

Cambridge International AS & A Level

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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.

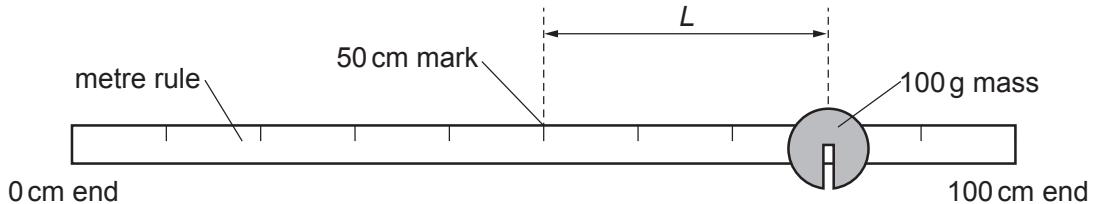


Fig. 1.1

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

Measure and record L .

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

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

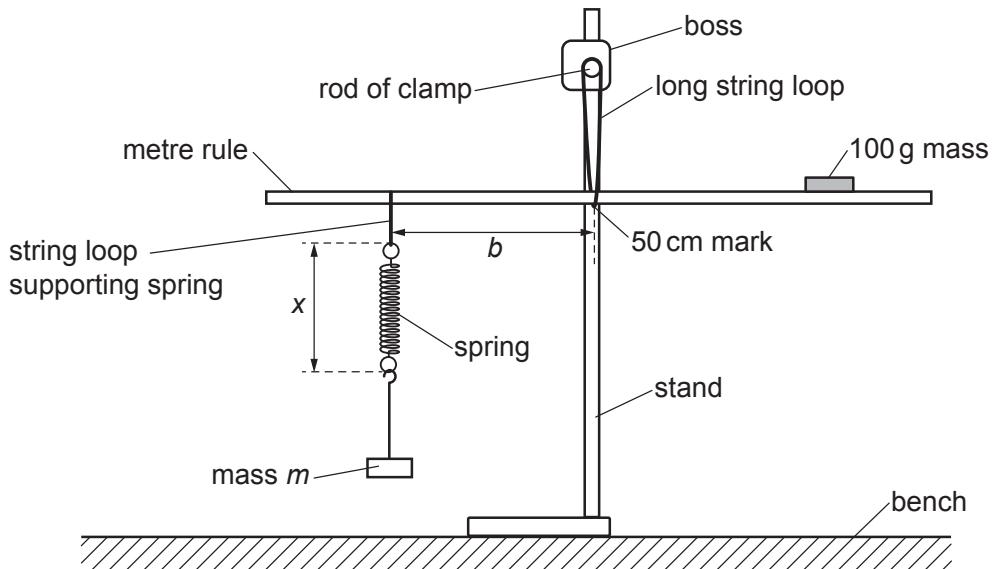


Fig. 1.2

- 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 .

$$m = \dots \text{ g}$$

- 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 .

$$x = \dots$$

$$b = \dots$$

[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]

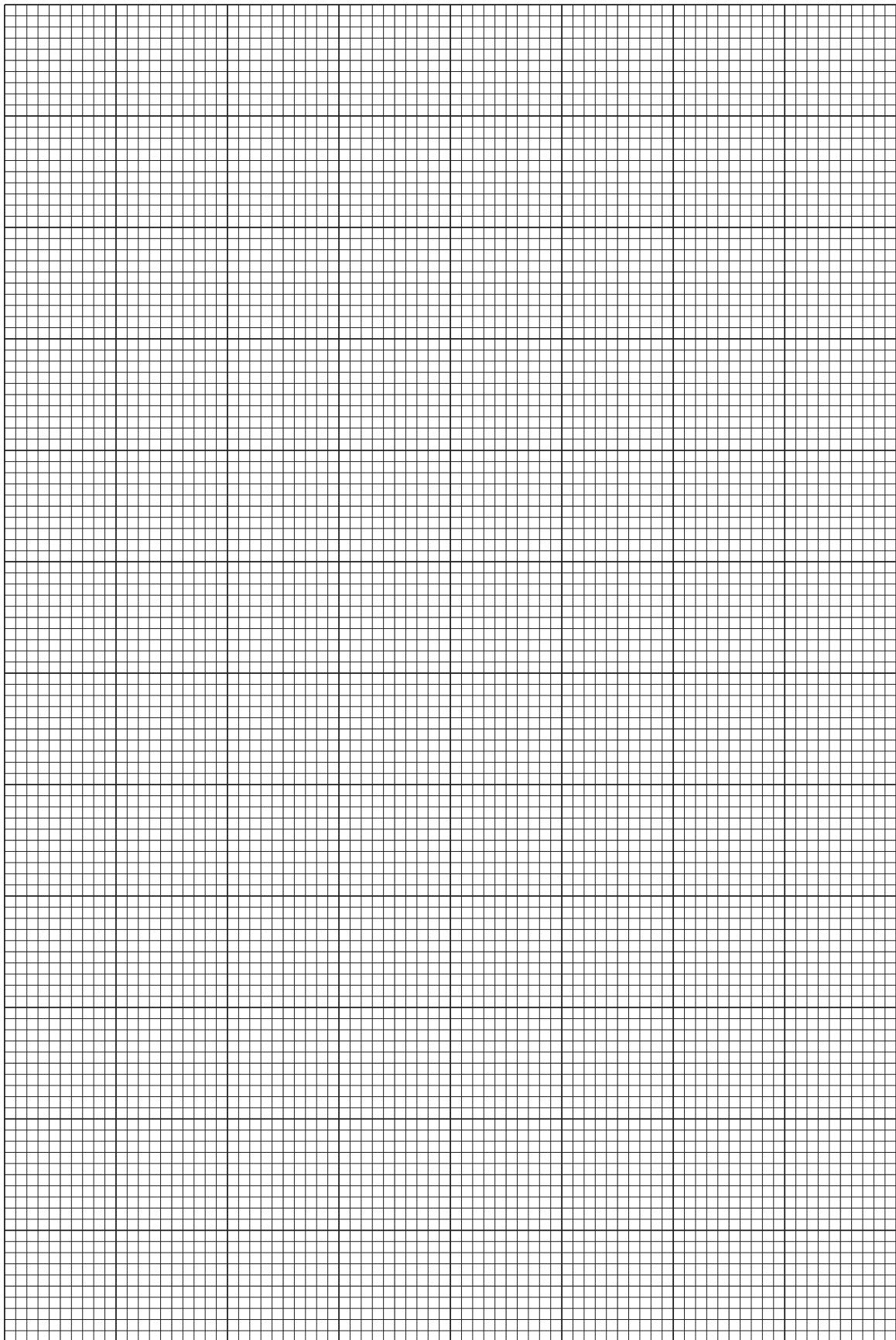
- (d) (i) Plot a graph of $\frac{1}{b}$ on the y -axis against x on the x -axis. [3]
(ii) Draw the straight line of best fit. [1]

- (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.

$$P = \dots$$

$$Q = \dots$$

[2]

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

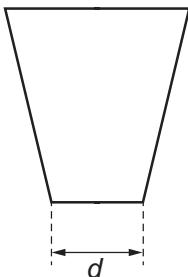


Fig. 2.1

Measure and record d .

$$d = \dots \quad [1]$$

- (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 .

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

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

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

- Calculate $\Delta\theta$ using

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

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

[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.

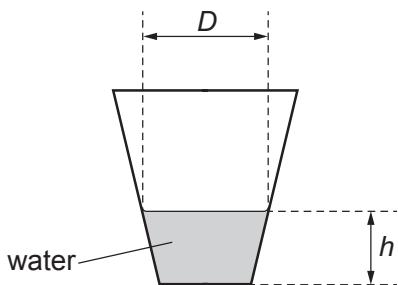


Fig. 2.2

Measure and record h and D .

$$h = \dots$$

$$D = \dots$$

[2]

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

$$\text{percentage uncertainty} = \dots \quad [1]$$

- (iii) Calculate C where

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

$$C = \dots \quad [1]$$

- (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.

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

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

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

$$h = \dots$$

$$D = \dots$$

$$C = \dots$$

[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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