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Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*9908315282*

**PHYSICS** **9702/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2024**

**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.


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[Turn over

**1** A thin cylindrical bar magnet of length $L$ and cross-sectional area $A$ is attached to a block. An identical magnet is attached to a trolley, as shown in Fig. 1.1.

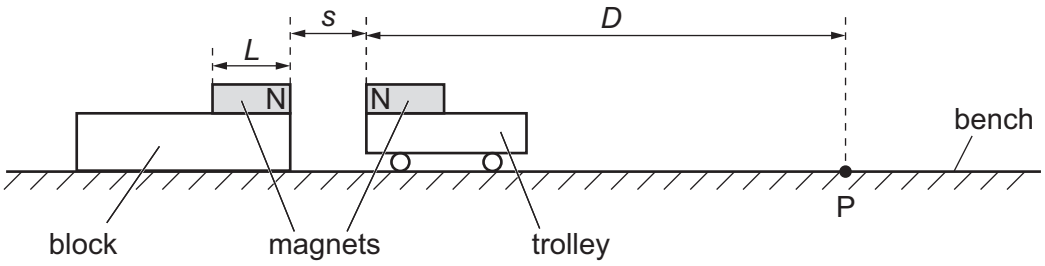



**Fig. 1.1**

The trolley is held so that the separation of the N poles of the two magnets is $s$.

Point P is a distance $D$ from the N pole of the magnet on the stationary trolley.

The trolley is released. The speed $v$ of the trolley at point P is determined using one light gate.

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

$$\frac{mv^2}{2D} = \frac{KA^2B^2L^2}{s^4} - Q$$

where $B$ is the magnetic flux density at the N pole of one of the magnets, $m$ is the mass of the trolley, and $K$ and $Q$ are constants.

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

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for $K$ and $Q$.

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.

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**Diagram**

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**2** A student investigates an electrical circuit. A power supply of electromotive force (e.m.f.) $E_s$ and negligible internal resistance is connected in series to three resistors, each of resistance $Z$.

A cell, an ammeter and a resistor of resistance $R$ are connected in parallel across one of these resistors, as shown in Fig. 2.1.

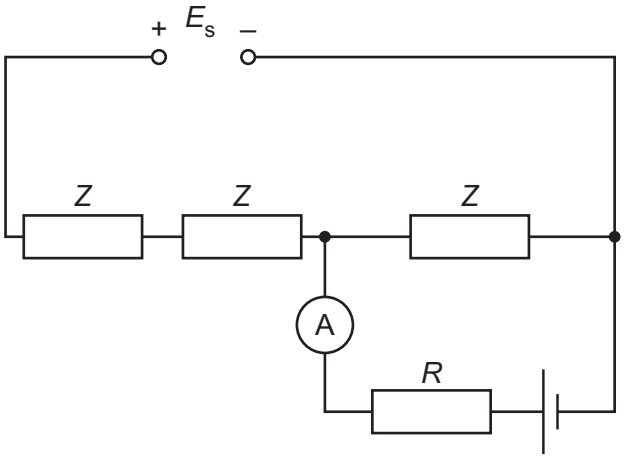



**Fig. 2.1**

The current $I$ is measured by the ammeter for different values of $R$.

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

$$3E - E_s = I(3R + 2Z)$$

where $E$ is the e.m.f. of the cell.

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

Determine expressions for the gradient and $y$-intercept.

gradient = .....

$y$-intercept = .....

[1]

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

**Table 2.1**

| $R$/kΩ | $I$/μA | $\frac{1}{I}$/A$^{-1}$ |
|---|---|---|
| 1.50 | 194 ± 2 | |
| 1.75 | 180 ± 2 | |
| 1.92 | 172 ± 2 | |
| 2.22 | 160 ± 2 | |
| 2.48 | 150 ± 2 | |
| 2.72 | 144 ± 2 | |

Calculate and record values of $\frac{1}{I}$/A$^{-1}$ in Table 2.1.

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

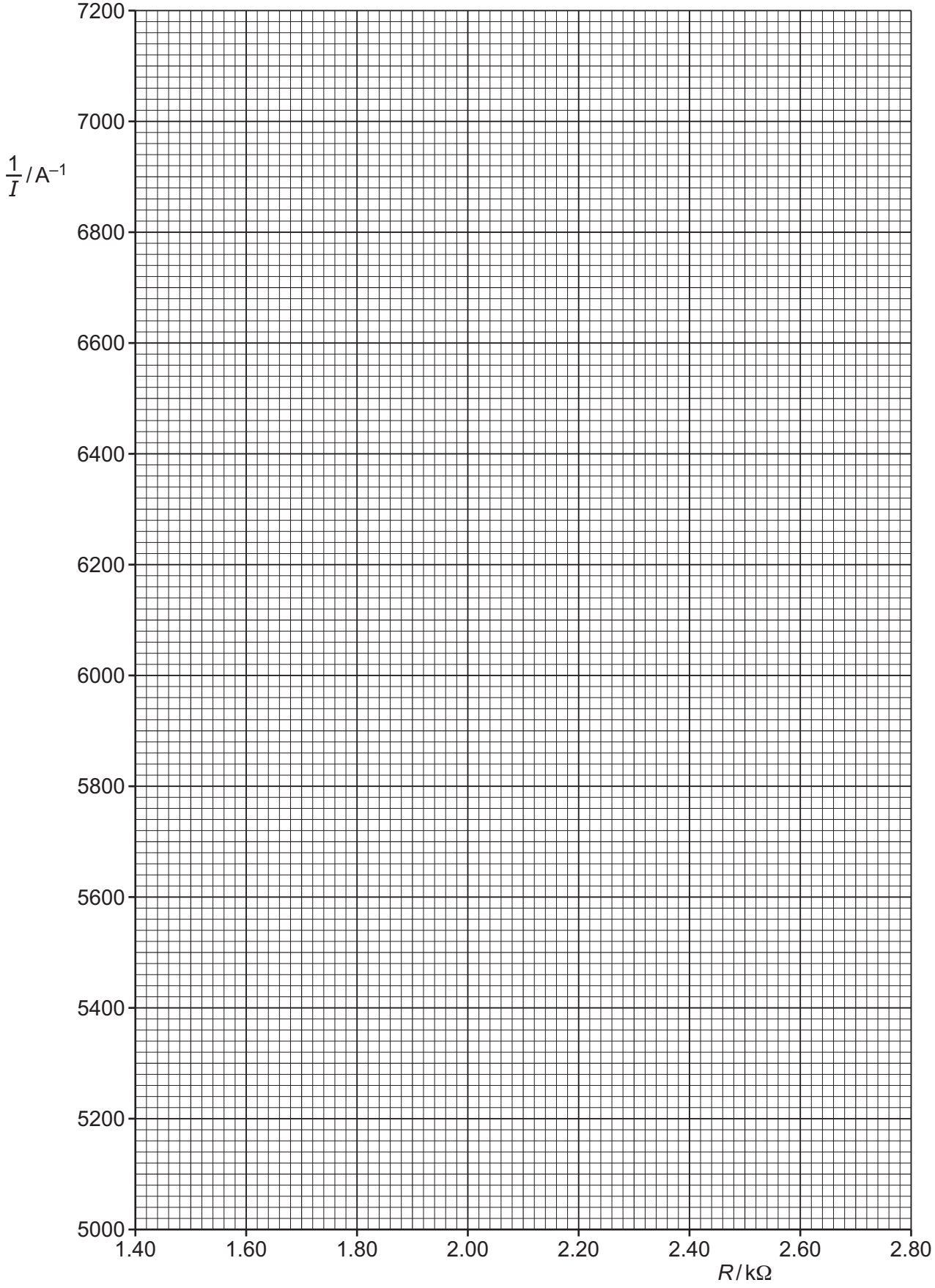
**(c) (i)** Plot a graph of $\frac{1}{I}$/A$^{-1}$ against $R$/kΩ. Include error bars for $\frac{1}{I}$. [2]

**(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]

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

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

**(d) (i)** Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of *E* and *Z*. Include appropriate units.

Data: $E_s = (2.20 \pm 0.05)\,\text{V}$

*E* = .....

*Z* = .....
[2]

**(ii)** Determine the absolute uncertainty in *E*.

absolute uncertainty in *E* = ..... [1]

**(e)** The experiment is repeated. Determine the resistance *R* that gives a value of *I* of 250 μA.

*R* = ..... Ω [1]

[Total: 15]

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