



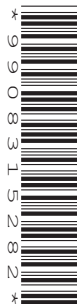
Cambridge International AS & A Level

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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.

- 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.

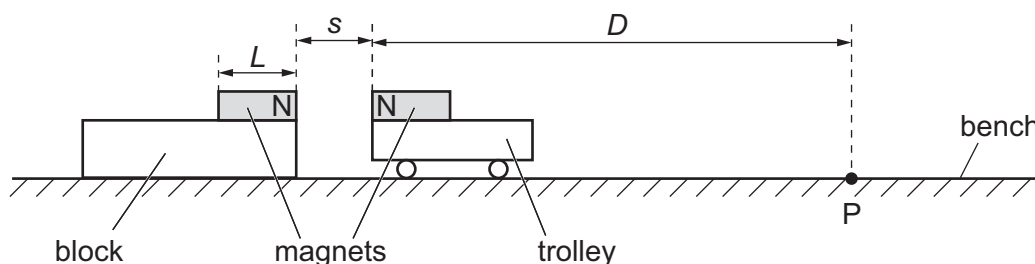


Fig. 1.1

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

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[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.

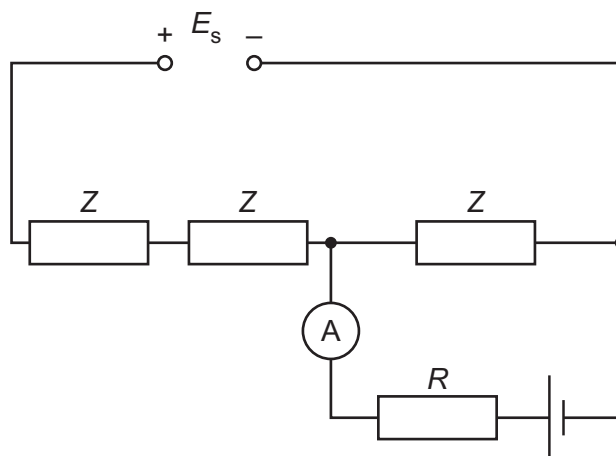


Fig. 2.1

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

$R/\text{k}\Omega$	$I/\mu\text{A}$	$\frac{1}{I}/\text{A}^{-1}$
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 $\frac{1}{I}/\text{A}^{-1}$ in Table 2.1.

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

[2]

(c) (i) Plot a graph of $\frac{1}{I}/\text{A}^{-1}$ against $R/\text{k}\Omega$. Include error bars for $\frac{1}{I}$.

[2]

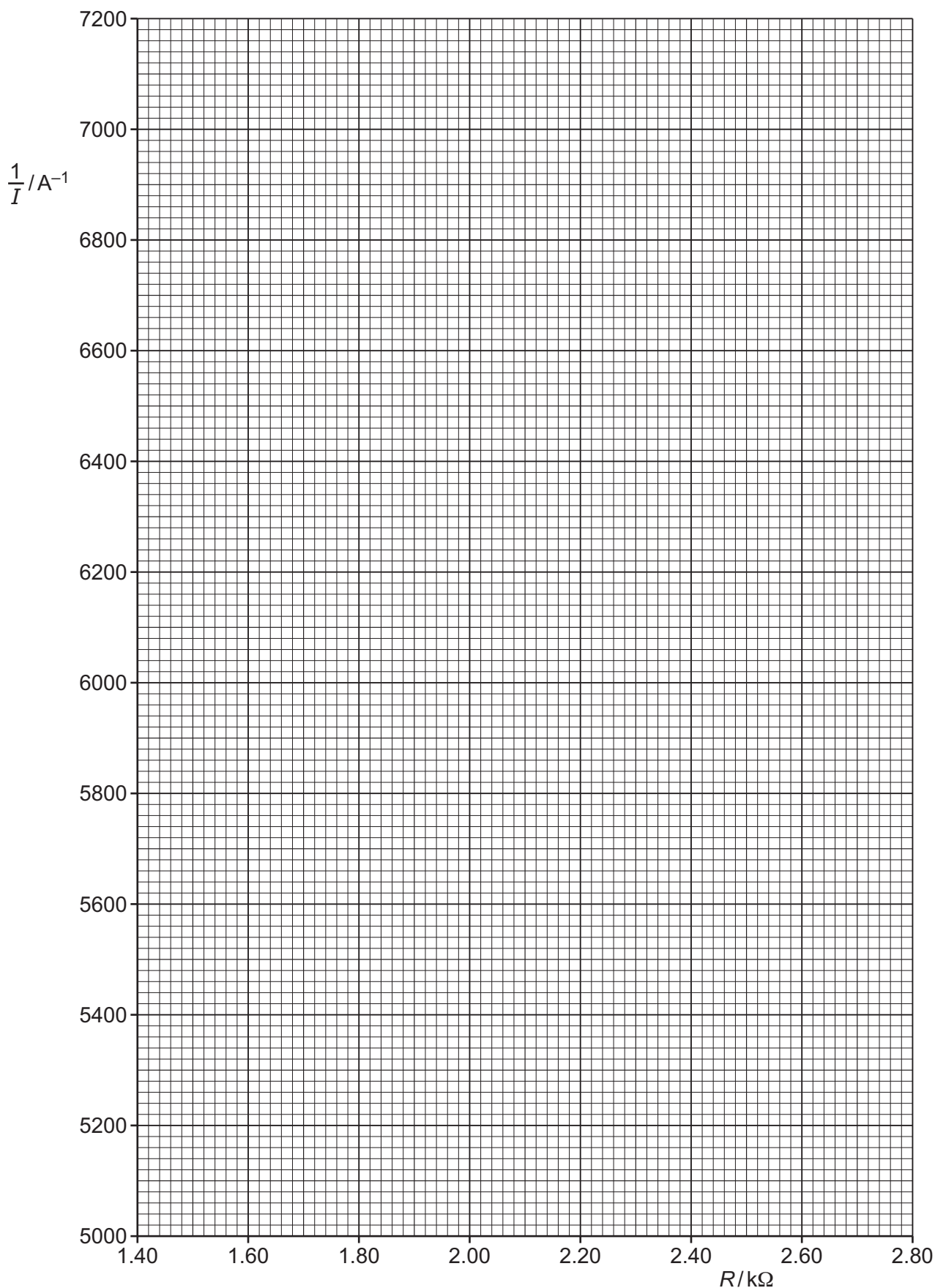
(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines.

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

$E = \dots\dots\dots$

$Z = \dots\dots\dots$ [2]

- (ii) Determine the absolute uncertainty in E .

absolute uncertainty in $E = \dots\dots\dots$ [1]

- (e) The experiment is repeated. Determine the resistance R that gives a value of I of $250 \mu\text{A}$.

$R = \dots\dots\dots \Omega$ [1]

[Total: 15]





Cambridge International AS & A Level

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PHYSICS

9702/52

Paper 5 Planning, Analysis and Evaluation

October/November 2024

1 hour 15 minutes

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1 Fig. 1.1 shows a coil made from resistance wire.

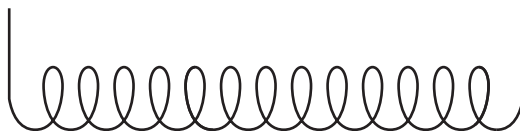


Fig. 1.1

The coil is placed in cooking oil of mass m . The total length of the resistance wire in the oil is L .

A potential difference V is applied to the coil. The temperature of the oil increases by $\Delta\theta$ in time t .

It is suggested that $\Delta\theta$ is related to L by the relationship

$$\frac{AtV^2}{L} = mK\Delta\theta + Z$$

where A is the cross-sectional area of the wire, and K and Z are constants.

Plan a laboratory experiment to test the relationship between $\Delta\theta$ and L .

Draw a diagram showing the arrangement of your equipment.

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

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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[illegible]

- 2 A student investigates the refraction of white light entering a transparent rectangular block. A narrow beam of light enters the block at the midpoint of one of the shorter sides. The angle of incidence θ is measured, as shown in Fig. 2.1.

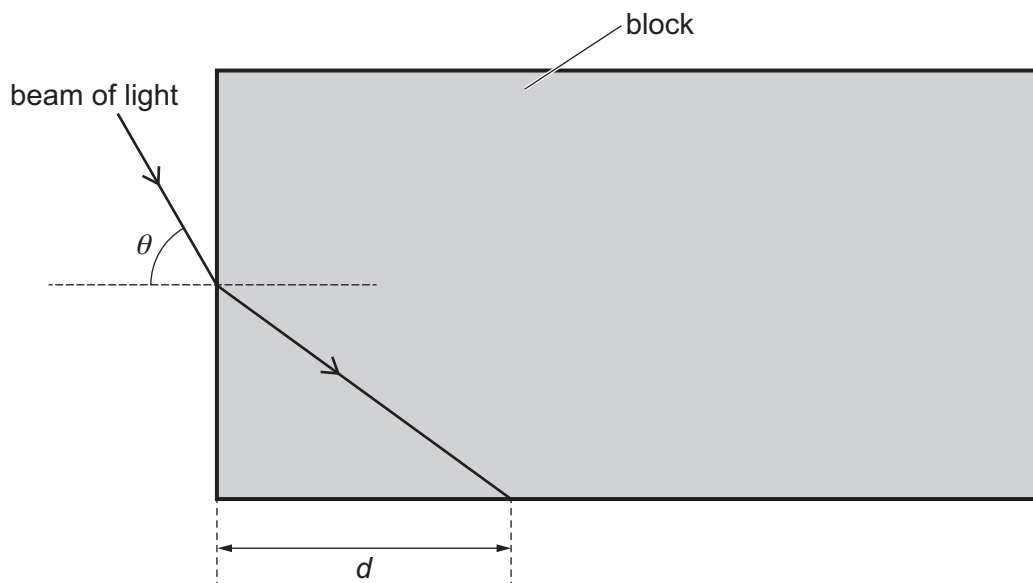


Fig. 2.1 (not to scale)

The distance d between the corner of the block and the point where the beam of light touches the boundary of the block is measured.

The experiment is repeated for different values of θ .

It is suggested that d and θ are related by the equation

$$\frac{B}{B + d^2} = \frac{\sin^2 \theta}{n^2}$$

where B and n are constants.

- (a) A graph is plotted of d^2 on the y -axis against $\frac{1}{\sin^2 \theta}$ on the x -axis.

Determine expressions for the gradient and y -intercept.

gradient = ...

y -intercept = ...

[1]





- (b) Values of θ , $\frac{1}{\sin^2 \theta}$ and d are given in Table 2.1.

Table 2.1

$\theta / ^\circ$	$\frac{1}{\sin^2 \theta}$	d / cm	d^2 / cm^2
28.5	4.39	24.8 ± 0.2	
33.5	3.28	21.4 ± 0.2	
42.5	2.19	17.1 ± 0.2	
50.0	1.70	14.7 ± 0.2	
57.5	1.41	12.9 ± 0.2	
63.5	1.25	11.8 ± 0.2	

Calculate and record values of d^2 / cm^2 in Table 2.1.

Include the absolute uncertainties in d^2 .

[2]

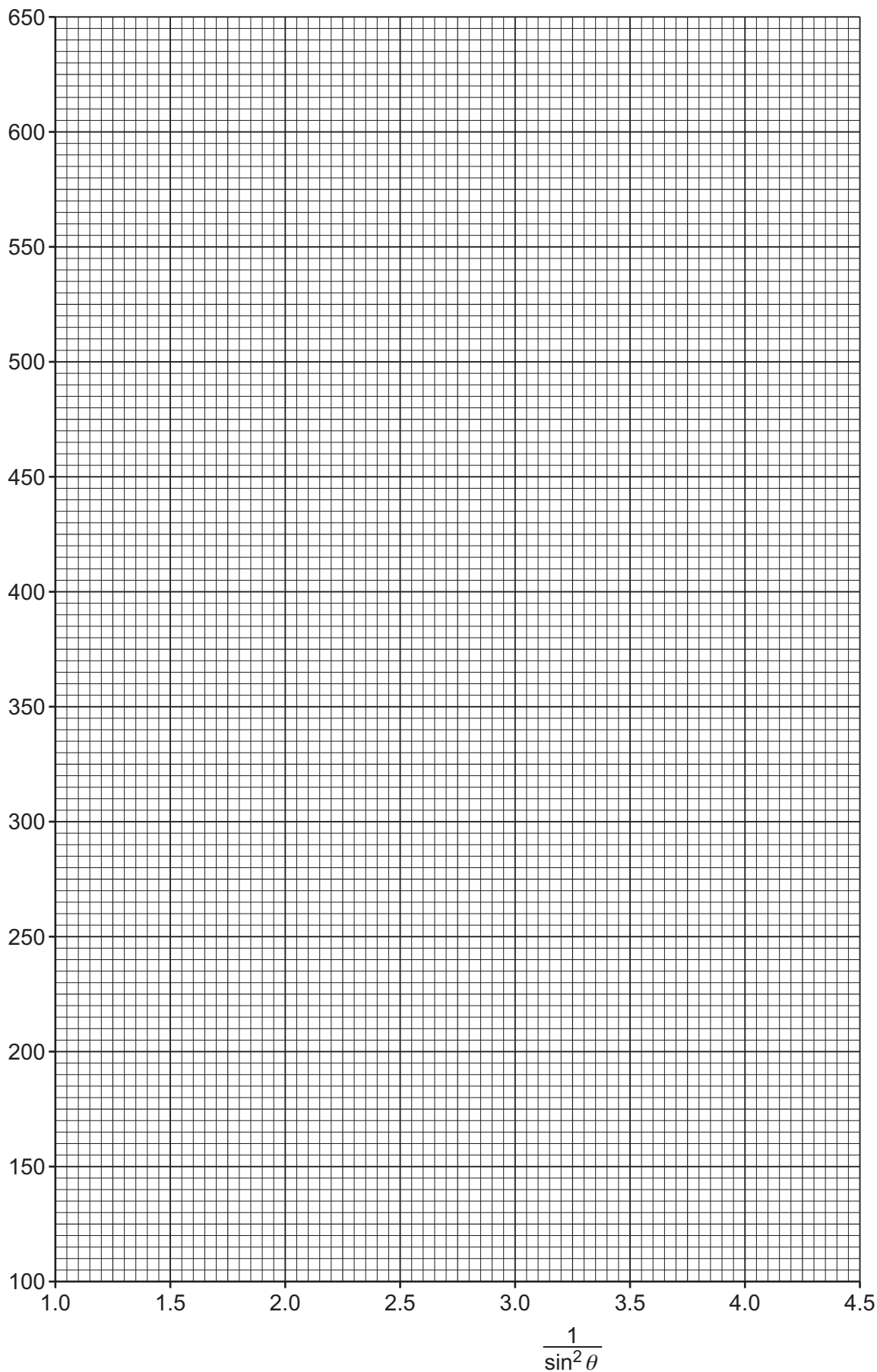
- (c) (i) Plot a graph of d^2 / cm^2 against $\frac{1}{\sin^2 \theta}$. Include error bars for d^2 . [2]
- (ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Label both lines. [2]
- (iii) Determine the gradient of the line of best fit. Include the absolute uncertainty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

gradient = ... [2]





d^2/cm^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 B and n . Include appropriate units.

B = ...

n = ... [2]

- (ii) Determine the percentage uncertainty in n .

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

- (e) The experiment is repeated. Determine the angle θ that gives a value of d of 30.0 cm.

θ = ... ° [1]

[Total: 15]





Cambridge International AS & A Level

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PHYSICS

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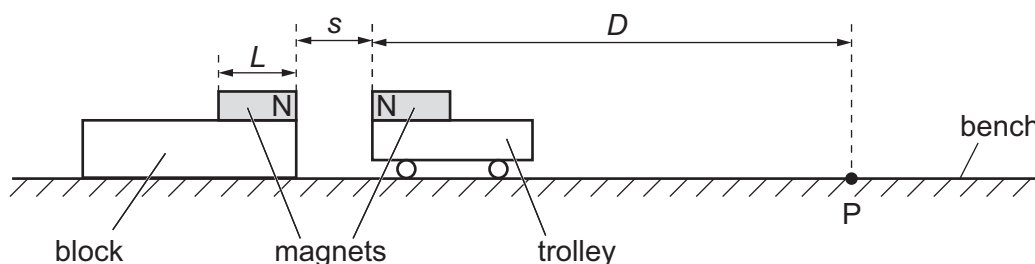


Fig. 1.1

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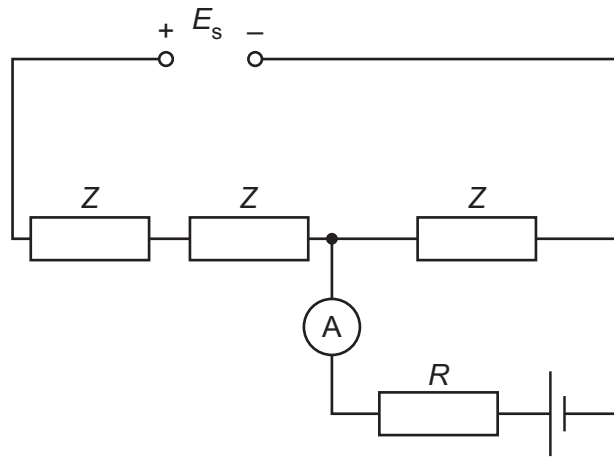


Fig. 2.1

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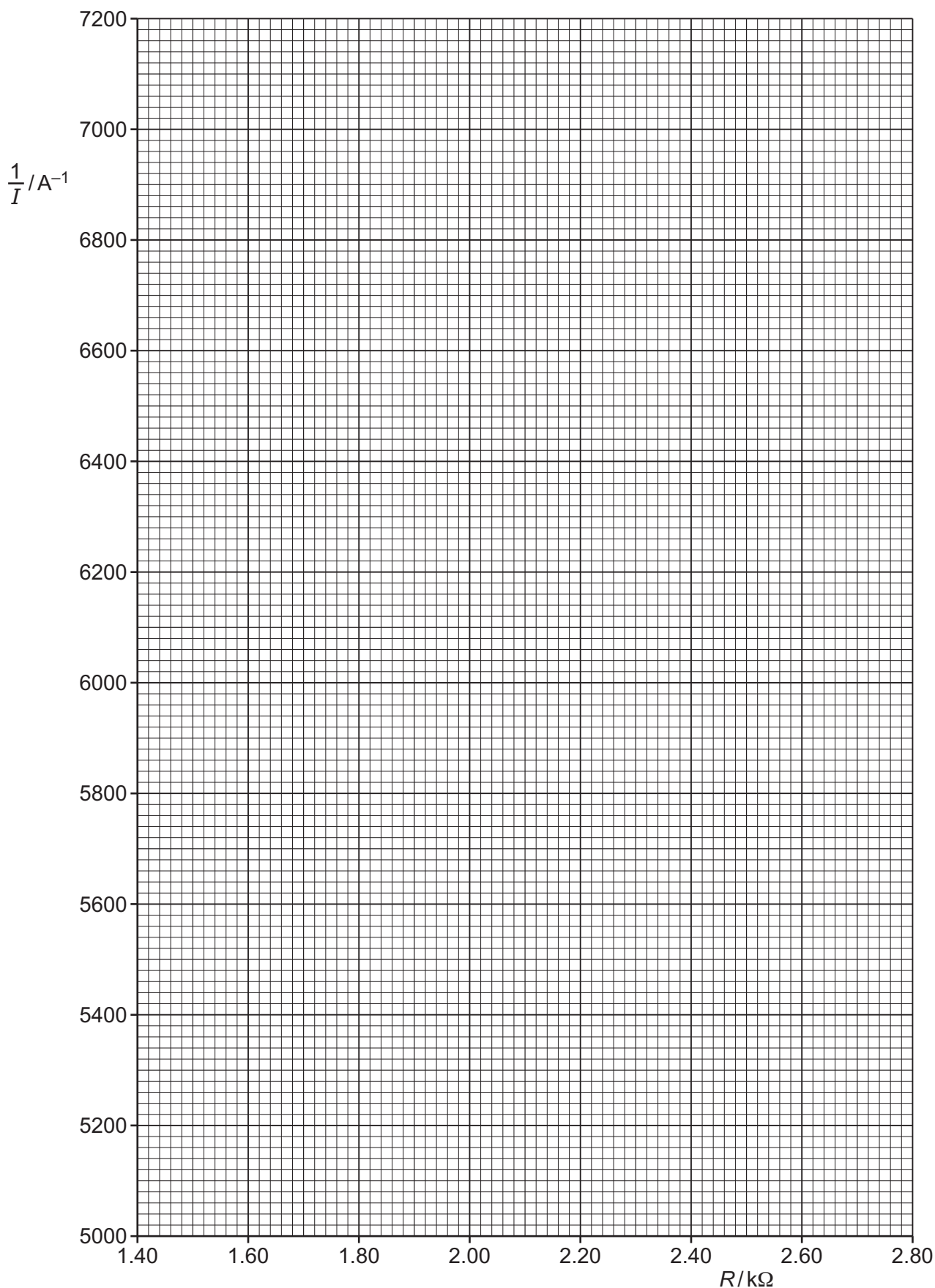
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[Total: 15]

