



Cambridge International AS & A Level

CANDIDATE
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PHYSICS

9702/51

Paper 5 Planning, Analysis and Evaluation

October/November 2020

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. Blank pages are indicated.

- 1 A student investigates a spring of width w made from a metal wire, as shown in Fig. 1.1.

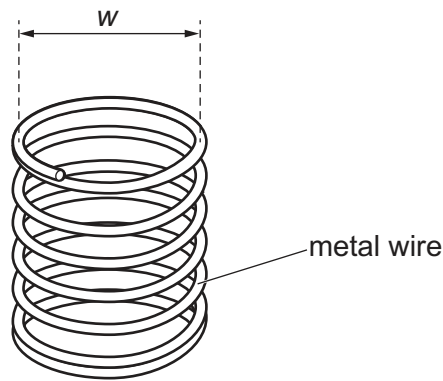


Fig. 1.1

The student constructs several springs, each made from a metal wire of different cross-sectional area A . The student investigates how the extension x of each spring varies with A when a load of mass m is applied.

It is suggested that the relationship between x and A is

$$x = \frac{mgw^3NA^n}{\gamma\rho}$$

where g is the acceleration of free fall, ρ is the density of the metal, N is the number of turns of wire in the spring and γ and n are constants.

Design a laboratory experiment to test the relationship between x and A . Explain how your results could be used to determine values for γ and n .

You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to:

- 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 student investigates the image of an object formed on a screen by a converging lens, as shown in Fig. 2.1.

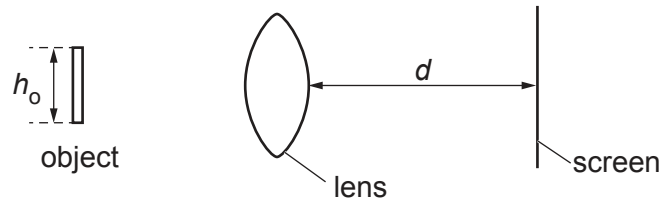


Fig. 2.1

The student measures the height h_o of the object and the distance d from the lens to the screen. The height h_i of the image is measured as shown in Fig. 2.2.

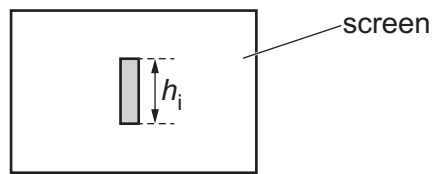


Fig. 2.2

The experiment is repeated for different values of d .

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

$$\frac{1}{f} \left(d + \frac{t}{2} \right) = \frac{h_i}{h_o} + 1$$

where f is a property of the lens called the focal length and t is the thickness of the lens.

- (a) A graph is plotted of $\frac{h_i}{h_o}$ on the y -axis against d on the x -axis.

Determine expressions for the gradient and y -intercept.

gradient =

y -intercept =

[1]

- (b) The value of h_o is (2.4 ± 0.1) cm.
Values of d and h_i are given in Table 2.1.

Table 2.1

| d/cm | h_i/cm | $\frac{h_i}{h_o}$ |
|---------------|-----------------|-------------------|
| 54.0 | 1.7 ± 0.1 | |
| 57.5 | 1.9 ± 0.1 | |
| 61.5 | 2.2 ± 0.1 | |
| 67.0 | 2.6 ± 0.1 | |
| 74.0 | 3.1 ± 0.1 | |
| 80.5 | 3.6 ± 0.1 | |

Calculate and record values of $\frac{h_i}{h_o}$ in Table 2.1.

Include the absolute uncertainties in $\frac{h_i}{h_o}$. [2]

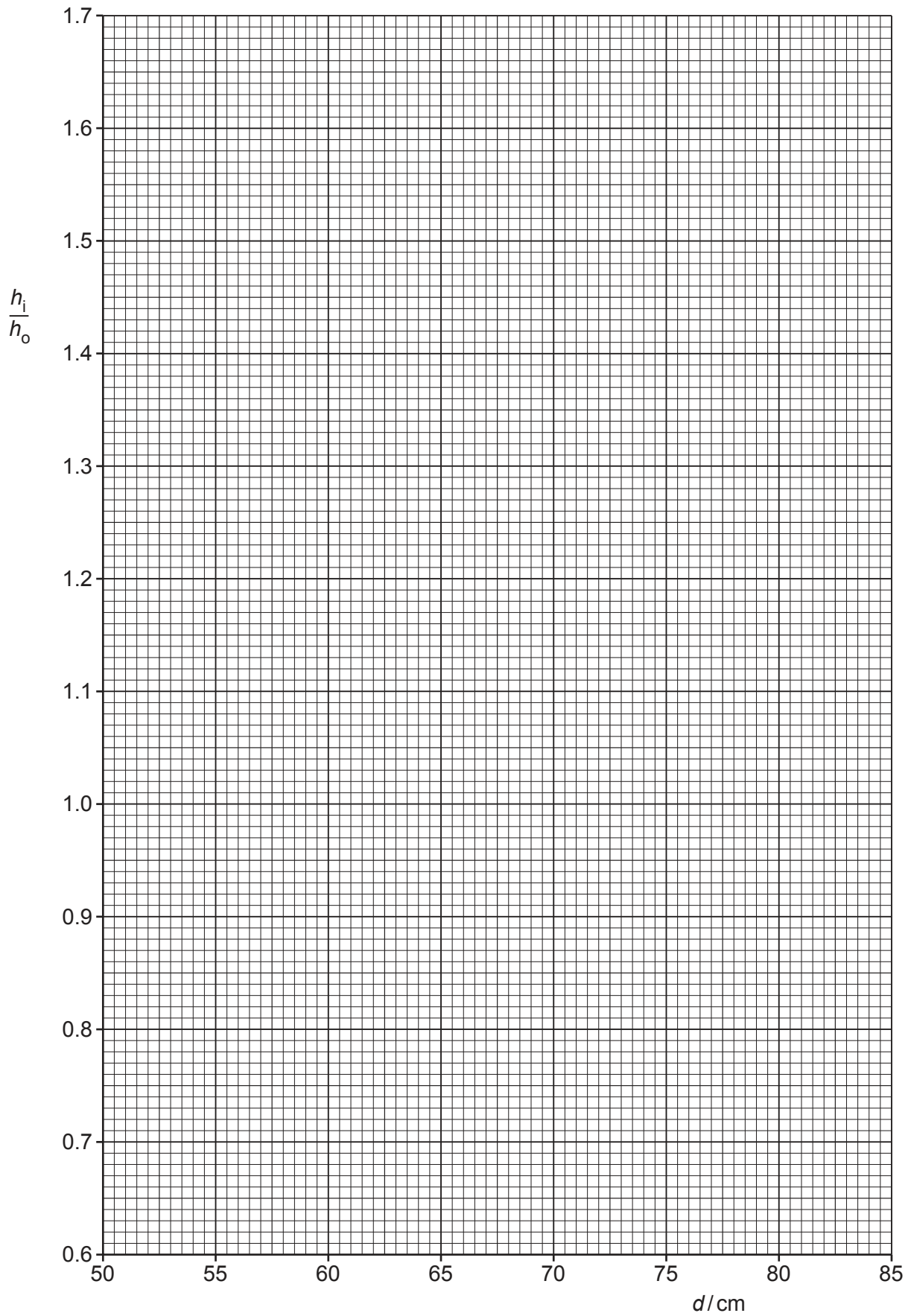
- (c) (i) Plot a graph of $\frac{h_i}{h_o}$ against d/cm .

Include error bars for $\frac{h_i}{h_o}$. [2]

- (ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [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) and (c)(iii), determine the value of f . Include an appropriate unit and the absolute uncertainty in your answer.

f = [3]

- (ii) Using your answers to (a), (c)(iii) and (c)(iv), determine the value of t .

t = [1]

[Total: 15]

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