



# Cambridge International AS & A Level

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## PHYSICS

9702/51

Paper 5 Planning, Analysis and Evaluation

May/June 2025

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

### INSTRUCTIONS

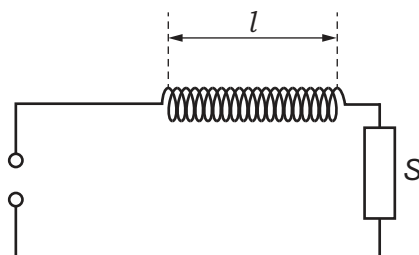
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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 Fig. 1.1 shows a thin coil of cross-sectional area  $A$  and length  $l$  connected to a resistor of resistance  $S$  and two terminals.



**Fig. 1.1**

An alternating voltage is applied to the terminals. The peak value of the alternating voltage is  $E$  and the frequency is  $f$ . The peak value of the potential difference  $V$  across the resistor is determined using an oscilloscope.

It is suggested that  $V$  is related to  $f$  by the relationship

$$\frac{ES}{V} = \frac{KAN^2f}{l}$$

where  $N$  is the number of turns on the coil and  $K$  is a constant.

Plan a laboratory experiment to test the relationship between  $V$  and  $f$ .

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.



[illegible]

..... [15]

- 2 A student investigates an electrical circuit.

The circuit is set up as shown in Fig. 2.1.

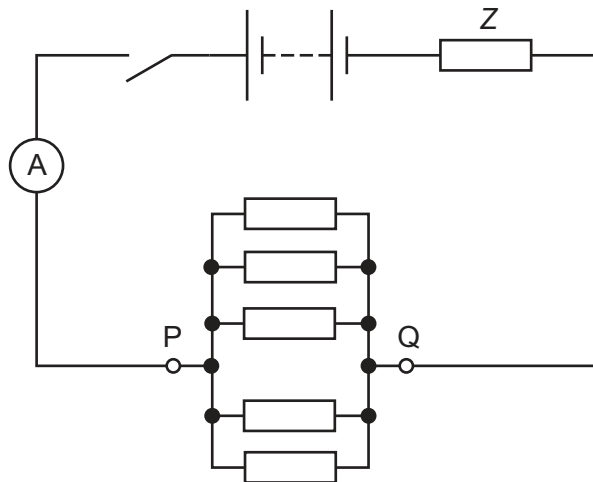


Fig. 2.1

A battery of negligible internal resistance is connected to a resistor of resistance  $Z$ . Five resistors, each of resistance  $R$ , are connected in parallel between P and Q.

The switch is closed. The total current  $I$  in the circuit is measured using the ammeter.

The experiment is then repeated by changing the number  $n$  of resistors, each of resistance  $R$ , connected in parallel between P and Q.

It is suggested that  $I$  and  $n$  are related by the equation

$$E = I \left( \frac{R}{n} + Z \right)$$

where  $E$  is the electromotive force (e.m.f.) of the battery.

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

Determine expressions for the gradient and y-intercept.

gradient = .....

y-intercept = .....

[1]





(b) Values of  $n$ ,  $\frac{1}{n}$  and  $I$  are given in Table 2.1.

**Table 2.1**

$n$	$\frac{1}{n}$	$I/\mu\text{A}$	$\frac{1}{I}/10^3\text{A}^{-1}$
5	0.200	$455 \pm 5$	
6	0.167	$525 \pm 5$	
7	0.143	$580 \pm 5$	
8	0.125	$635 \pm 5$	
9	0.111	$685 \pm 5$	
11	0.0909	$765 \pm 5$	

Calculate and record values of  $\frac{1}{I}/10^3\text{A}^{-1}$  in Table 2.1. Include the absolute uncertainties in  $\frac{1}{I}$ . [2]

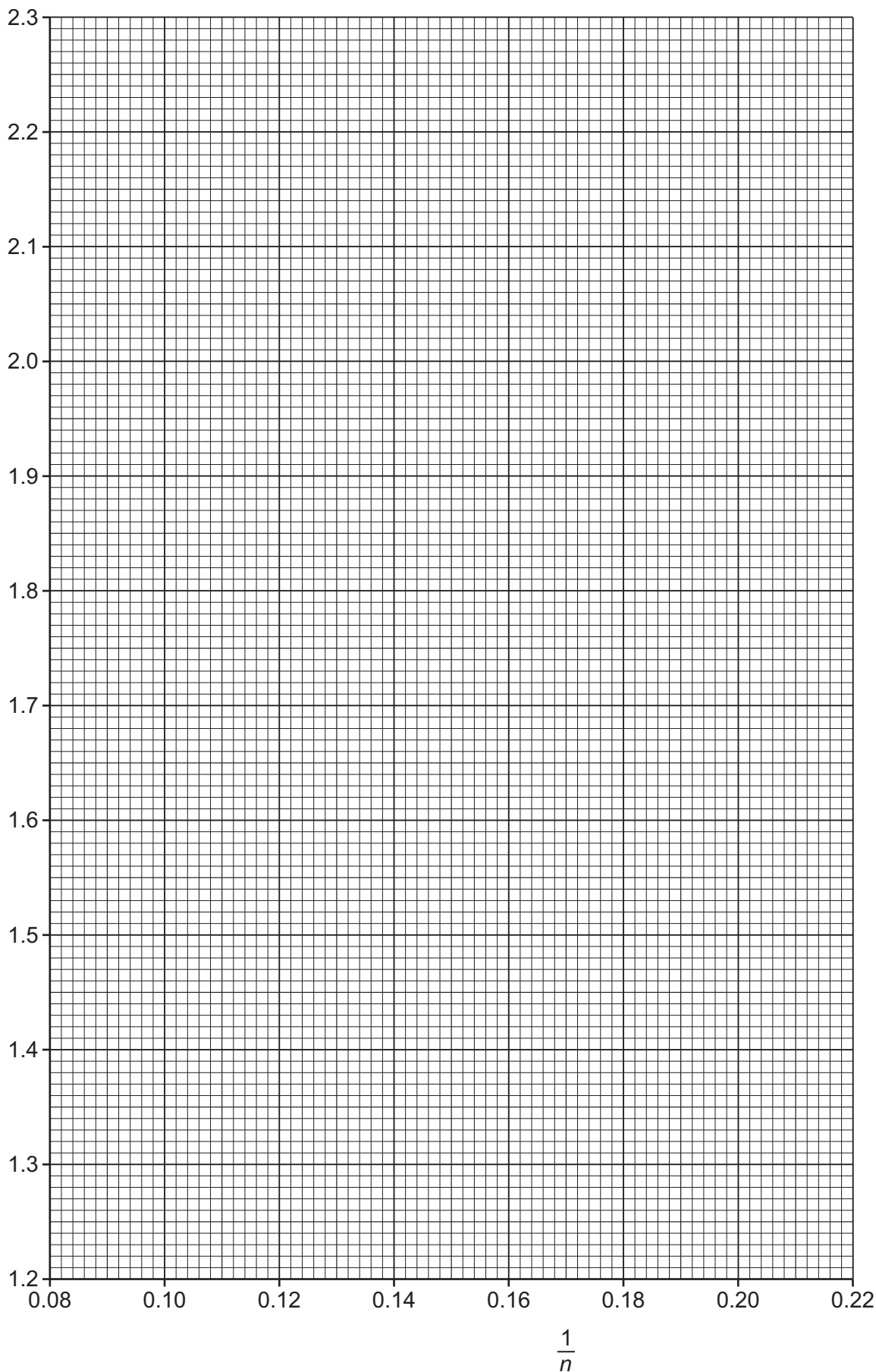
- (c) (i) Plot a graph of  $\frac{1}{I}/10^3\text{A}^{-1}$  against  $\frac{1}{n}$ . Include error bars for  $\frac{1}{I}$ . [2]
- (ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines. [2]
- (iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ..... [2]





$\frac{1}{I} / 10^3 \text{A}^{-1}$





- (iv) Determine the  $y$ -intercept of the line of best fit. Include the absolute uncertainty in your answer.

$y$ -intercept = ..... [2]

- (d) The e.m.f.  $E$  of the battery is determined twice during the experiment. The values obtained are 5.6 V and 6.0 V.

- (i) Using your answers to (a), (c)(iii) and (c)(iv), determine the values of  $R$  and  $Z$ . Include appropriate units.

$R$  = .....

$Z$  = .....

[2]

- (ii) Determine the percentage uncertainty in your value of  $R$ .

percentage uncertainty = ..... % [1]

- (e) The experiment is repeated with 20 resistors, each of resistance  $R$ , connected in parallel between P and Q. Determine the total current  $I$  in the circuit.

$I$  = ..... A [1]

[Total: 15]

