Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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.

[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.

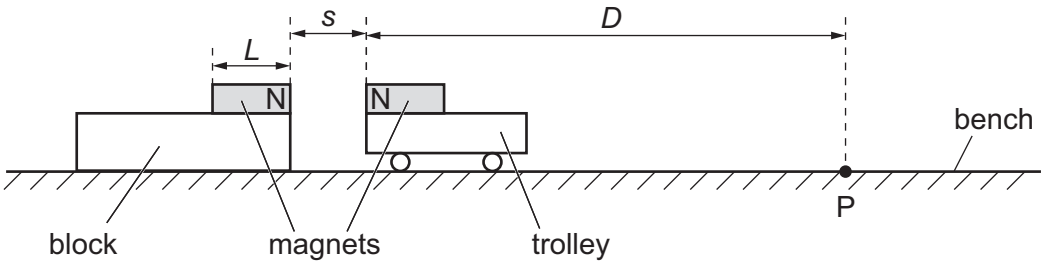


Fig. 1.1

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.

Diagram

[15]

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.

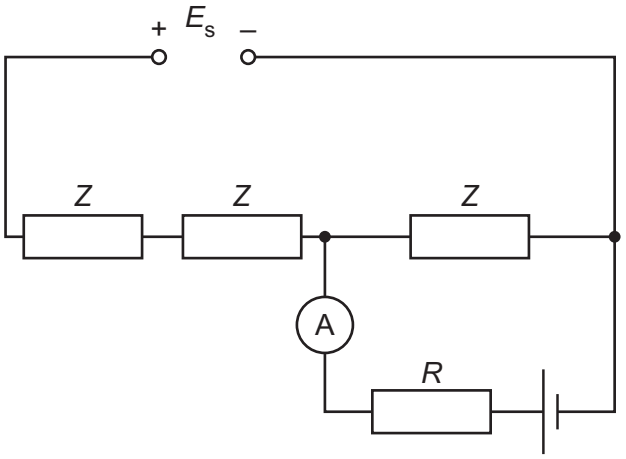


Fig. 2.1

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.

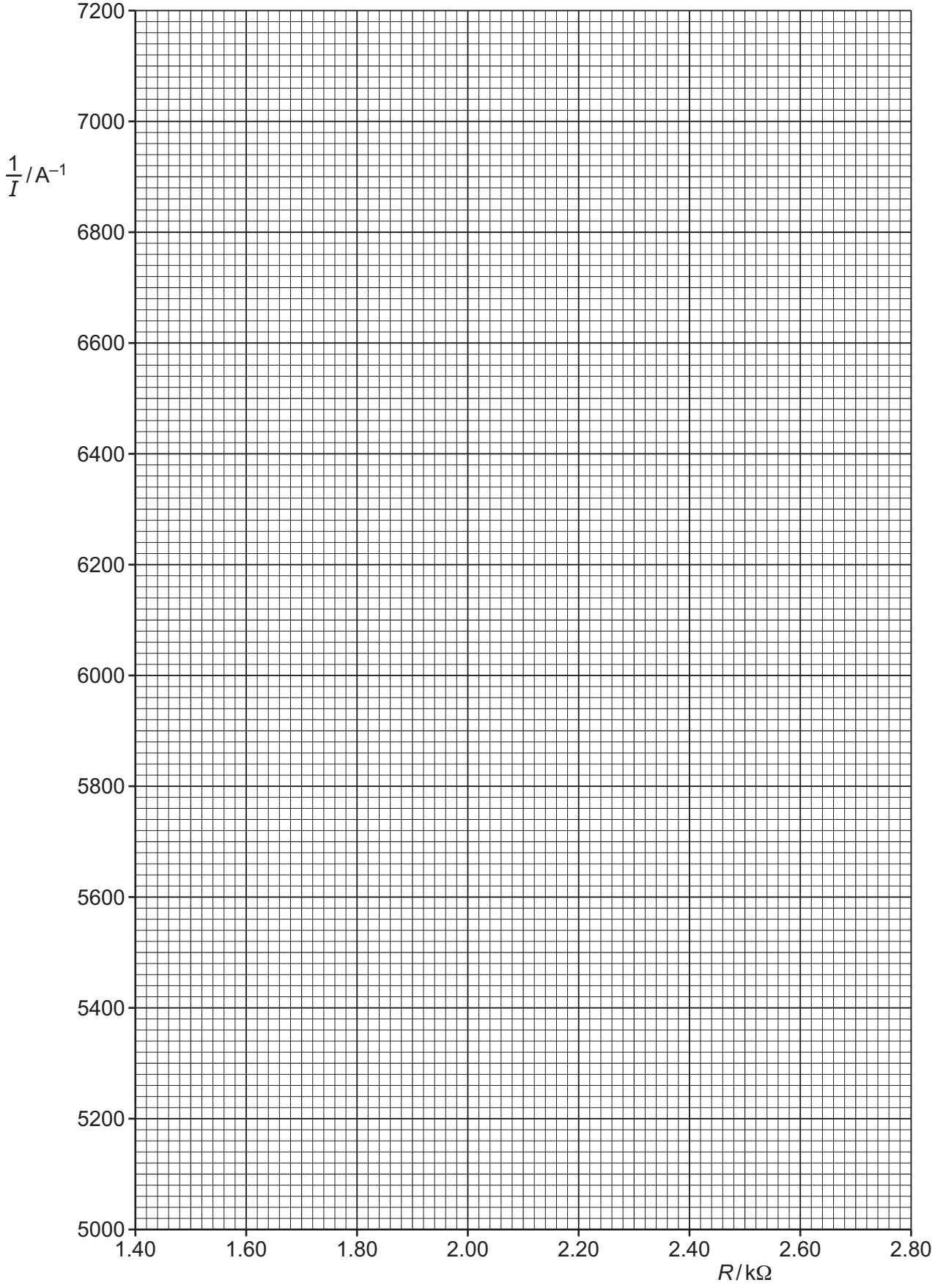
Include the absolute uncertainties in $\frac{1}{I}$. [2]

(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]



(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]