



# Cambridge International AS & A Level

CANDIDATE  
NAME

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**PHYSICS**

**9702/51**

Paper 5 Planning, Analysis and Evaluation

**October/November 2022**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

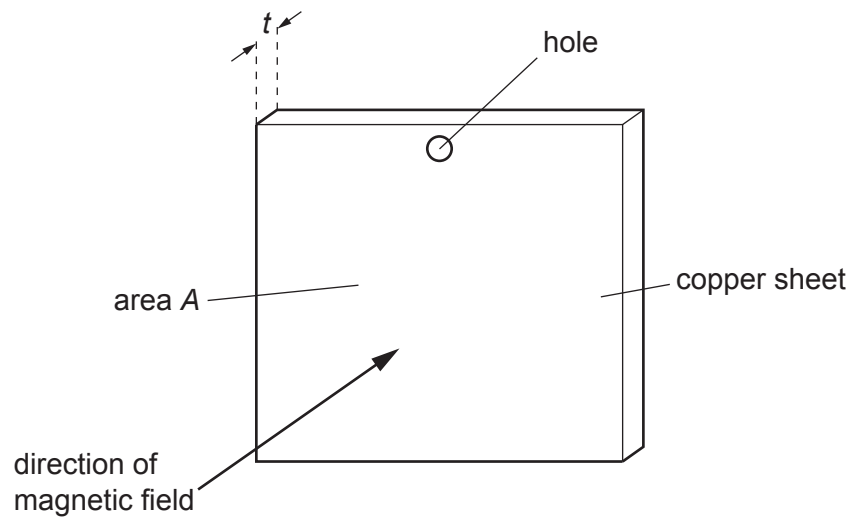
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **8** pages.

- 1 A thin copper sheet is suspended from a small hole near the top of the sheet and placed in a magnetic field, as shown in Fig. 1.1.



**Fig. 1.1** (not to scale)

The sheet has area  $A$  and thickness  $t$ .

The sheet is displaced from its equilibrium position through a horizontal distance  $s_0$  and then released so that it oscillates perpendicular to the direction of the magnetic field. The horizontal distance  $s$  of the sheet from its equilibrium position is measured after five complete oscillations.

It is suggested that  $s$  is related to  $A$  by the relationship

$$s = s_0 e^{-ABKt}$$

where  $B$  is the magnetic flux density of the field and  $K$  is a constant.

Plan a laboratory experiment to test the relationship between  $s$  and  $A$ .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine a value for  $K$ .

In your plan you should include:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

**Diagram**

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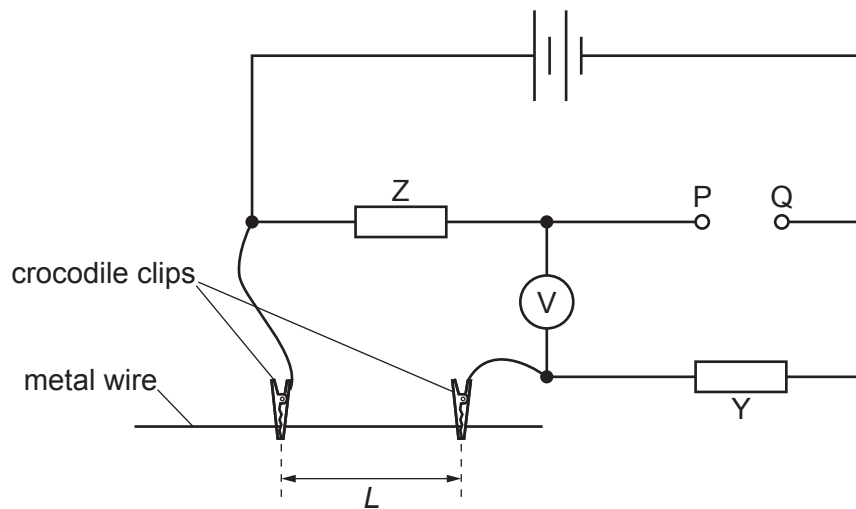
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- 2 A student investigates a circuit containing resistors and a metal wire as shown in Fig. 2.1.



**Fig. 2.1**

Resistors Y and Z have resistances  $Y$  and  $Z$  respectively.

The student connects a resistor of resistance  $R$  between P and Q.

The student then adjusts the length of the wire between the crocodile clips until the voltmeter reads zero. The student measures the length  $L$  of wire between the crocodile clips.

The student repeats the experiment with different values of  $R$ .

It is suggested that  $L$  and  $R$  are related by the equation

$$\frac{Z}{R} = \frac{4\rho L}{\pi Yd^2}$$

where  $d$  is the diameter of the wire and  $\rho$  is the resistivity of the metal.

- (a) A graph is plotted of  $L$  on the  $y$ -axis against  $\frac{1}{R}$  on the  $x$ -axis.

Determine an expression for the gradient.

gradient = ..... [1]

(b) Values of  $R$  and  $L$  are given in Table 2.1.

Each resistance value  $R$  has a percentage uncertainty of  $\pm 5\%$ .

**Table 2.1**

$R/\Omega$	$\frac{1}{R}/10^{-3}\Omega^{-1}$	$L/\text{cm}$
22		71.0
27		57.5
33		45.0
39		36.5
47		27.5
54		23.0

Calculate and record values of  $\frac{1}{R}/10^{-3}\Omega^{-1}$  in Table 2.1.

Include the absolute uncertainties in  $\frac{1}{R}$ . [2]

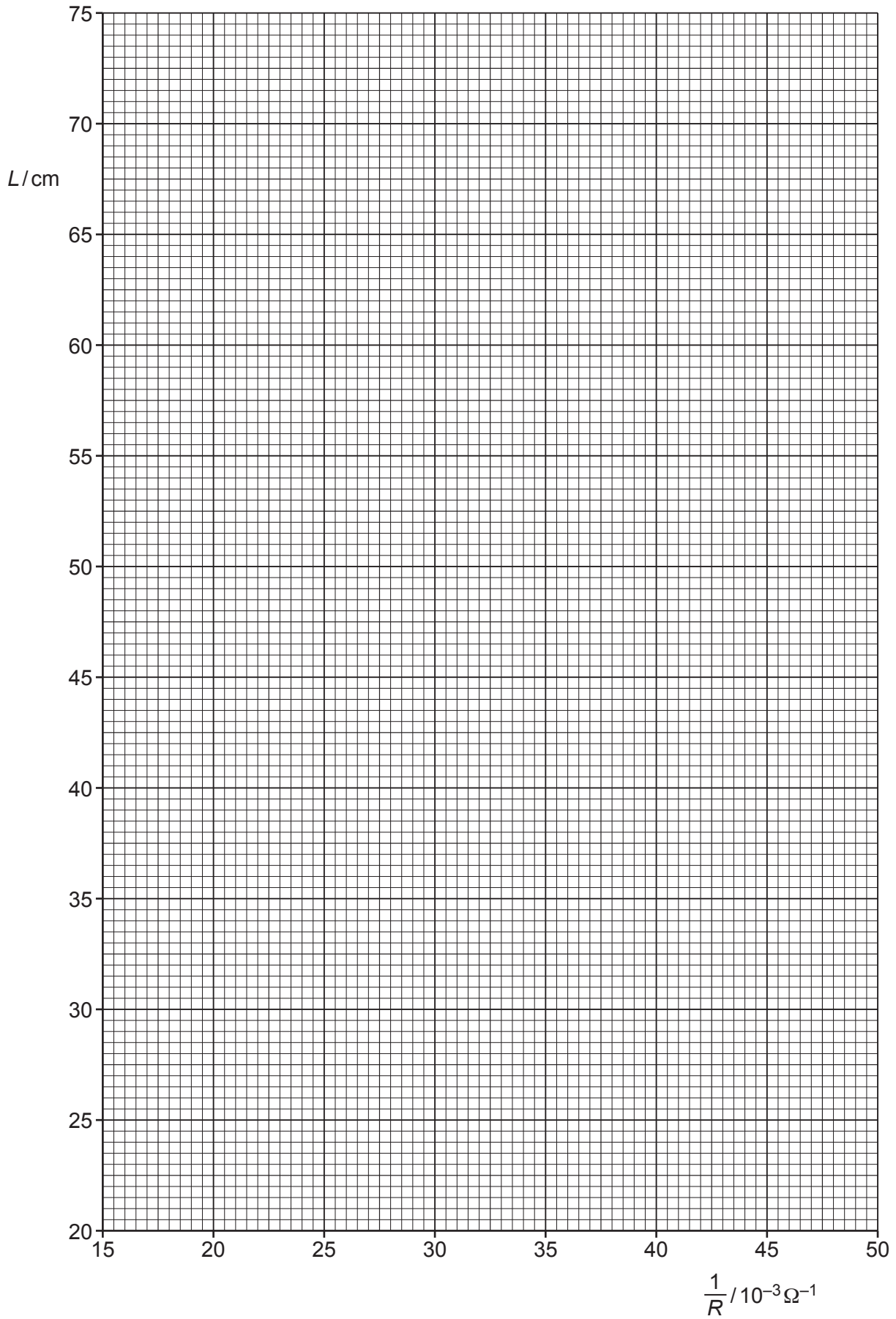
(c) (i) Plot a graph of  $L/\text{cm}$  against  $\frac{1}{R}/10^{-3}\Omega^{-1}$ .

Include error bars for  $\frac{1}{R}$ . [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines. [2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ..... [2]



(d) The student measures the diameter of the wire. The student's values are:

0.263 mm    0.262 mm    0.263 mm    0.257 mm    0.262 mm    0.259 mm.

Determine the average diameter  $d$ . Include the absolute uncertainty in  $d$ .

$$d = \dots\dots\dots \text{ mm [1]}$$

(e) (i) Resistors Y and Z each have a resistance of  $22 \Omega \pm 5\%$ .

Using your answers to (a), (c)(iii) and (d), determine the value of  $\rho$ . Include an appropriate unit.

$$\rho = \dots\dots\dots [2]$$

(ii) Determine the percentage uncertainty in  $\rho$ .

$$\text{percentage uncertainty in } \rho = \dots\dots\dots \% [1]$$

(f) Determine the resistance  $R$  that would give a value of  $L$  of 95.0 cm. Include the absolute uncertainty in your answer.

$$R = \dots\dots\dots \Omega [2]$$

[Total: 15]