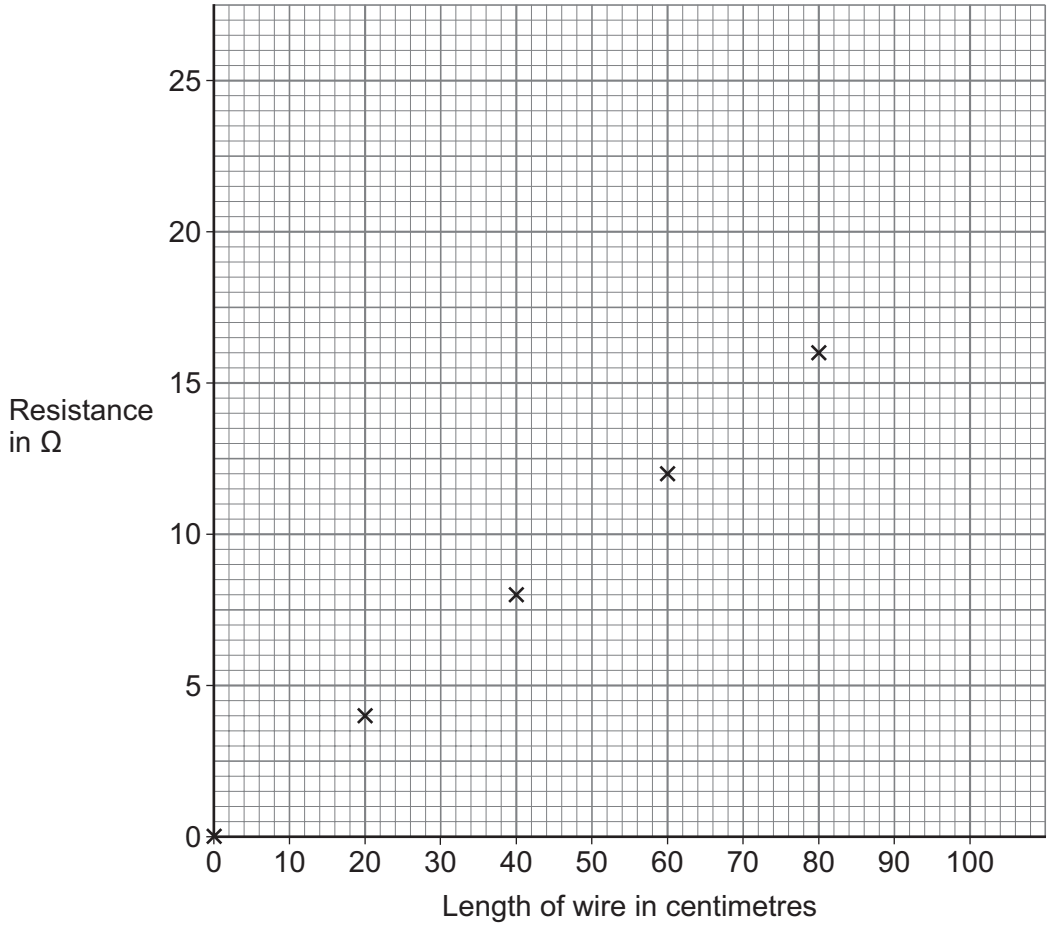
[1 mark]

Question 6 continues on the next page

The student used readings from the circuit to calculate the resistance of the wire at different lengths.

Figure 7 shows the results.

Figure 7



0 6 . 2 Draw a line of best fit on **Figure 7**.

[1 mark]

0 6 . 3 A 100 cm length of wire is placed between the crocodile clips.

Predict the resistance of the 100 cm length of wire.

Use **Figure 7**.

[1 mark]

Resistance = _____ Ω

Do not write outside the box

0 6 . 4 Describe how the results on **Figure 7** show that resistance is directly proportional to length.

[2 marks]

The student switched the circuit off between readings.

Another student did the same investigation but did **not** switch the circuit off between readings.

0 6 . 5 What would happen to the temperature of the wire if the circuit was **not** switched off between readings?

[1 mark]

0 6 . 6 What would happen to the resistance of the wire if the circuit was **not** switched off between the readings?

[1 mark]

Question 6 continues on the next page

Do not write outside the box

0 6 . 7 When the student switched the circuit off the ammeter reading was 0.02 A.

What type of error caused the ammeter reading to be 0.02 A?

[1 mark]

Tick (✓) **one** box

A human error ☐

A random error ☐

A zero error ☐

8

Do not write outside the box

Turn over for the next question

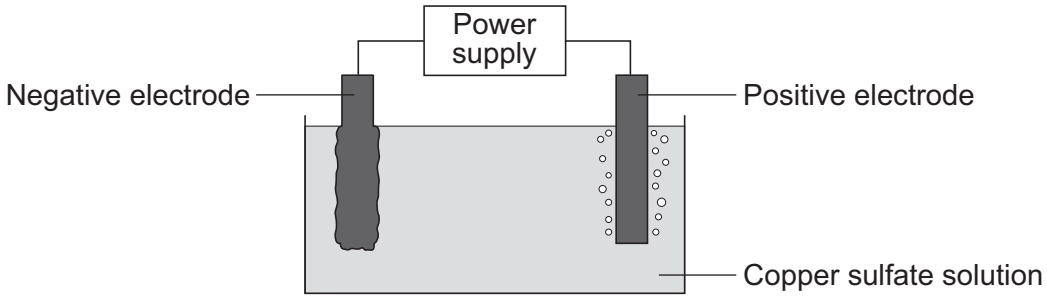
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 A student electrolysed copper sulfate solution using inert electrodes.

Figure 8 shows the apparatus used.

Figure 8



Copper was produced at the negative electrode.

Oxygen was produced at the positive electrode.

0 7 . 1 Describe the observations seen at each electrode.

[2 marks]

Negative electrode _____

_____

Positive electrode _____

_____

Do not write outside the box

0 7 . 2 Copper sulfate solution contains copper ions and hydrogen ions.

Why is copper produced instead of hydrogen during the electrolysis of copper sulfate solution?

[1 mark]

Tick (✓) **one** box.

Copper is less reactive than hydrogen. ☐

Copper has the same reactivity as hydrogen. ☐

Copper is more reactive than hydrogen. ☐

Question 7 continues on the next page

The student measured how the mass of copper produced varied with time.

Table 1 shows the results.

Table 1

Time in seconds	Mass of copper produced in grams
120	0.08
240	0.16
360	0.24
480	0.32
600	0.40

0 7 . 3 What conclusion can be made about how the mass of copper produced varied with time?

Use **Table 1**.

[1 mark]

_____

_____

0 7 . 4 Predict the time taken to produce 0.20 g of copper.

Use **Table 1**.

[1 mark]

_____

Time = _____ s

Do not write outside the box

0 7 . 5 0.5 dm^3 of a solution of copper sulfate contains 3.2 g of copper sulfate.

Calculate the concentration of the solution of copper sulfate.

Use the equation:

$$\text{Concentration} = \frac{\text{mass of copper sulfate}}{\text{volume of solution}}$$

Choose the unit from the box.

dm^3/g	**g/dm^3**	**gdm^3**

[3 marks]

Concentration = _____ Unit _____

Question 7 continues on the next page

Do not write outside the box

0 7 . 6 Copper sulfate has the formula $CuSO_4$

Calculate the percentage (%) by mass of copper in $CuSO_4$

Give your answer to 3 significant figures.

Relative atomic mass (A_r): Cu = 63.5

Relative formula mass (M_r): $CuSO_4$ = 159.5

[3 marks]

Percentage (3 significant figures) = _____ %

11

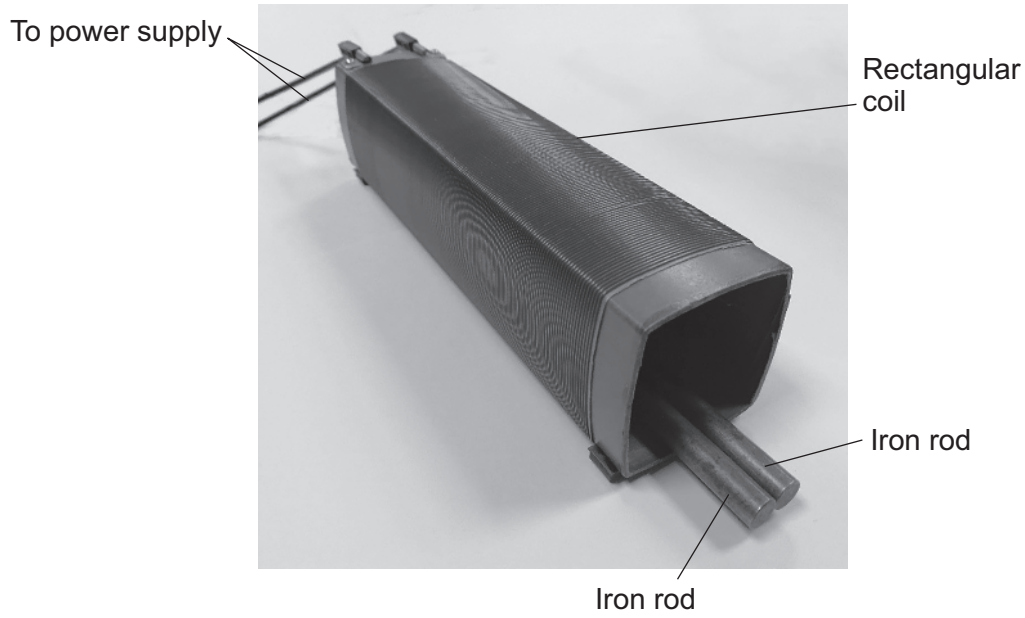
Do not write outside the box

0 8 A student investigated the magnetic effect of an electric current.

The student placed two iron rods inside a rectangular coil.

Figure 9 shows the equipment.

Figure 9



When the power supply is switched on there is a current in the rectangular coil.

0 8 . 1 Complete the sentence.

[1 mark]

When there is a current in the rectangular coil, there is a magnetic field around the coil.

The magnetic field has a similar shape to the magnetic field around

a _____.

Question 8 continues on the next page

Do not write outside the box

0 8 . 2 The two iron rods repel each other when there is a magnetic field around the coil.

Explain why.

[2 marks]

0 8 . 3 The two iron rods are replaced with copper rods.

The two copper rods remain stationary when there is a magnetic field around the coil.

Give **one** reason why.

[1 mark]

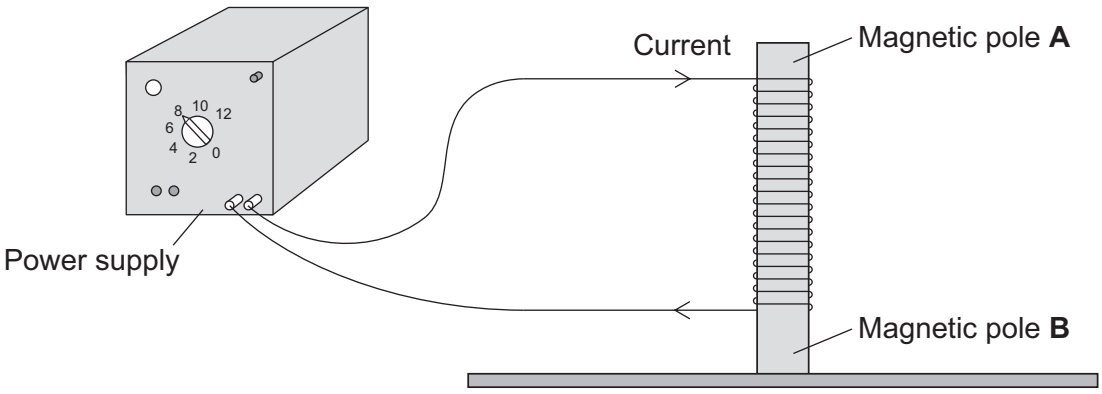
The student made an electromagnet by:

- wrapping a coil of wire around an iron bar
- connecting the coil of wire to a power supply.

The student investigated how the current in the electromagnet affected the strength of the electromagnet.

Figure 10 shows the electromagnet.

Figure 10



0 8 . 4 Identify magnetic poles **A** and **B** in **Figure 10**.

[1 mark]

Magnetic pole **A** _____

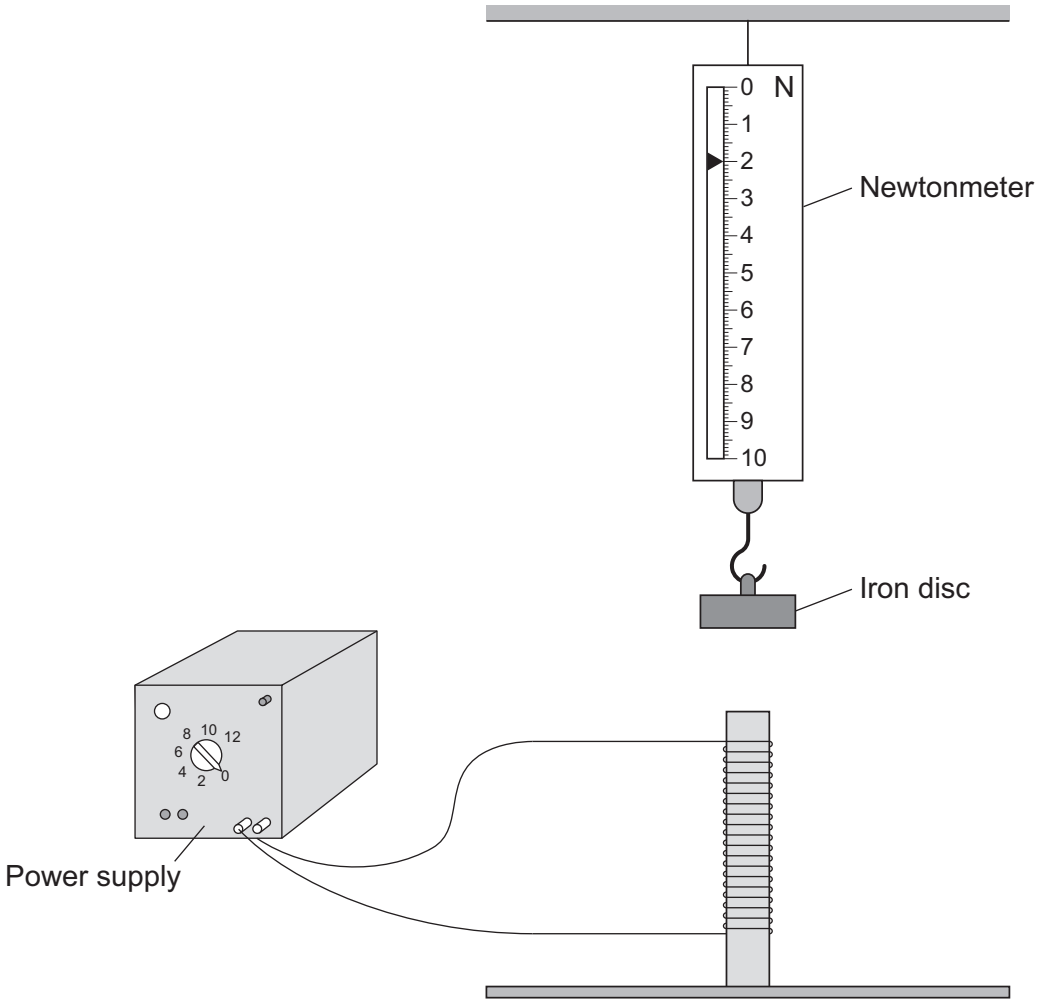
Magnetic pole **B** _____

Question 8 continues on the next page

The student arranged a newtonmeter and an iron disc above the electromagnet.

Figure 11 shows the equipment.

Figure 11



Do not write outside the box

0 8 . 5 The power supply is switched off.

Why is the newtonmeter reading 2.0 N?

[1 mark]

Tick (✓) **one** box.

The weight of the electromagnet is 2.0 N. ☐

The weight of the iron disc is 2.0 N. ☐

The weight of the newtonmeter is 2.0 N. ☐

0 8 . 6 The student switched the power supply on and then increased the current in the electromagnet.

The iron disc was not touching the electromagnet, but the reading on the newtonmeter changed.

Explain why.

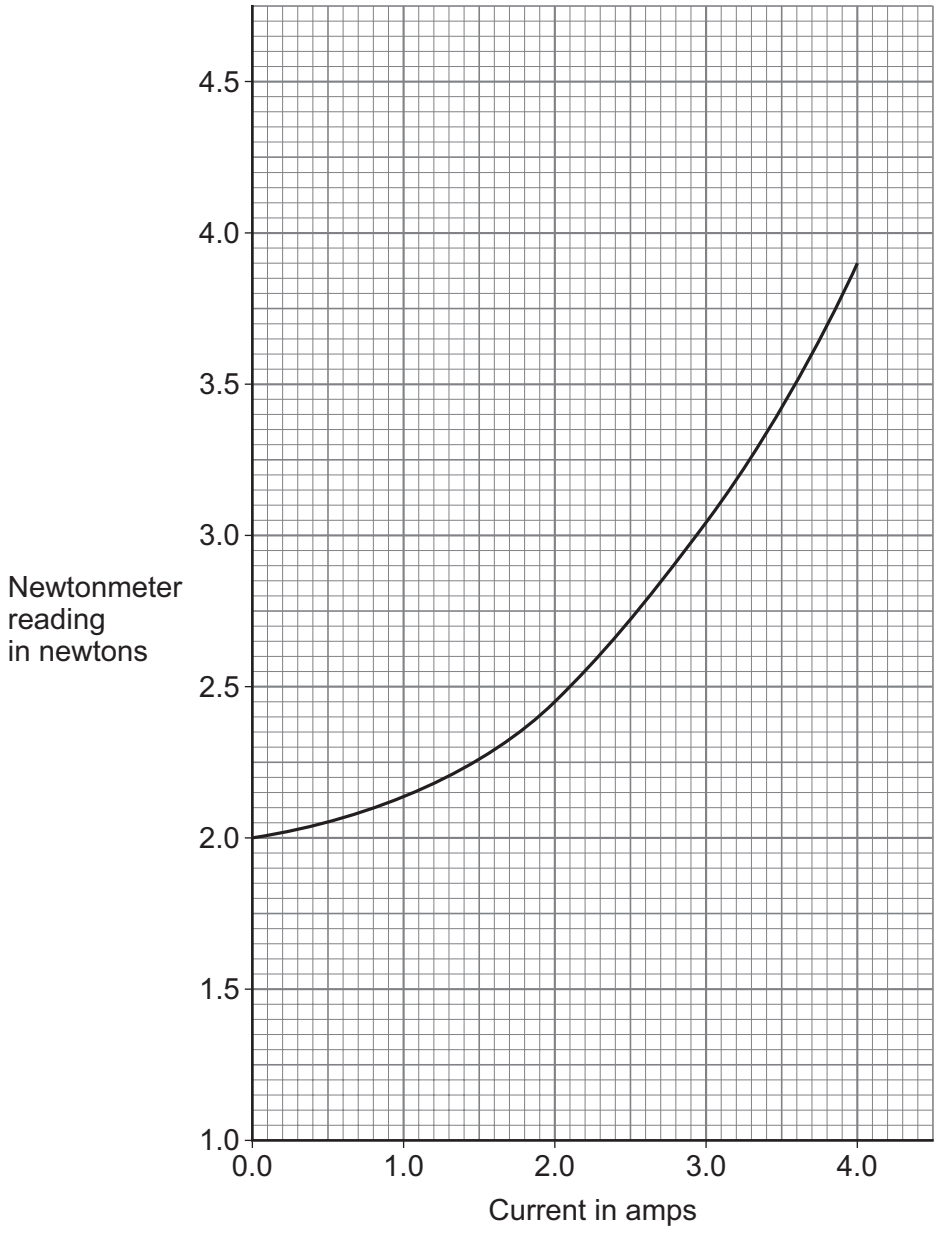
[3 marks]

Question 8 continues on the next page

0 8 . 7 The student recorded the readings on the newtonmeter as the current increased.

Figure 12 shows the results.

Figure 12



The student wrapped twice as many turns of wire around the iron bar and repeated the investigation.

Draw a line on **Figure 12** to show the expected results.

[2 marks]

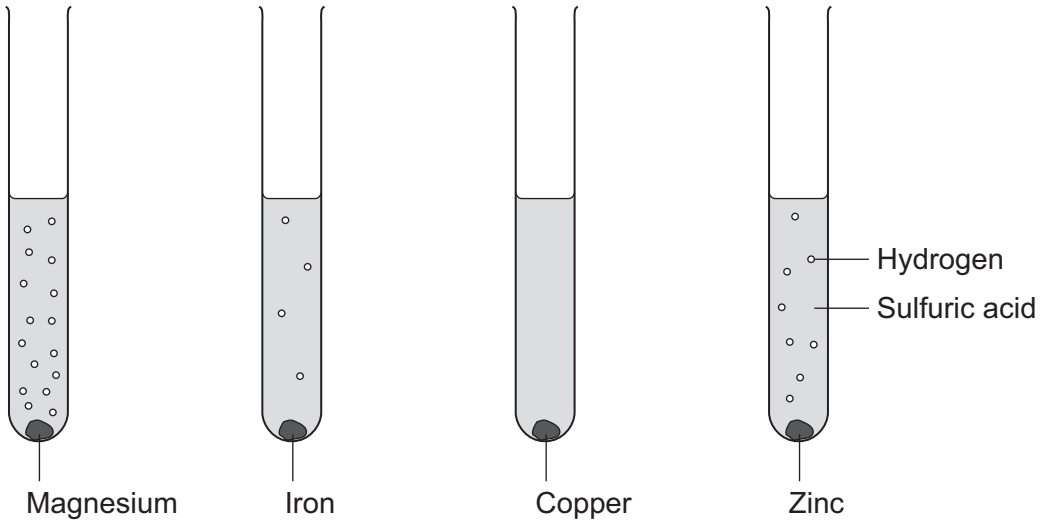
11

Turn over for the next question

0 9 A student investigated the reactivity of four metals with sulfuric acid.

Figure 13 shows the apparatus.

Figure 13



0 9 . 1 Give **two** variables the student should control.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 9 . 2 Write the order of reactivity from least reactive to most reactive for the four metals.

Use **Figure 13**.

[1 mark]

Least reactive _____

_____

_____

Most reactive _____

0 9 . 3 The gas produced in **Figure 13** is hydrogen.

Describe the test for hydrogen gas.

Give the result if hydrogen is present.

[2 marks]

Test _____

_____

Result _____

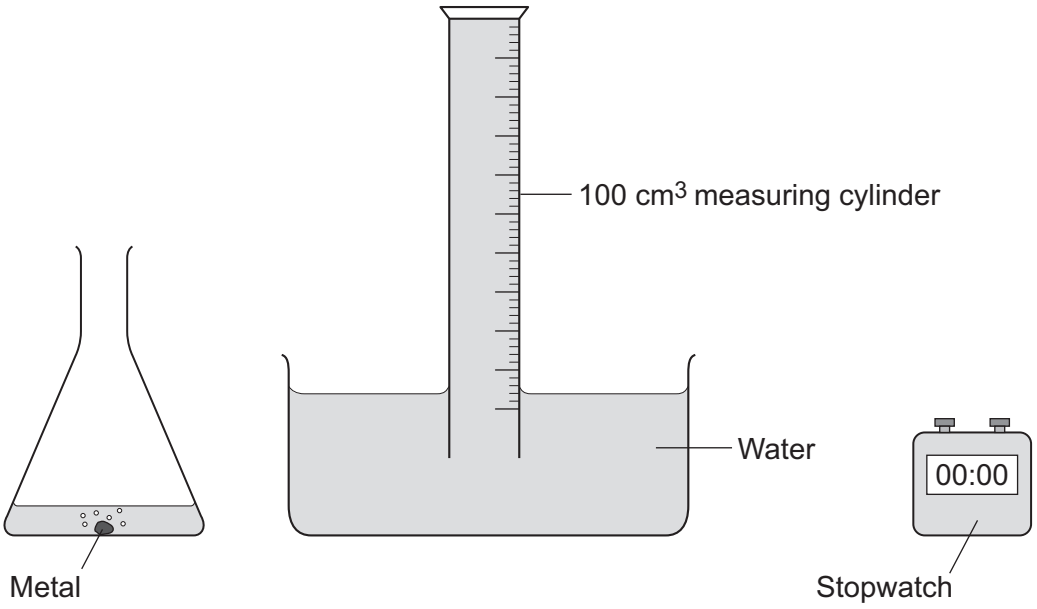
_____

Question 9 continues on the next page

The student repeated the investigation using different apparatus to determine the rate of reaction.

Figure 14 shows part of the apparatus.

Figure 14



0 9 . 4 Complete **Figure 14** so that the apparatus can be used to determine the rate of reaction.

[1 mark]

0 9 . 5 Give **two** measurements the student should make to determine the rate of reaction.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 6 What is the unit for the rate of reaction determined using the apparatus in **Figure 14**?

[1 mark]

_____

9

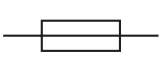
Do not write outside the box

1 0 A thermistor is an electrical component.

1 0 . 1 What is the circuit symbol for a thermistor?

[1 mark]

Tick (✓) **one** box.



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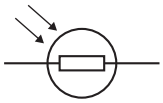

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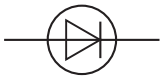

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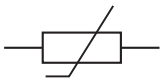

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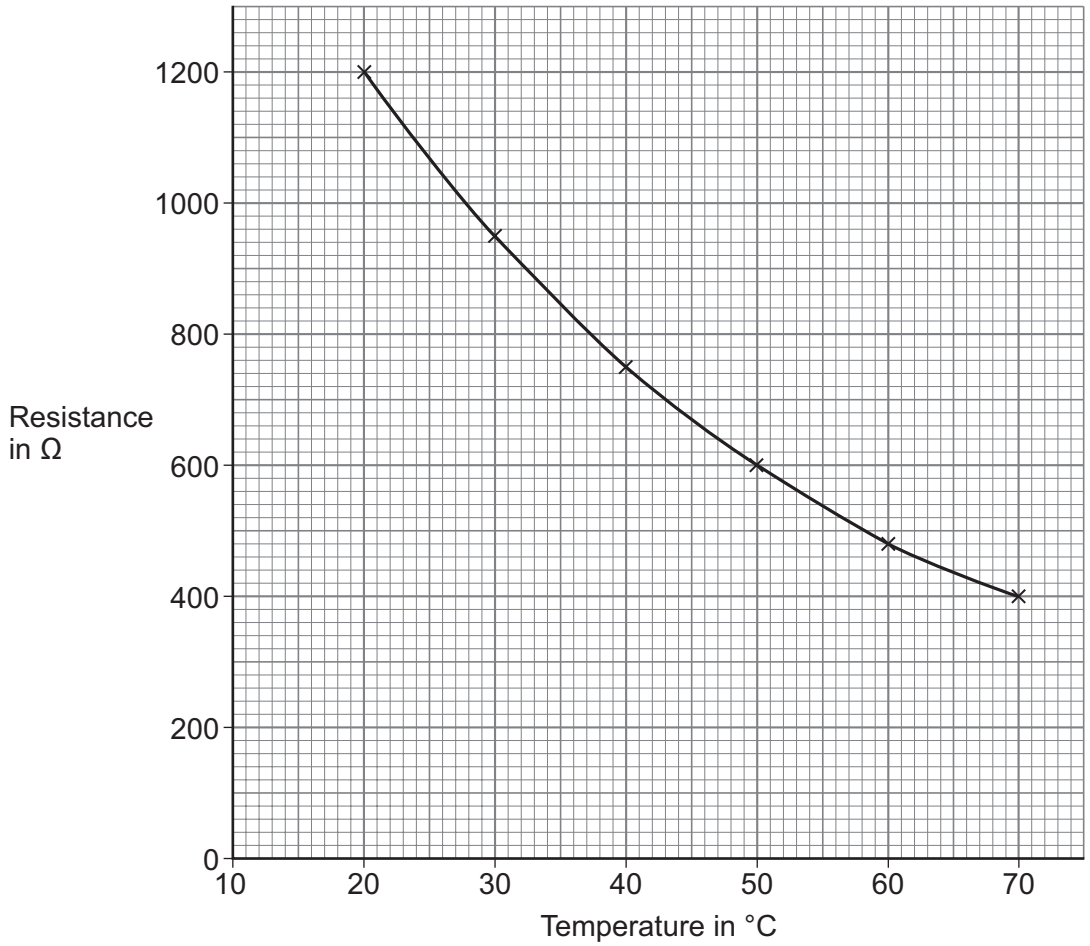
Question 10 continues on the next page

A student investigated how the resistance of a thermistor varies with temperature.

Figure 15 shows the results.

Figure 15



1 0 . 2 Suggest why the student was **not** able to take measurements at temperatures below 20 °C.

[1 mark]

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1 0 . 3 The student used an ammeter and a voltmeter to take measurements to determine the resistance of the thermistor.

Describe a method the student could have used to obtain the results shown in **Figure 15**.

[6 marks]

Question 10 continues on the next page

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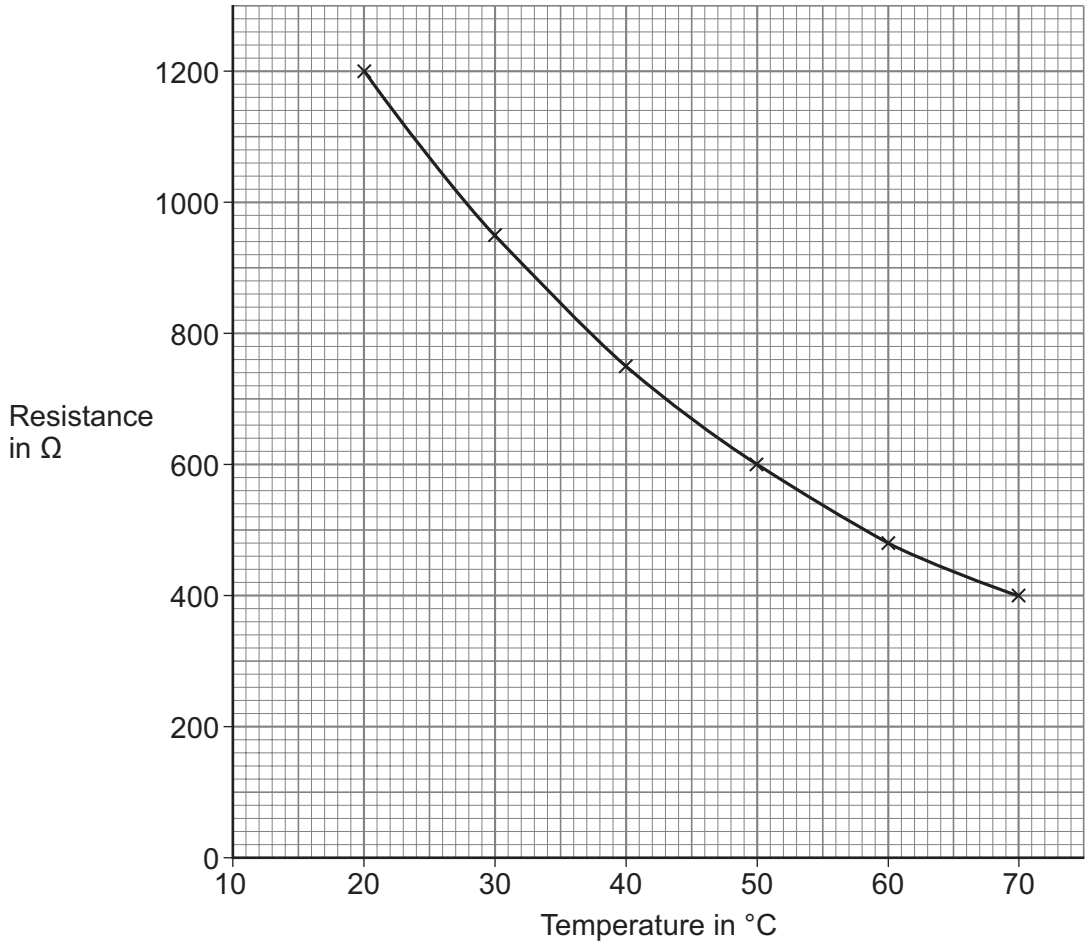
Figure 15 is repeated below

Figure 15



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Use the Physics Equations Sheet to answer Questions **10.4** and **10.5**.

1 0 . 4 Write down the equation which links current (I), potential difference (V) and resistance (R).

[1 mark]

_____

1 0 . 5 The potential difference across the thermistor was 6.0 V.

Determine the current in the thermistor when the temperature of the thermistor was 40 °C.

Use **Figure 15**.

[4 marks]

_____

_____

_____

_____

_____

_____

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Current = _____ A

13

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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