



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/51

October/November 2023

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 Two coils, C and D, are placed with their axes on a straight line, as shown in Fig. 1.1.

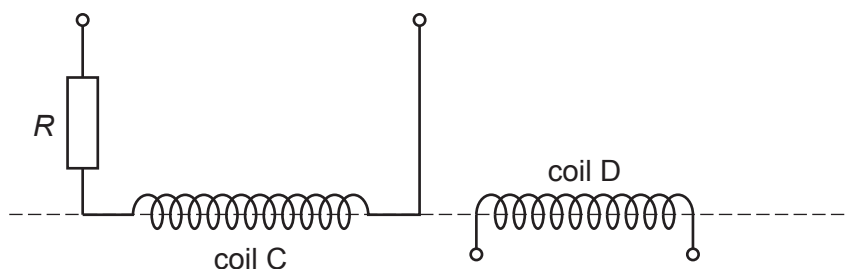


Fig. 1.1

A resistor of resistance R is connected in series with coil C.

A changing magnetic flux of frequency f in coil C causes an electromotive force (e.m.f.) E to be induced across the terminals of coil D.

It is suggested that E is related to f by the relationship

$$E = \frac{pf^qV}{R}$$

where V is the potential difference across the resistor and coil C, and p and q are constants.

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

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for p 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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- 2 A block of modelling clay of mass M is attached to a string as shown in Fig. 2.1.

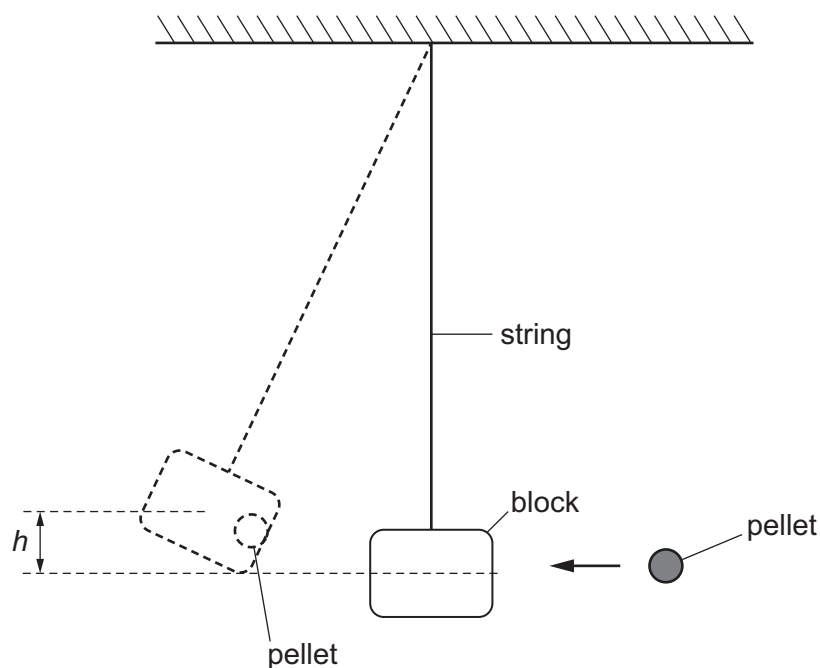


Fig. 2.1

A pellet travelling at speed u enters the block and causes the block to move through a vertical height h .

The experiment is repeated for different values of M .

It is suggested that h and M are related by the equation

$$\frac{1}{h} = 2g \left(\frac{M+Z}{uZ} \right)^2$$

where g is the acceleration of free fall and Z is a constant.

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

Determine expressions for the gradient and y -intercept.

gradient =

y -intercept =

[1]

(b) Values of M and h are given in Table 2.1.

Table 2.1

M/g	h/cm	$\sqrt{\frac{1}{h}}/\text{cm}^{-\frac{1}{2}}$
565	21.0 ± 0.2	
637	17.8 ± 0.2	
675	16.2 ± 0.2	
723	14.6 ± 0.2	
790	12.6 ± 0.2	
892	10.2 ± 0.2	

Calculate and record values of $\sqrt{\frac{1}{h}}/\text{cm}^{-\frac{1}{2}}$ in Table 2.1.

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

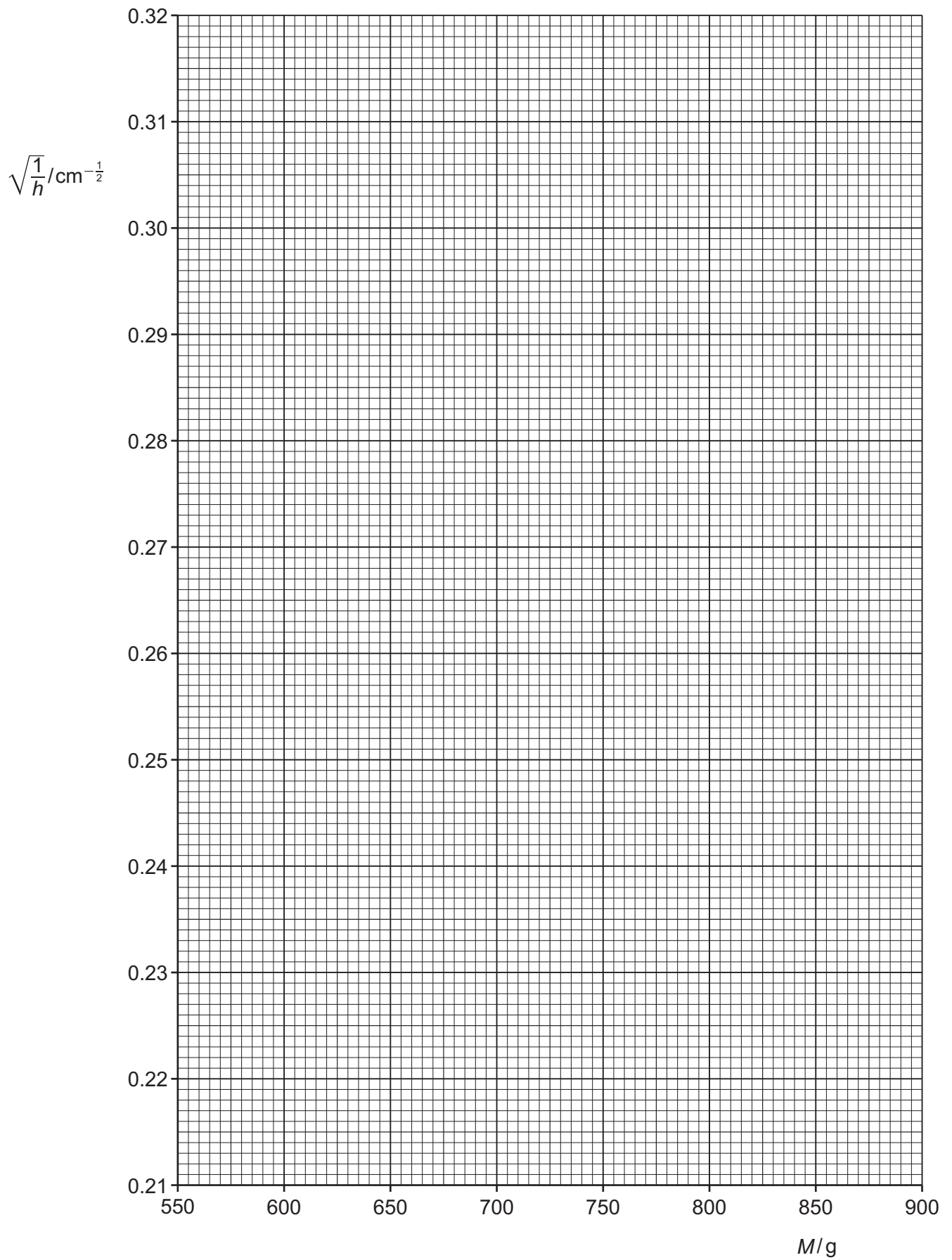
(c) (i) Plot a graph of $\sqrt{\frac{1}{h}}/\text{cm}^{-\frac{1}{2}}$ against M/g .

Include error bars for $\sqrt{\frac{1}{h}}$. [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 u and Z . Include appropriate units.

Data: $g = 981 \text{ cm s}^{-2}$

$u = \dots\dots\dots$

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

- (ii) Determine the percentage uncertainty in Z .

percentage uncertainty in $Z = \dots\dots\dots\%$ [1]

- (e) The experiment is repeated. Determine the mass M that gives a value of h of 25.0 cm.

$M = \dots\dots\dots \text{ g}$ [1]

[Total: 15]