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9702/35

October/November 2023

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

For Examiner's Use	
1	
2	
Total	

This document has **12** pages. Any blank pages are indicated.

You may not need to use all of the materials provided.

1 In this experiment, you will determine the resistivity of a metal.

- (a) • Set up the circuit shown in Fig. 1.1.

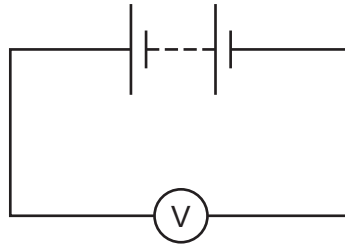


Fig. 1.1

- The voltmeter reading is E .

Record E .

$E = \dots\dots\dots$ V

- Set up the circuit shown in Fig. 1.2.

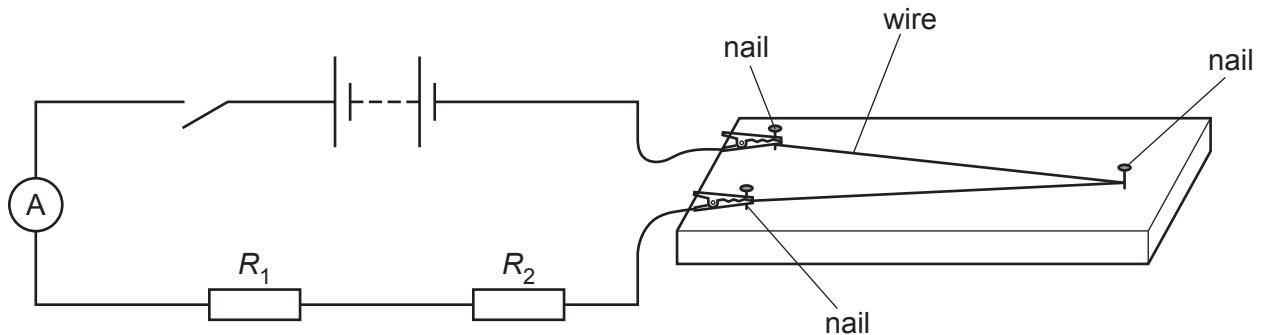


Fig. 1.2 (not to scale)

- You have been provided with several resistors, each with a different value of resistance. Select resistors and connect them so that $R_1 = 33\,\Omega$ and $R_2 = 56\,\Omega$.

- Record R_1 and R_2 .

$R_1 = \dots\dots\dots$

$R_2 = \dots\dots\dots$

- Calculate $(R_1 + R_2)$.

$(R_1 + R_2) = \dots\dots\dots$

- Close the switch.
- The ammeter reading is I .

Record I .

$I =$ mA

- Open the switch.

[1]

- (b) Change the values of R_1 and R_2 to provide six different values of $(R_1 + R_2)$.

For each arrangement, record values of R_1 , R_2 and I in a table. Include values of $(R_1 + R_2)$ and $\frac{1}{I}$ in your table.

[8]

- (c) (i) Plot a graph of $\frac{1}{I}$ on the y -axis against $(R_1 + R_2)$ on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

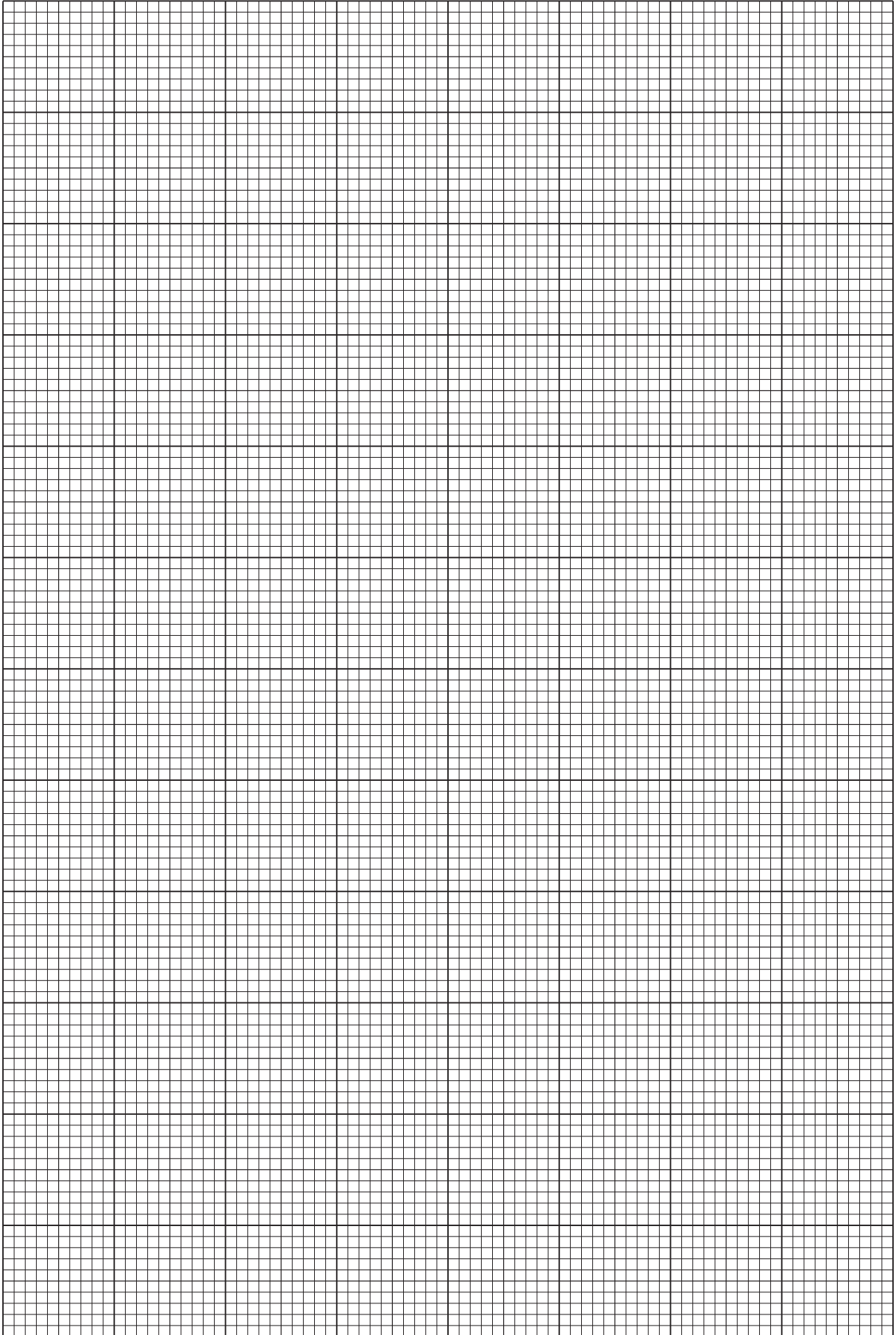
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient =

y -intercept =

[2]



- (d) It is suggested that the quantities I , R_1 and R_2 are related by the equation

$$\frac{1}{I} = F(R_1 + R_2) + G$$

where F and G are constants.

Using your answers in (c)(iii), determine the values of F and G .

Give appropriate units.

$$F = \dots\dots\dots$$

$$G = \dots\dots\dots [2]$$

- (e) (i) Use the micrometer to measure the diameter d of the wire.

$$d = \dots\dots\dots [2]$$

- (ii) It is suggested that G is given by the equation

$$G = \frac{4\rho L}{\pi d^2 E}$$

where L is 0.560 m and ρ is the resistivity of the metal of the wire.

Using your answers in (a), (d) and (e)(i), determine a value for ρ .

$$\rho = \dots\dots\dots \Omega \text{ m} [1]$$

[Total: 20]

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You may not need to use all of the materials provided.

2 In this experiment, you will investigate the movement of a mass hanger.

(a) You are provided with a number of paper clips.

Use the top-pan balance to determine the mass m of **one** paper clip.

$m = \dots\dots\dots$ g [1]

(b) (i) • Set up the apparatus as shown in Fig. 2.1.

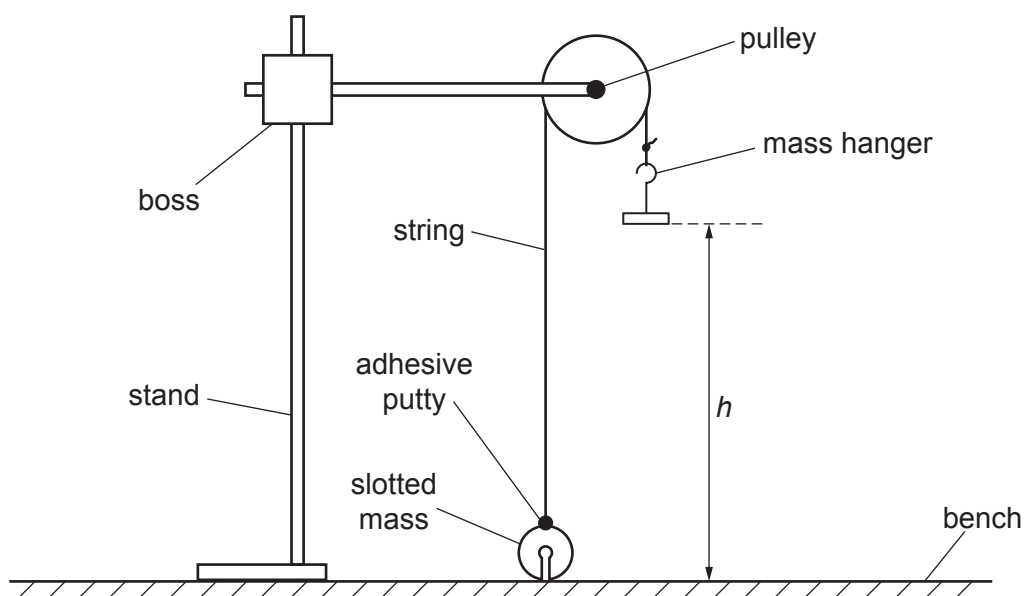


Fig. 2.1 (not to scale)

- Lower the slotted mass until it just touches the bench.
- The distance between the bottom of the mass hanger and the bench is h , as shown in Fig. 2.1.

Measure and record h .

$h = \dots\dots\dots$ cm [1]

- (ii) • Add just enough paper clips to the mass hanger so that it falls smoothly to the bench without stopping.
- Record the total number N of paper clips on the mass hanger.

$N = \dots\dots\dots$ [1]

- (iii) • Adjust the position of the slotted mass so that it is just touching the bench again.
- Release the slotted mass and measure the time t for the mass hanger and N paper clips to fall to the bench.

$t = \dots\dots\dots$ [2]

- (iv) Estimate the percentage uncertainty in your value of t . Show your working.

percentage uncertainty = $\dots\dots\dots$ % [1]

- (v) The acceleration a of the mass hanger is given by the relationship

$$a = \frac{2h}{t^2}.$$

Calculate a .

$a = \dots\dots\dots \text{cms}^{-2}$ [1]

- (vi) Justify the number of significant figures that you have given for your value of a .

$\dots\dots\dots$

$\dots\dots\dots$

$\dots\dots\dots$ [1]

- (c) • Add two more paper clips to the mass hanger.
- Record the total number N of paper clips on the mass hanger.

$N =$

- Repeat (b)(iii) and (b)(v).

$t =$

$a =$ cm s^{-2}
[2]

- (d) It is suggested that the relationship between a , m and N is

$$\frac{k}{a} = 1 + \frac{2Z}{Nm}$$

where Z is the mass of the slotted mass and has the value 10.0 g, and k is a constant.

Using your data, calculate two values of k .

first value of $k =$

second value of $k =$
[1]

- (e) It is suggested that the percentage uncertainty in the values of k is 25%.

Using this uncertainty, explain whether your results support the relationship in (d).

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..... [1]

- (f) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1

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2

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3

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4

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[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1

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4

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[4]

[Total: 20]

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