



Cambridge International AS & A Level

CANDIDATE
NAME

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CENTRE
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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

May/June 2021

2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

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 will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

For Examiner's Use

1	
2	
Total	

This document has **12** pages. Any blank pages are indicated.

You may not need to use all of the materials provided.

1 In this experiment, you will investigate the equilibrium of a metre rule.

- (a) • Use the adhesive putty to attach the 100 g mass to the metre rule as close as possible to the 80 cm mark, as shown in Fig. 1.1.

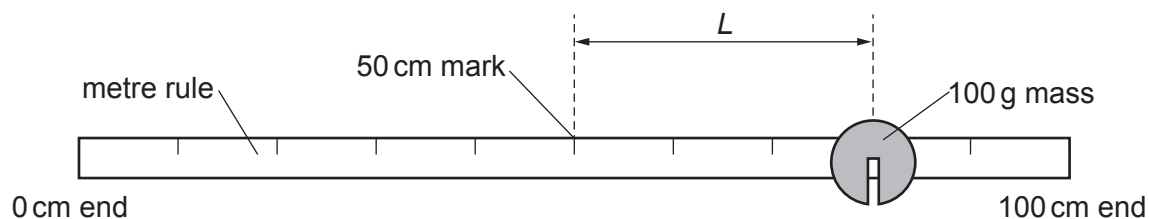


Fig. 1.1

- The distance between the 50 cm mark and the centre of the mass is L .

Measure and record L .

$L = \dots\dots\dots$ [1]

- (b) • Set up the apparatus as shown in Fig. 1.2.

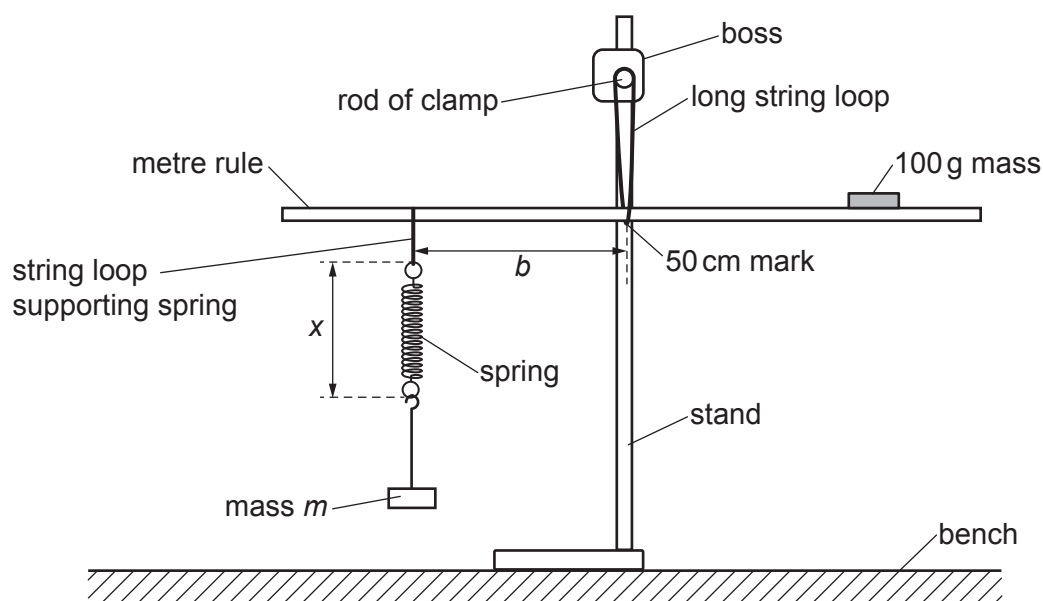


Fig. 1.2

- Suspend the rule from the long string loop at the 50 cm mark on the rule.
- Add the two 50 g masses to the mass hanger to make a total mass m of 110 g. Suspend mass m from the spring.
- Record m .

$m = \dots\dots\dots$ g

- The distance between the string loop supporting the spring and the 50 cm mark on the rule is b .

The distance between the top of the top loop of the spring and the bottom of the bottom loop of the spring is x , as shown in Fig. 1.2.

Adjust the position of the string loop supporting the spring until the rule is horizontal and in equilibrium.

- Measure and record x and b .

$x = \dots\dots\dots$

$b = \dots\dots\dots$

[1]

- (c) Repeat (b) with different values of m until you have six sets of readings. Record m , x and b . Include your values from (b).

Record your results in a table. Include values of $\frac{1}{b}$ in your table.

[9]

- (d) (i) Plot a graph of $\frac{1}{b}$ on the y -axis against x on the x -axis.

[3]

- (ii) Draw the straight line of best fit.

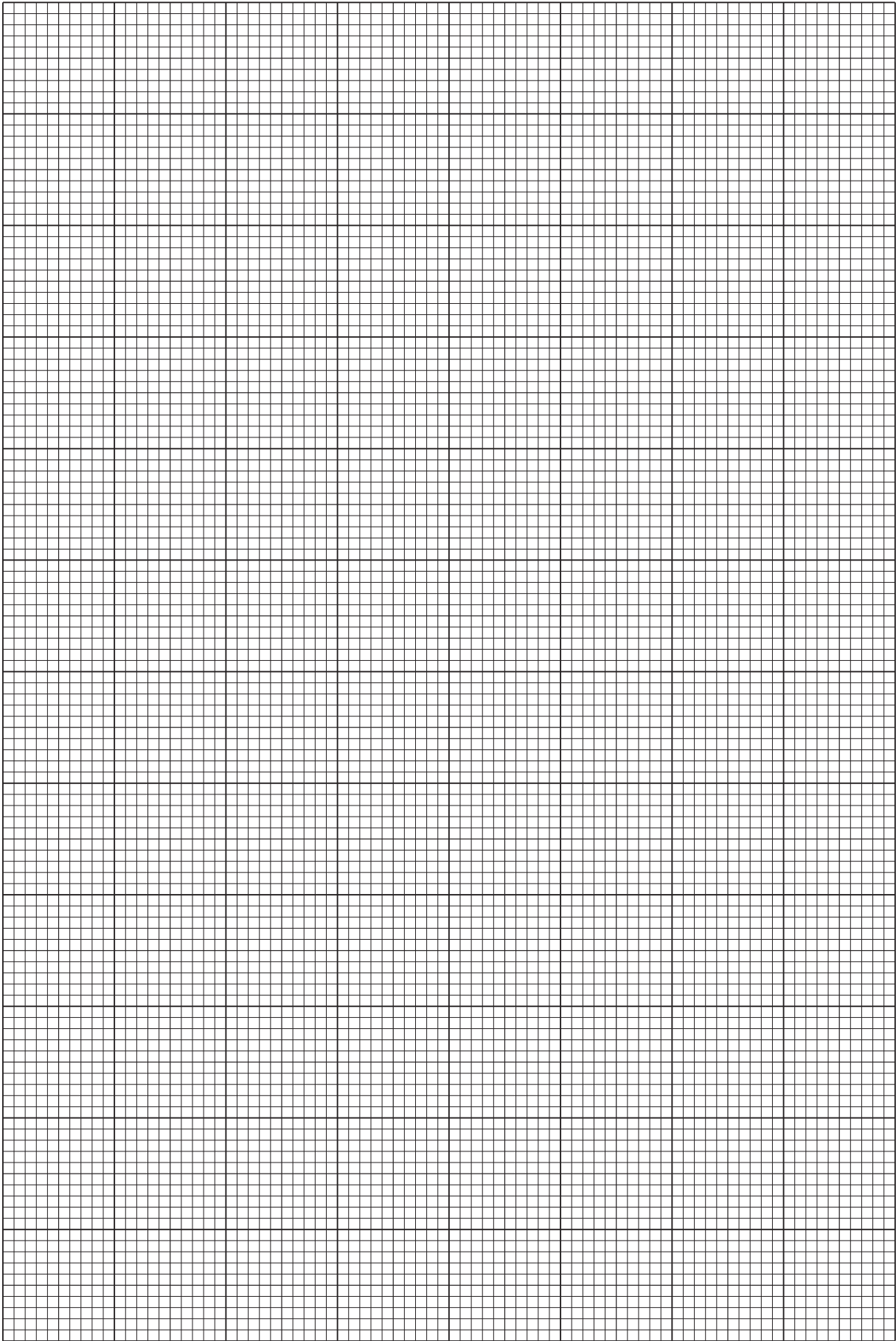
[1]

- (iii) Determine the gradient and y -intercept of this line.

gradient =

y -intercept =

[2]



- (e) It is suggested that the quantities b and x are related by the equation

$$\frac{1}{b} = Px + Q$$

where P and Q are constants.

Using your answers in (d)(iii), determine values for P and Q .
Give appropriate units.

$P =$

$Q =$
[2]

- (f) A student repeats the experiment placing the 100g mass closer to the 50 cm mark on the rule.

Theory suggests that P and Q are both inversely proportional to L .

For this experiment, draw a second line on the graph to show the expected results.
Label this line W.

[1]

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate how the rate of cooling of a hot liquid depends on its volume.

(a) You have been provided with a cup. The diameter of the base of the cup is d , as shown in Fig. 2.1.

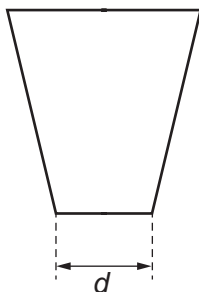


Fig. 2.1

Measure and record d .

$d =$ [1]

(b) • Pour boiling water into the cup until it is approximately one-third full.

• When the temperature of the water is 75°C , start the stop-watch.

Record this starting temperature θ_0 .

$\theta_0 =$ $^{\circ}\text{C}$

• After two minutes, measure and record the temperature θ .

$\theta =$ $^{\circ}\text{C}$

• Calculate $\Delta\theta$ using

$$\Delta\theta = (\theta_0 - \theta).$$

$\Delta\theta =$ $^{\circ}\text{C}$
[1]

- (c) (i) The height of the water in the cup is h and the diameter of the surface of the water is D , as shown in Fig. 2.2.

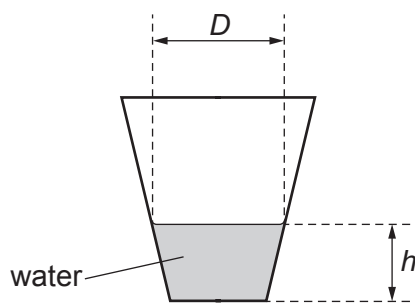


Fig. 2.2

Measure and record h and D .

$h =$

$D =$

[2]

- (ii) Estimate the percentage uncertainty in your value of h . Show your working.

percentage uncertainty = [1]

- (iii) Calculate C where

$$C = \frac{D^3 - d^3}{D - d}.$$

$C =$ [1]

- (iv) Justify the number of significant figures that you have given for your value of C .

.....

.....

..... [1]

- (d) • Empty the cup.
- Repeat **(b)**, **(c)(i)** and **(c)(iii)** with the cup approximately two-thirds full.

$$\theta_0 = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$\theta = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$\Delta\theta = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$h = \dots\dots\dots$$

$$D = \dots\dots\dots$$

$$C = \dots\dots\dots$$

[3]

- (e) It is suggested that the relationship between $\Delta\theta$, h and C is

$$\Delta\theta = \frac{k}{\sqrt{(hC)}}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

first value of k =

second value of k =

[1]

- (ii) Explain whether your results support the suggested relationship.

.....
.....
.....
..... [1]

(f) (i) Describe four sources of uncertainty or limitations of the procedure for this experiment.

- 1.
.....
- 2.
.....
- 3.
.....
- 4.
.....

[4]

(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

- 1.
.....
- 2.
.....
- 3.
.....
- 4.
.....

[4]

[Total: 20]

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