Cambridge Assessment International Education

# Cambridge International AS & A Level

24

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*3463316370*

**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.



**[Turn over**

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

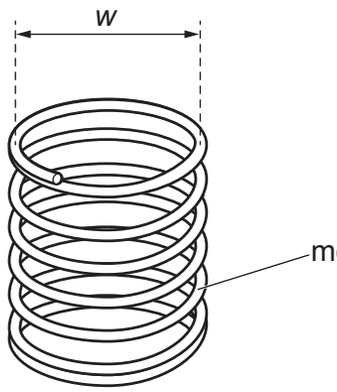



**Fig. 1.1**

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, $\rho$ is the density of the metal, $N$ is the number of turns of wire in the spring and $\gamma$ 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 $\gamma$ and $n$.

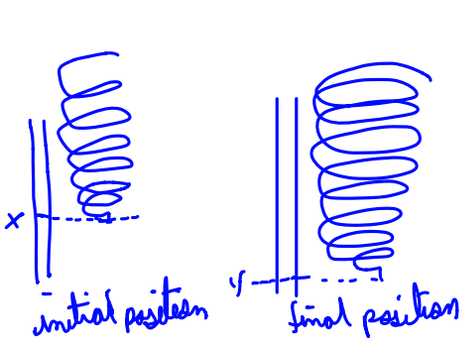
You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to:

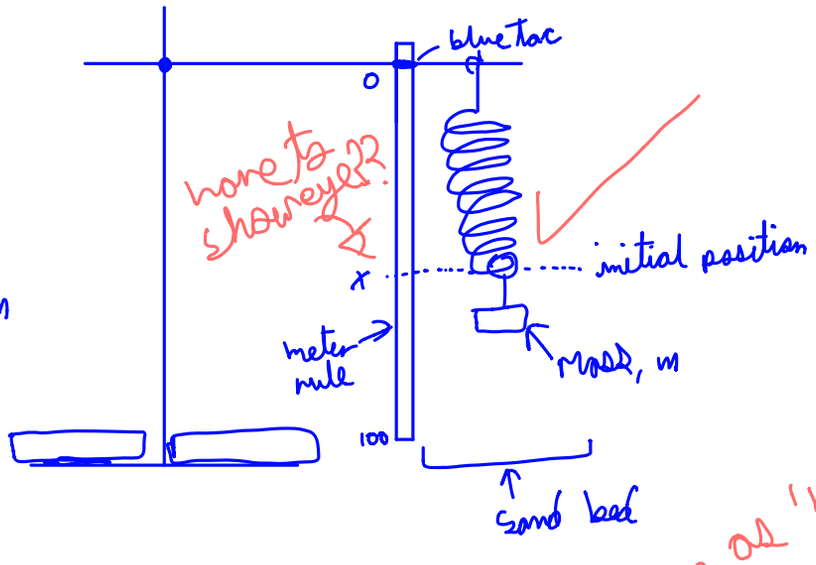
- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

I thought it was different A, harmony marks last?? I thought.

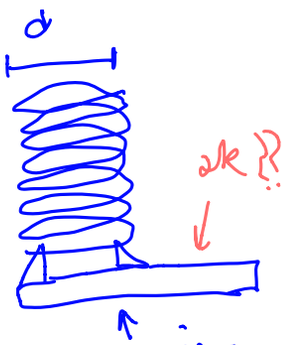
3

**Diagram**

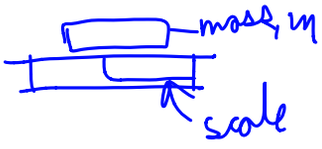




have to show eye??




same as 'keep it constant'?




In this exp, cross sectional area, A, is the is the indepent variable, extension, X, is dependent varible, mass, m, is the control. The number of turns, N, and springs of same material are used to keep ρ, density constant.

m.s says of wire?!

To measure A, a vernier caliper is used its measure the inner diameter, d, of the spring and $A = \frac{\pi d^2}{4}$. To vary A, springs of different diameters is used however the number of turns should be same and they should be made of the same material. Extention, x, is measured as shown in the diagram!! $X = x - y$. Mass, m, is measured using a weighing scale. Number of turns are counted. density, ρ, is measure like shown in diagram, seeing the volume displaced when the

spring is dipped in a graduated measuring cylinder
$\rho = \frac{\text{Mass of spring}}{\text{Volume displaced}}$ whats DS in MS? ?.

A graph is plotted of ln X against ln A, if the line is straight relationship is valid. The gradient of the graph is determined. Y intercept is determined as well ← by which method?

gradient = n $\quad y = \frac{mg}{P \times e^{y\text{-intercept}}} w^3 N$

← do we have to say why ??

Sand bed is used incase the spring detaches and falls.
The values of change in volumes are determined multiple times for each spring, and avg value taken each time.

any other additional stuff ??.

[15]

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

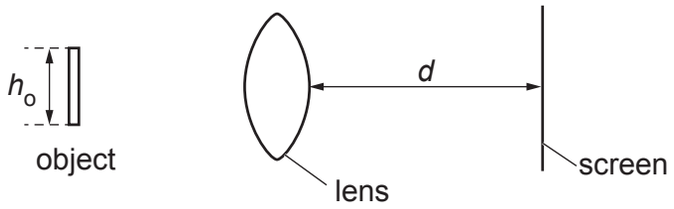



**Fig. 2.1**

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.

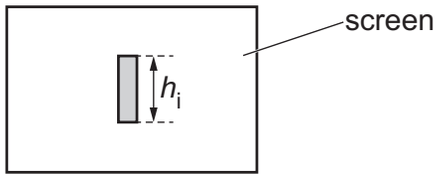



**Fig. 2.2**

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.

$\frac{h_i}{h_o} = \frac{d}{f} + \frac{t}{2f} - 1$

gradient = $\frac{1}{f}$

$y$-intercept = $\frac{t}{2f} - 1$ [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.

1.8 / 2.3

**Table 2.1**

| $d$ / cm | $h_i$ / cm | $\frac{h_i}{h_o}$ |
|---|---|---|
| 54.0 | 1.7 ± 0.1 | 0.71 ± 0.074 |
| 57.5 | 1.9 ± 0.1 | 0.79 ± 0.078 |
| 61.5 | 2.2 ± 0.1 | 0.92 ± 0.083 |
| 67.0 | 2.6 ± 0.1 | 1.08 ± 0.091 |
| 74.0 | 3.1 ± 0.1 | 1.29 ± 0.10 |
| 80.5 | 3.6 ± 0.1 | 1.50 ± 0.11 |

he only had 0.07

marks 2.

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]

1 1

**(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]

1

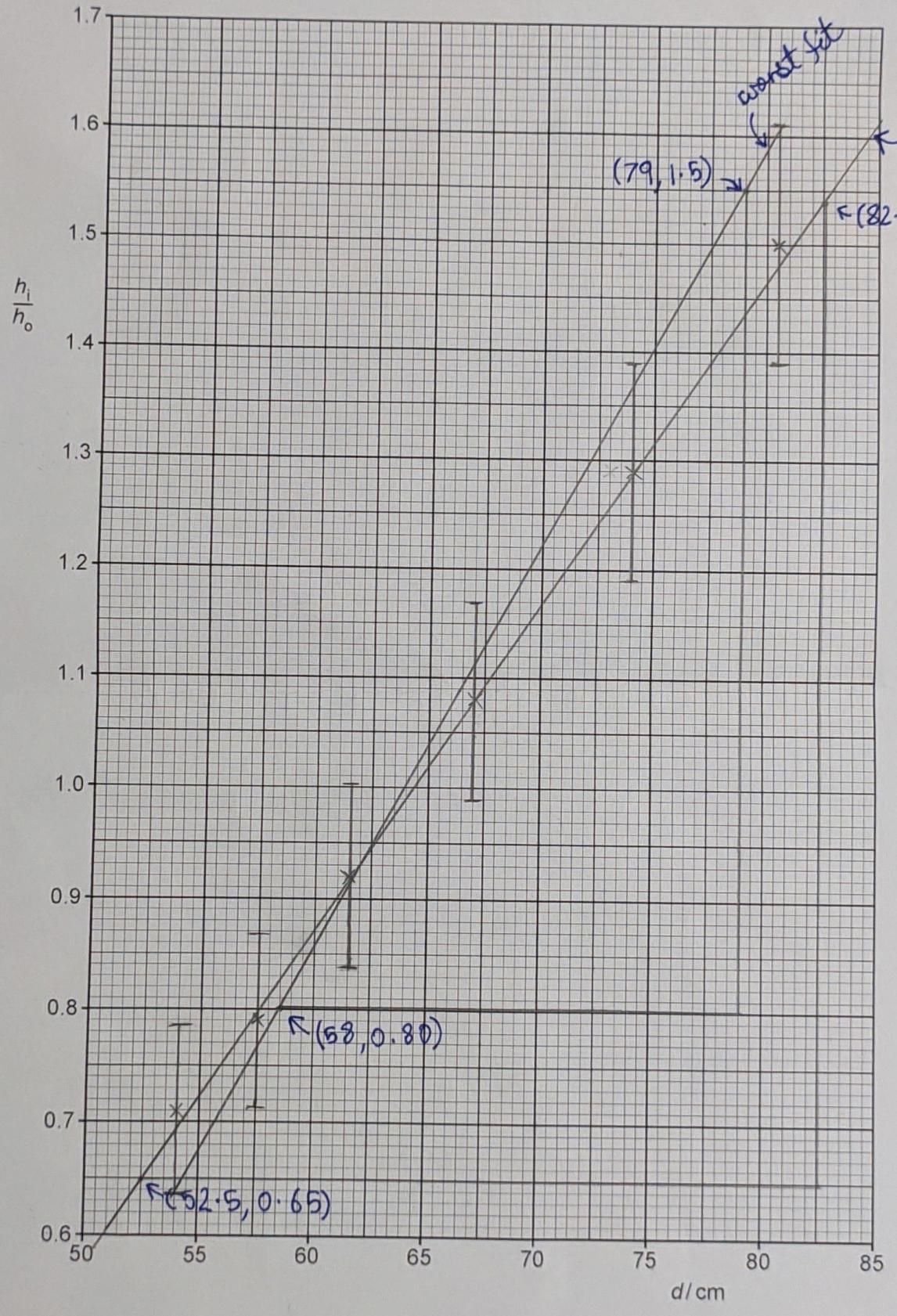
**(iii)** Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient of best fit : $\frac{(1.54 - 0.65)}{(82.5 - 52.9)} = 0.0296666 \approx 0.030$

gradient of worst fit : $\frac{(1.5 - 0.8)}{(79 - 58)} = 0.0333 \approx 0.033$

$\Delta g = 0.0333 - 0.02966 = 0.003673$

gradient = ....0.0297 ± 0.00367.... [2]


worst fit
line of best fit
(79, 1·5)
(82·5, 1·54)
(58, 0·80)
(52·5, 0·65)
$\frac{h_i}{h_o}$
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
50
55
60
65
70
75
80
85
d / cm

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

$y = mx + c$

$c = y - mx$

$c = 0.65 - 0.0297(52.5)$

$= -0.90925$

$\max c = y - mx$

$= 0.65 - 0.0333(52.5)$

$= -1.09825$

$\Delta c = 1.09825 - 0.90925$

$= 0.189$

*y*-intercept = ..... $-0.91 \pm 0.19$ ..... [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.

$\frac{1}{f} = \text{gradient}$

$f = \frac{1}{\text{gradient}} = \frac{1}{0.0297} = 33.67$

% uncertainty in gradient $= \frac{0.00367}{0.0297} \times 100$

$= 12.3569\%$

$1.12356$

$33.67 \times 1.123569 = 37.83057$

$37.83057 - 33.67 = 4.160569$

*f* = ..... $33.7 \pm 4.16$ cm ..... [3]

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

$-0.90925 = \frac{t}{2(33.67)} - 1$

$\frac{t}{67.34} = 0.09075$

$t = 6.1111$

% uncertainty in $t$ = % uncertainty in y intercept + % uncertainty in $f$

$= \left(\frac{0.189}{0.91} + \frac{4.16}{33.67}\right) \times 100$

$= 33.124\%$

$= 6.11 \times 0.33124$

$= 2.02$

*t* = ..... $6.11 \pm 2.02$ ..... [1]

[Total: 15]