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

H

Higher 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	
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.

Do not write outside the box

There are no questions printed on this page

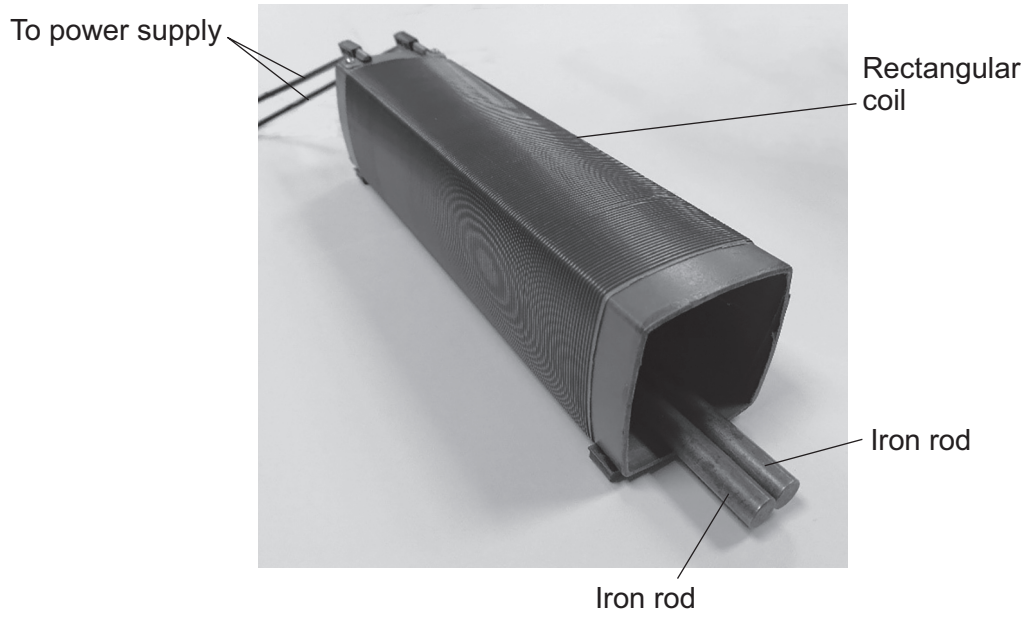
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 1 A student investigated the magnetic effect of an electric current.

The student placed two iron rods inside a rectangular coil.

Figure 1 shows the equipment.

Figure 1



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

0 1 . 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 1 continues on the next page

Do not write outside the box

0 1 . 2 The two iron rods repel each other when there is a magnetic field around the coil.

Explain why.

[2 marks]

0 1 . 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]

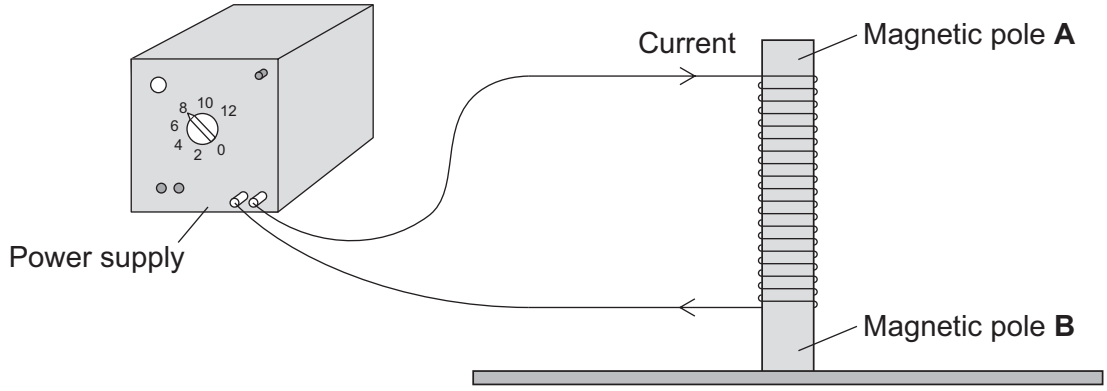
The student made an electromagnet by:

- 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 2 shows the electromagnet.

Figure 2



0 1 . 4 Identify magnetic poles **A** and **B** in **Figure 2**.

[1 mark]

Magnetic pole **A** _____

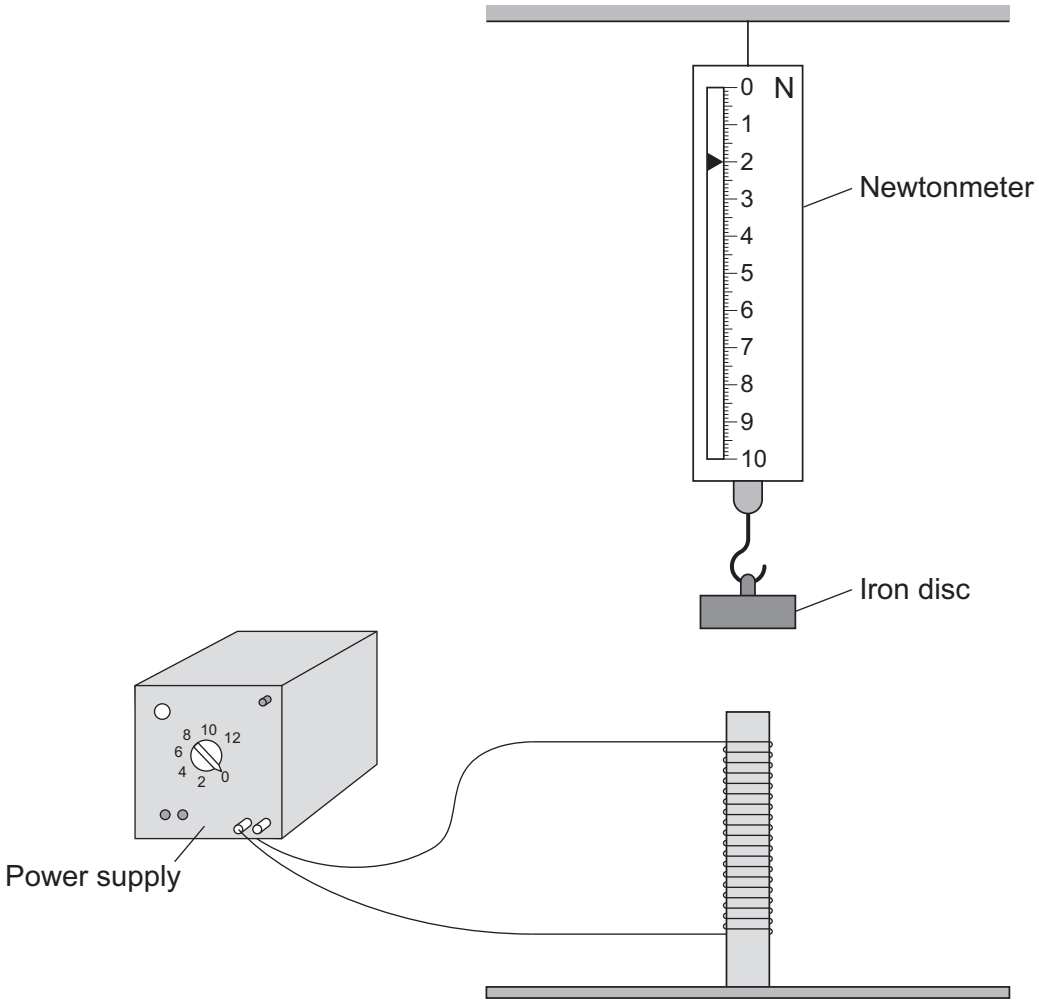
Magnetic pole **B** _____

Question 1 continues on the next page

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

Figure 3 shows the equipment.

Figure 3



Do not write outside the box

0 1 . 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 1 . 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.

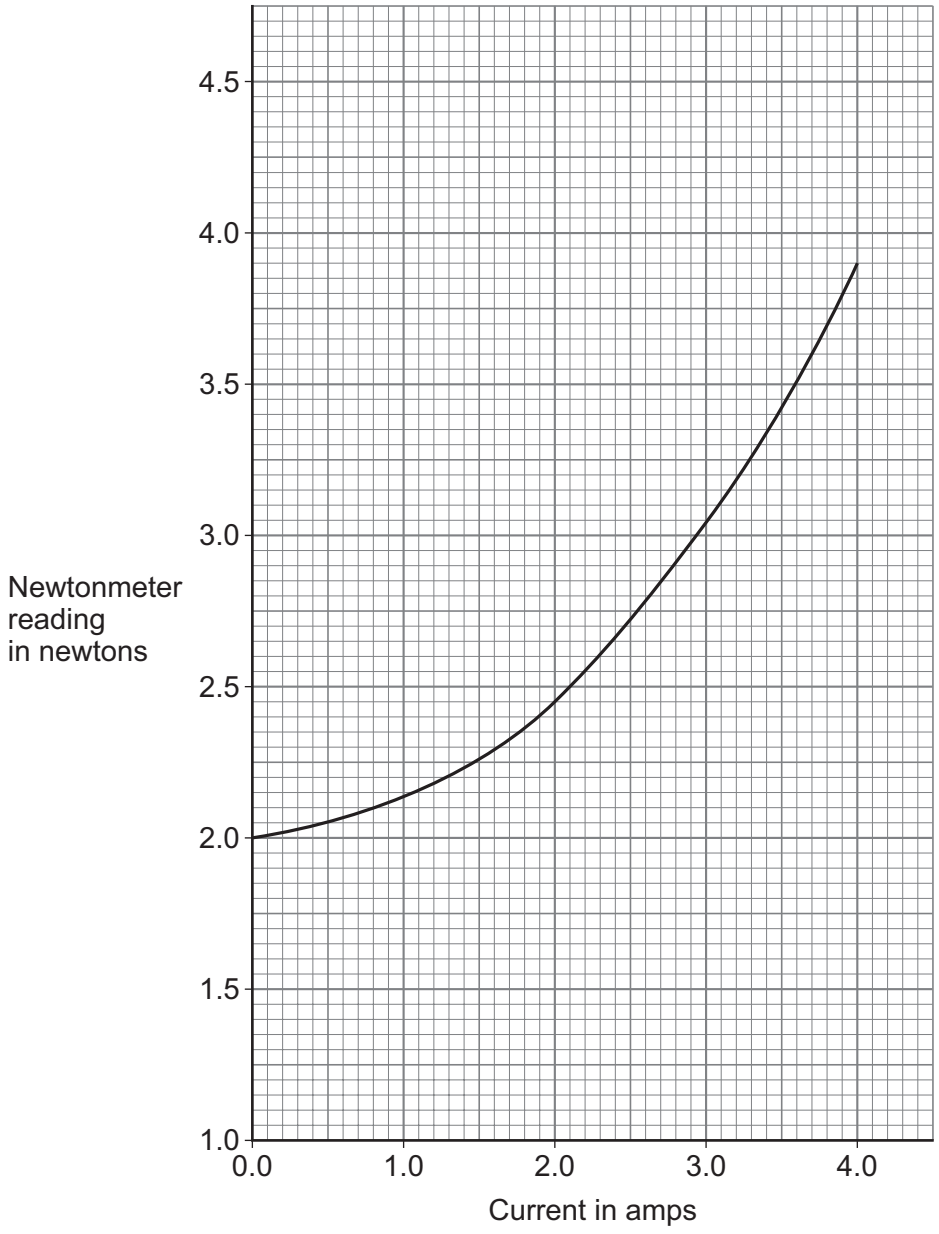
[3 marks]

Question 1 continues on the next page

0 1 . 7 The student recorded the readings on the newtonmeter as the current increased.

Figure 4 shows the results.

Figure 4



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

Draw a line on **Figure 4** to show the expected results.

[2 marks]

11

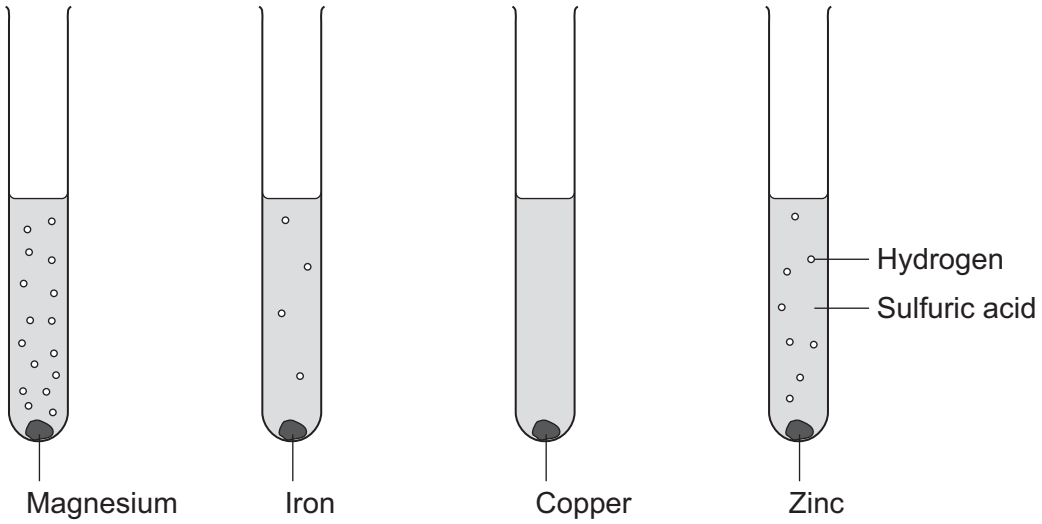
Turn over for the next question

Do not write outside the box

0 2 A student investigated the reactivity of four metals with sulfuric acid.

Figure 5 shows the apparatus.

Figure 5



0 2 . 1 Give **two** variables the student should control.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

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

Use **Figure 5**.

[1 mark]

Least reactive _____

_____

_____

Most reactive _____

0 2 . 3 The gas produced in **Figure 5** is hydrogen.

Describe the test for hydrogen gas.

Give the result if hydrogen is present.

[2 marks]

Test _____

_____

Result _____

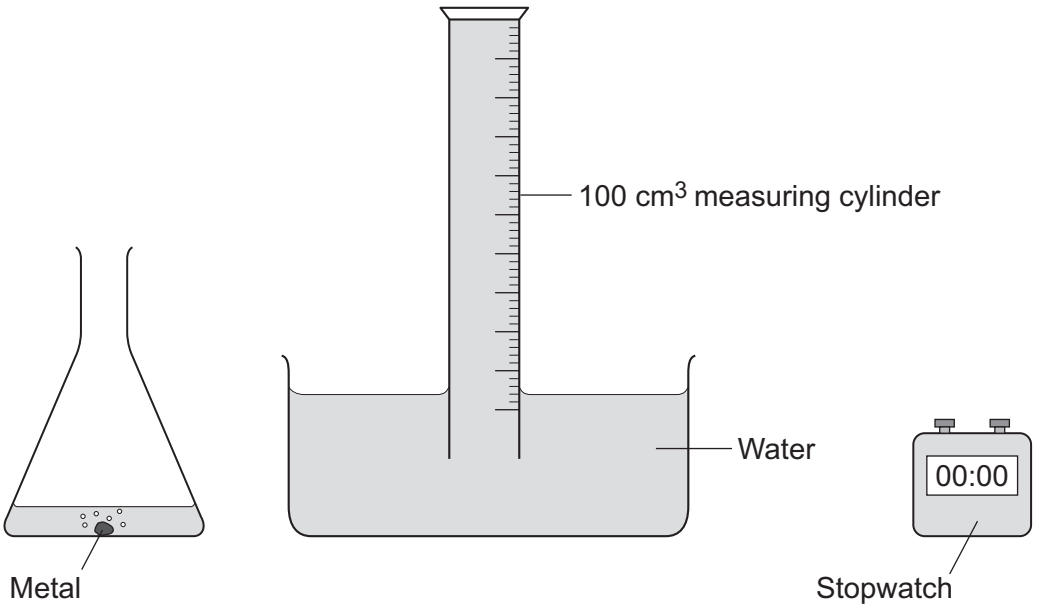
_____

Question 2 continues on the next page

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

Figure 6 shows part of the apparatus.

Figure 6



0 2 . 4 Complete **Figure 6** so that the apparatus can be used to determine the rate of reaction.

[1 mark]

0 2 . 5 Give **two** measurements the student should make to determine the rate of reaction.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 6 What is the unit for the rate of reaction determined using the apparatus in **Figure 6**?

[1 mark]

_____

9

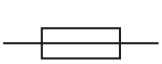
Do not write outside the box

0 3 A thermistor is an electrical component.

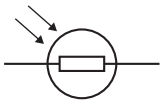
0 3 . 1 What is the circuit symbol for a thermistor?

[1 mark]

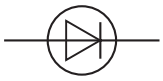
Tick (✓) **one** box.



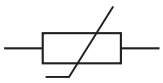
☐



☐



☐



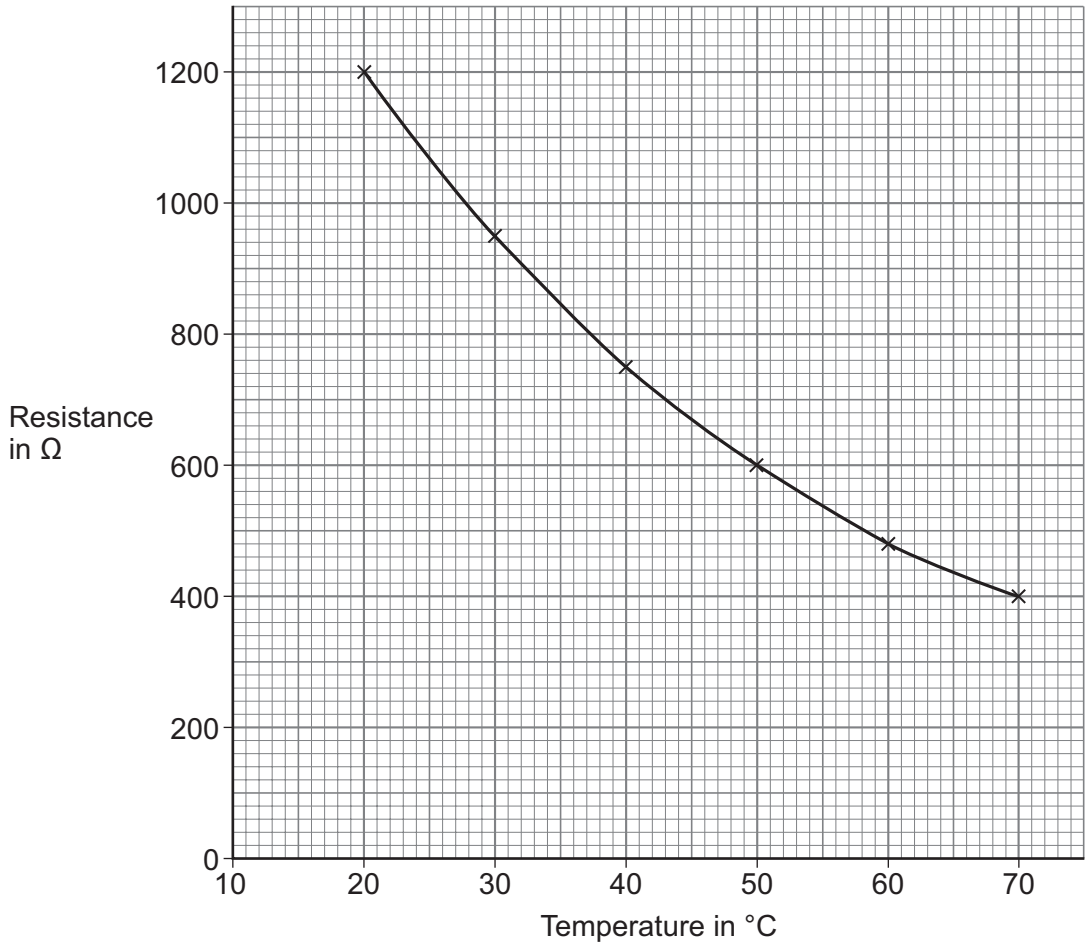
☐

Question 3 continues on the next page

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

Figure 7 shows the results.

Figure 7



0 3 . 2 Suggest why the student was **not** able to take measurements at temperatures below 20 °C.

[1 mark]

Do not write outside the box

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

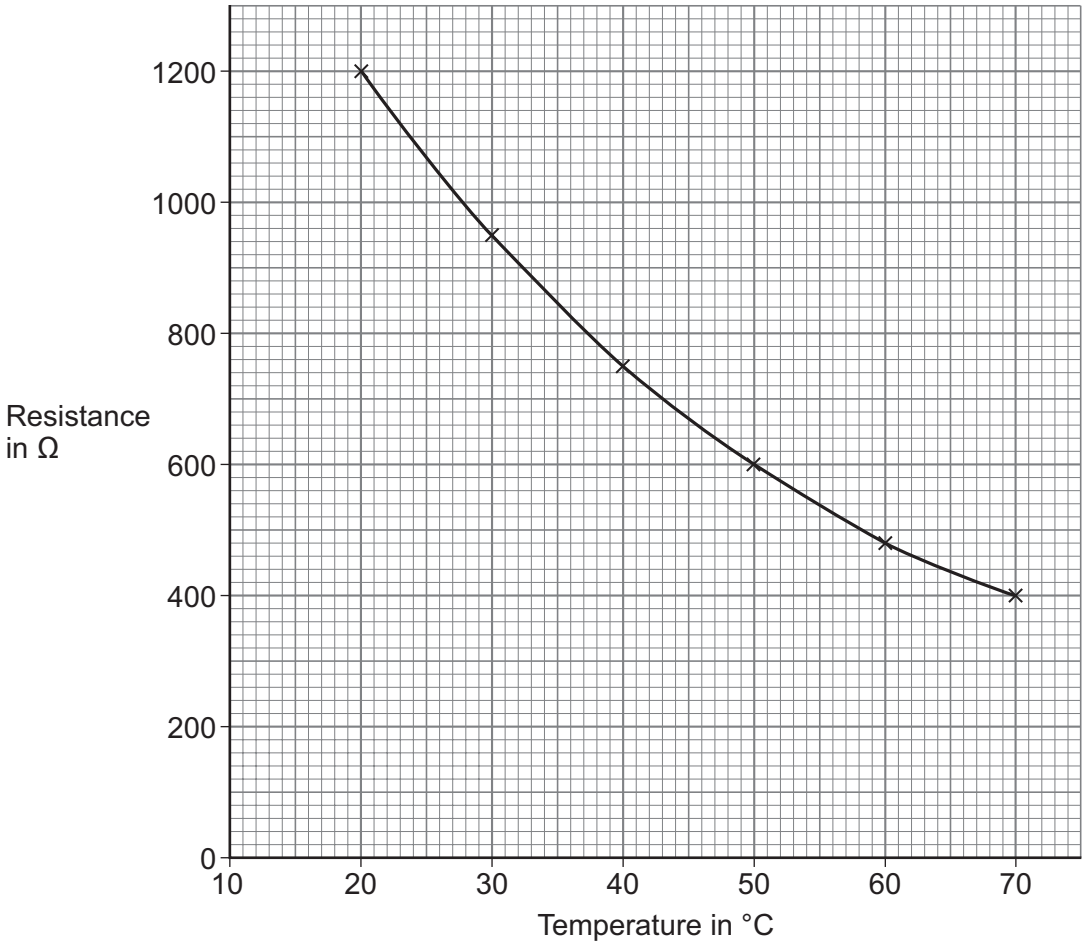
Describe a method the student could have used to obtain the results shown in **Figure 7**.

[6 marks]

Question 3 continues on the next page

Figure 7 is repeated below.

Figure 7



Do not write outside the box

Use the Physics Equations Sheet to answer Questions **03.4** and **03.5**.

0 3 . 4 Write down the equation which links current (I), potential difference (V) and resistance (R).

[1 mark]

_____

0 3 . 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 7**.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

Current = _____ A

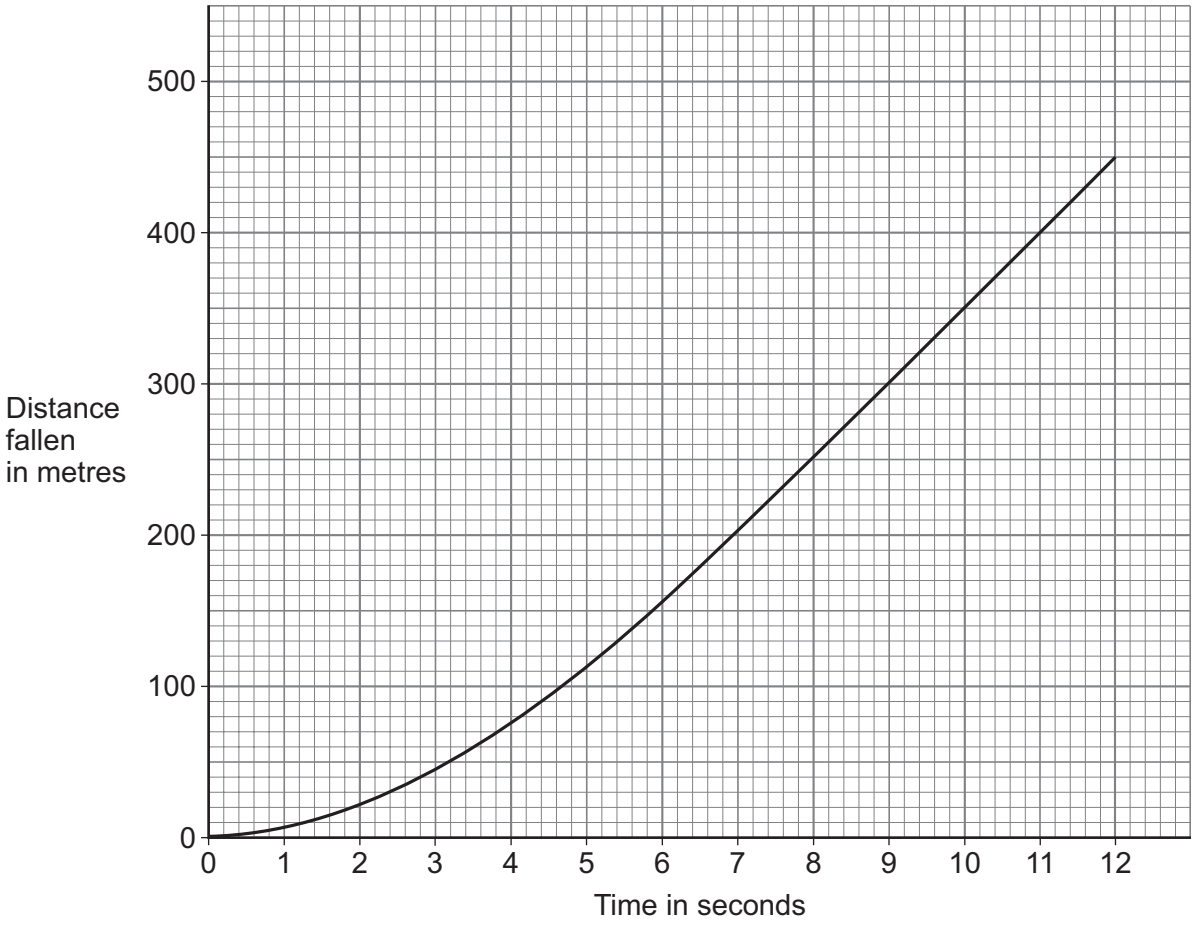
13

Turn over for the next question

0 4 A skydiver jumped out of a helicopter.

Figure 8 shows a distance-time graph for the first 12 seconds after the skydiver jumped out of the helicopter.

Figure 8



0 4 . 1 Determine the speed of the skydiver between 8 and 12 seconds.

Use the Physics Equations Sheet.

[2 marks]

Speed = _____ m/s

Do not write outside the box

0 4 . 2 Describe how the motion of the skydiver changed between 0 and 12 seconds.

[2 marks]

0 4 . 3 Explain why the resultant force on the skydiver changed as the skydiver fell.

[4 marks]

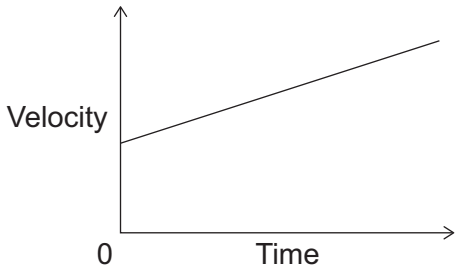
Question 4 continues on the next page

Do not write outside the box

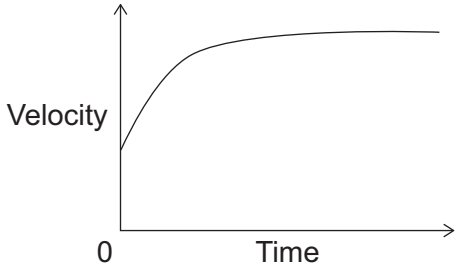
0 4 . 4 Which of the velocity–time graphs shows how the velocity of the skydiver changed after the parachute was opened?

[1 mark]

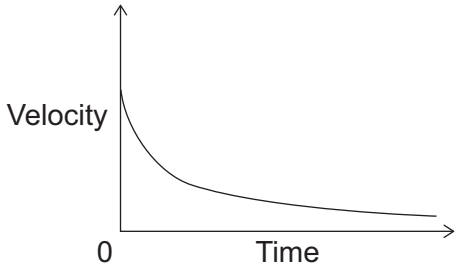
Tick (✓) **one** box.



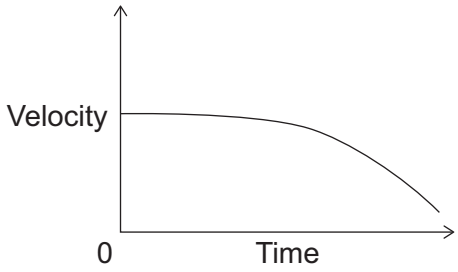
☐



☐



☐



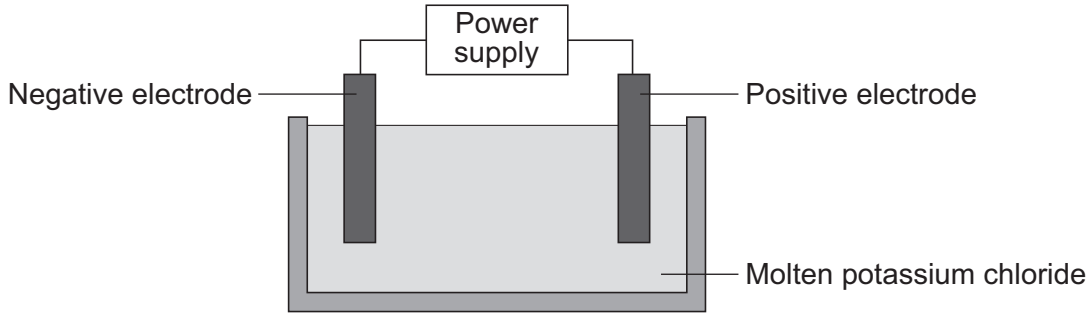
☐

9

0 5 This question is about electrolysis.

Figure 9 shows the electrolysis of molten potassium chloride using inert electrodes.

Figure 9



0 5 . 1 Why must potassium chloride be **molten** during the electrolysis?

[1 mark]

0 5 . 2 Why are **inert** electrodes used in electrolysis?

[1 mark]

Question 5 continues on the next page

Do not write outside the box

0 5 . 3 A gas is released during the electrolysis of molten potassium chloride.

Describe the test to identify the gas released.

Give the result if the gas is present.

[2 marks]

Test _____

_____

Result _____

_____

Potassium is produced at the **negative** electrode.

0 5 . 4 Write the half equation for the reaction at the **negative** electrode during the electrolysis of molten potassium chloride.

[1 mark]

_____ + _____ ⟶ _____

0 5 . 5 What type of reaction occurs at the **negative** electrode?

[1 mark]

_____

Do not write outside the box

0 5 . 6 An **aqueous** solution of potassium chloride was electrolysed.

Hydrogen gas was produced at the negative electrode.

Explain why hydrogen gas is produced during the electrolysis of an **aqueous** solution of potassium chloride.

[4 marks]

0 5 . 7 50 cm^3 of potassium chloride solution contains 0.030 moles of potassium chloride.

Calculate the concentration of the potassium chloride solution in g/dm^3.

Relative formula mass (M_r) of potassium chloride = 74.5

[4 marks]

Concentration = _____ g/dm^3

14

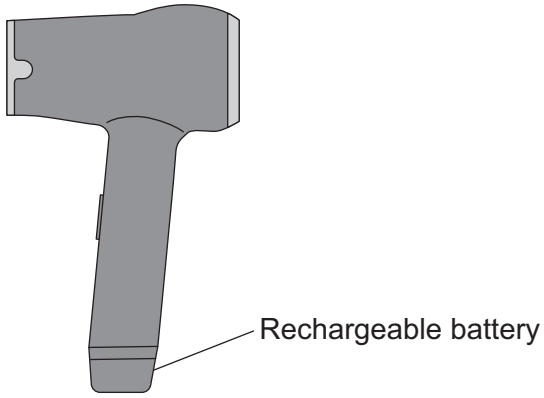
Do not write outside the box

0 6 A cordless hairdryer contains a heating element and a fan.

The hairdryer is powered by a rechargeable battery.

Figure 10 shows the cordless hairdryer.

Figure 10



0 6 . 1 The power output of the heating element is 0.24 kW when the potential difference across the heating element is 16 V.

Calculate the current in the heating element.

Use the Physics Equations Sheet.

[4 marks]

Current = _____ A

Do not write outside the box

0 6 . 2 The battery of the hairdryer can be recharged from 0 to 100% in 6.0 hours.

The power input to the battery is 18 W.

The potential difference across the battery is 24 V.

Calculate the charge flow through the battery in 6.0 hours.

Use the Physics Equations Sheet.

[6 marks]

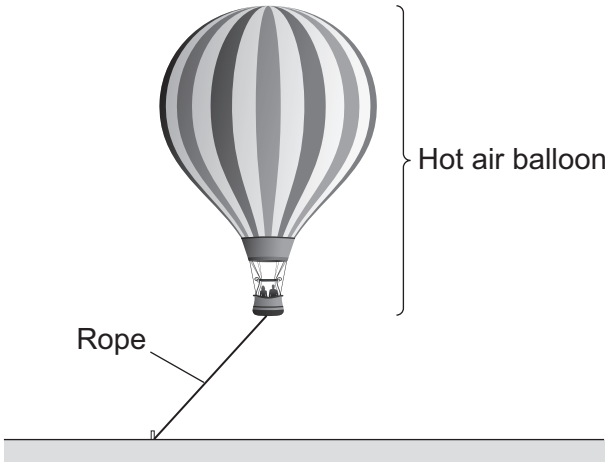
Charge flow = _____ C

10

Turn over for the next question

0 7 **Figure 11** shows a floating hot air balloon attached to the ground by a rope.

Figure 11



The hot air balloon is stationary.

0 7 . 1 The wind is exerting a force on the hot air balloon in **Figure 11**.

Which direction is the force of the wind acting?

[1 mark]

_____

0 7 . 2 What is the name of the upwards force on the hot air balloon?

[1 mark]

_____

Do not write outside the box

0 7 . 3 The weight of the hot air balloon is 3.43 kN.

gravitational field strength = 9.8 N/kg

Calculate the mass of the hot air balloon.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

0 7 . 4 The resultant force on the balloon is zero.

What is meant by 'resultant force'?

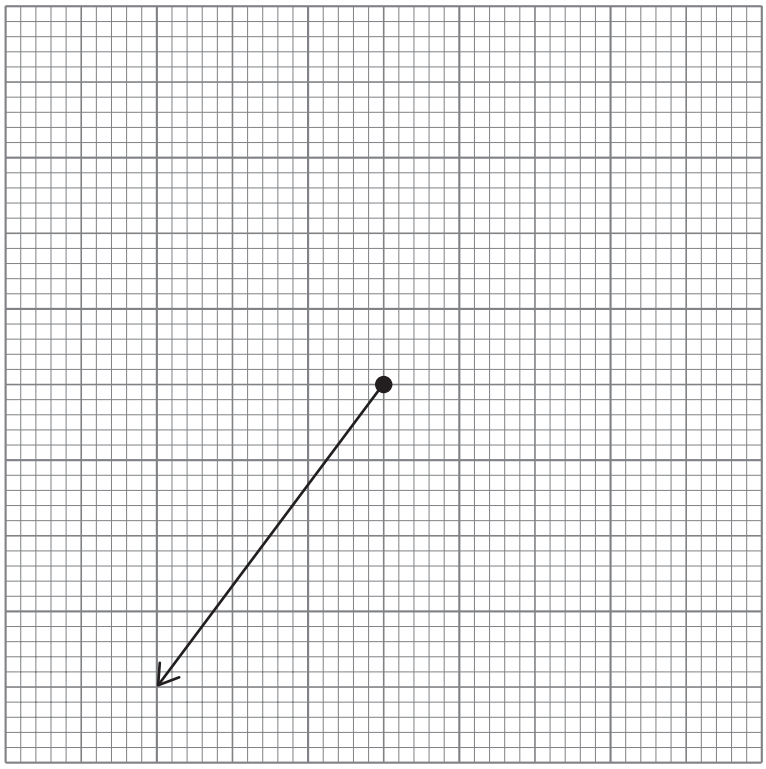
[1 mark]

Question 7 continues in the next page

Do not write outside the box

0 7 . 5 **Figure 12** shows a vector diagram of the force of the rope on the hot air balloon.

Figure 12



Scale 1 cm = 50 N

Complete the vector diagram to determine the magnitude of the horizontal and vertical components of the force.

[3 marks]

Horizontal component = _____ N

Vertical component = _____ N

10

Do not write outside the box

0 8 This question is about acids and salts.

0 8 . 1 Nitric acid is a strong acid.

A solution of nitric acid can be dilute.

Explain how nitric acid can be both strong **and** dilute.

[2 marks]

0 8 . 2 The pH value of a solution of nitric acid increases by 1.

How does the hydrogen ion concentration of the solution change?

[1 mark]

Tick (✓) **one** box.

Decreases by a factor of 10 ☐

Decreases by a factor of 100 ☐

Increases by a factor of 10 ☐

Increases by a factor of 100 ☐

Question 8 continues in the next page

Do not write outside the box

0 8 . 3 A student reacted nitric acid with **excess** calcium carbonate.

The word equation for the reaction is:

calcium carbonate + nitric acid ⟶ calcium nitrate + water + carbon dioxide

This is the method used.

1. Measure 100 cm^3 of nitric acid into a beaker.
2. Add calcium carbonate powder to the nitric acid.
3. Stir the mixture.
4. Repeat steps 2 and 3 until the calcium carbonate is in excess.
5. Filter the mixture.

Describe the additional steps that should be included in the method to determine the mass of calcium carbonate that reacted.

[5 marks]

The formula of nitric acid is HNO_3

0 8 . 4 Which expression gives the percentage (%) by mass of oxygen in HNO_3?

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $HNO_3 = 63$

[1 mark]

Tick (✓) **one** box.

$\frac{16}{63} \times 100$ ☐

$\frac{3 \times 16}{63} \times 100$ ☐

$\frac{63}{3 \times 16} \times 100$ ☐

$\frac{63}{16} \times 100$ ☐

0 8 . 5 What is the formula of calcium nitrate?

Use the periodic table.

[1 mark]

Tick (✓) **one** box.

$CaNO_3$ ☐

$Ca(NO_3)_2$ ☐

Ca_2NO_3 ☐

$Ca_2(NO_3)_3$ ☐

Question 8 continues in the next page

Do not write outside the box

0 8 . 6 Magnesium chloride is a salt.

Calculate the number of magnesium ions in 47.5 g of magnesium chloride ($MgCl_2$).

Relative atomic masses (A_r): Mg = 24 Cl = 35.5

Avogadro constant = 6.02×10^{23} per mole

[6 marks]

Number of magnesium ions = _____

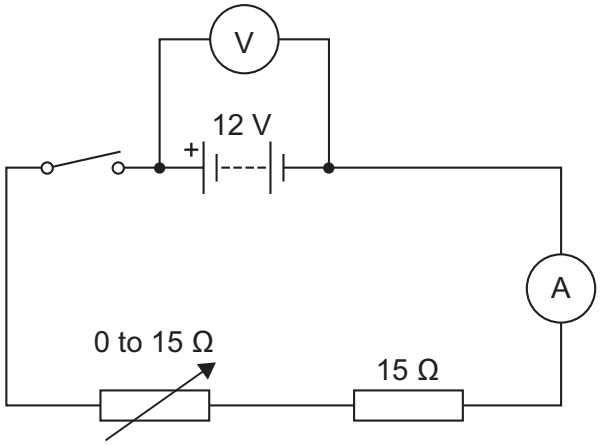
16

Do not write outside the box

0 9 A student investigated electrical circuits.

0 9 . 1 **Figure 13** shows a circuit the student made.

Figure 13



The student increased the resistance of the variable resistor from 0 to 15 Ω.

Explain what happened to the readings on the voltmeter and ammeter as the resistance was increased.

[4 marks]

Voltmeter reading _____

_____

_____

_____

Ammeter reading _____

_____

_____

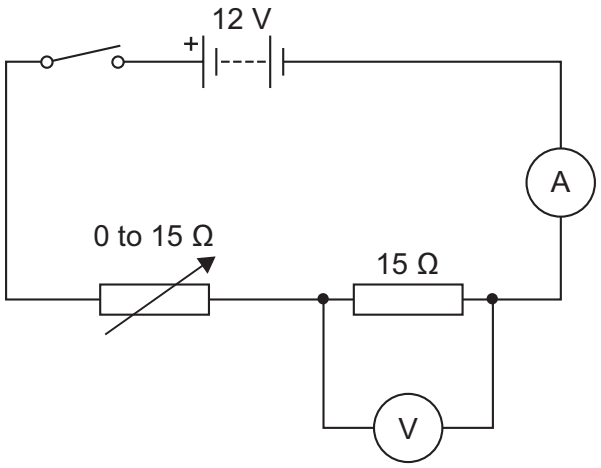
_____

Question 9 continues in the next page

The student changed the position of the voltmeter.

Figure 14 shows the new circuit.

Figure 14



The student connected the voltmeter across the 15 Ω fixed resistor.

The student used the variable resistor to vary the potential difference across the fixed resistor.

0 9 . 2 The potential difference across the fixed resistor can only be varied between 6 V and 12 V using the circuit in **Figure 14**.

Explain why.

[3 marks]

Do not write outside the box

0 9 . 3 Give **one** way the student could vary the potential difference across the fixed resistor below 6 V.

[1 mark]

_____

_____

_____

8

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

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

Do not write outside the box

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

Do not write outside the box

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

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED