



Cambridge International AS & A Level

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PHYSICS

9702/51

Paper 5 Planning, Analysis and Evaluation

May/June 2026

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. Do **not** use correction fluid or tape.
- 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.

- 1 A rod is fixed horizontally. A solid bar of mass M is attached to the rod by two vertical strings so that the bar is horizontal, as shown in Figure 1.1.

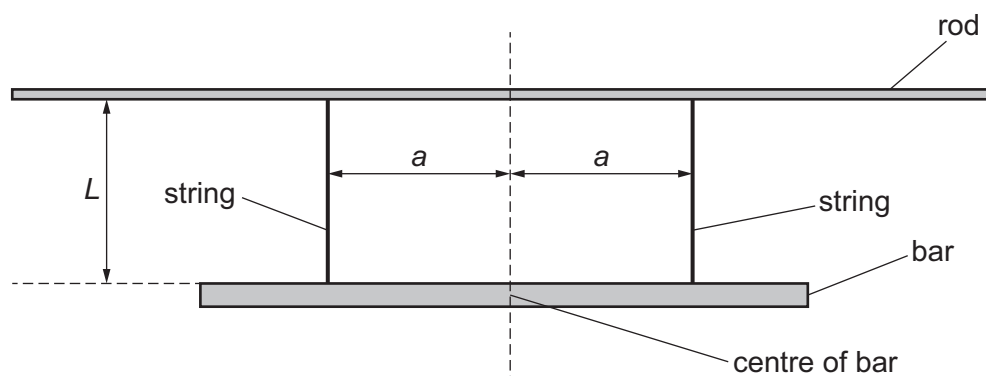


Figure 1.1

The vertical strings are equal horizontal distances a from the centre of the bar.

The separation between the rod and the bar is L .

One end of the bar is displaced horizontally and then released. The bar rotates with oscillations about its centre. The period of the oscillations is T .

It is suggested that T is related to a by the relationship

$$T = \frac{2\pi P}{a^q} \sqrt{\frac{L}{M}}$$

where P and q are constants.

Plan a laboratory experiment to test the relationship between T and a .

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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[15]



- 2 A long tube contains a liquid of density σ . Two rubber bands are placed on the tube towards the bottom as shown in Figure 2.1.

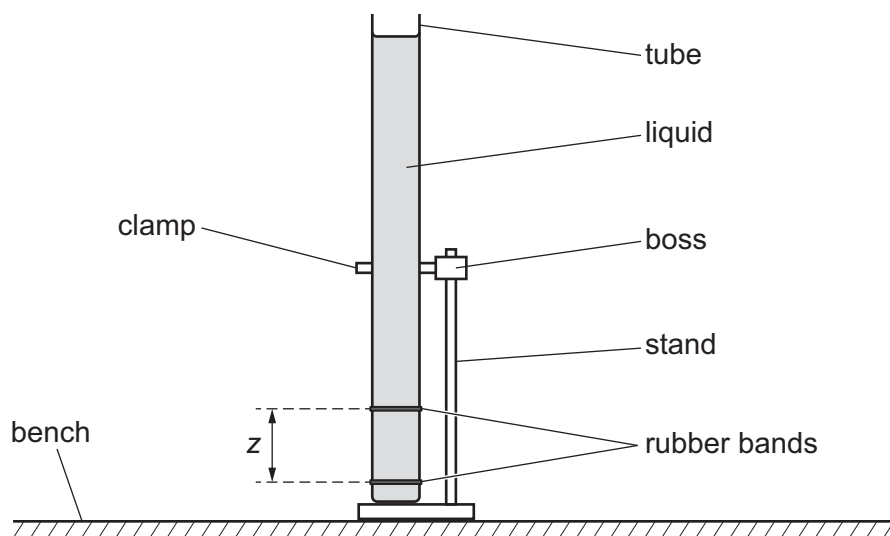


Figure 2.1

The distance between the two rubber bands is z .

A small steel ball of diameter d is dropped from the surface of the liquid. The time t for the ball to pass between the two rubber bands is measured.

The experiment is repeated with steel balls of different diameters.

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

$$\frac{z}{t} = \frac{gd^2(\rho - \sigma)}{18\beta}$$

where g is the acceleration of free fall, ρ is the density of steel and β is a constant.

- (a) A graph is plotted of t on the y -axis against $\frac{1}{d^2}$ on the x -axis.

Determine an expression for the gradient.

gradient = [1]

(b) Values of d and t are given in Table 2.1.

Table 2.1

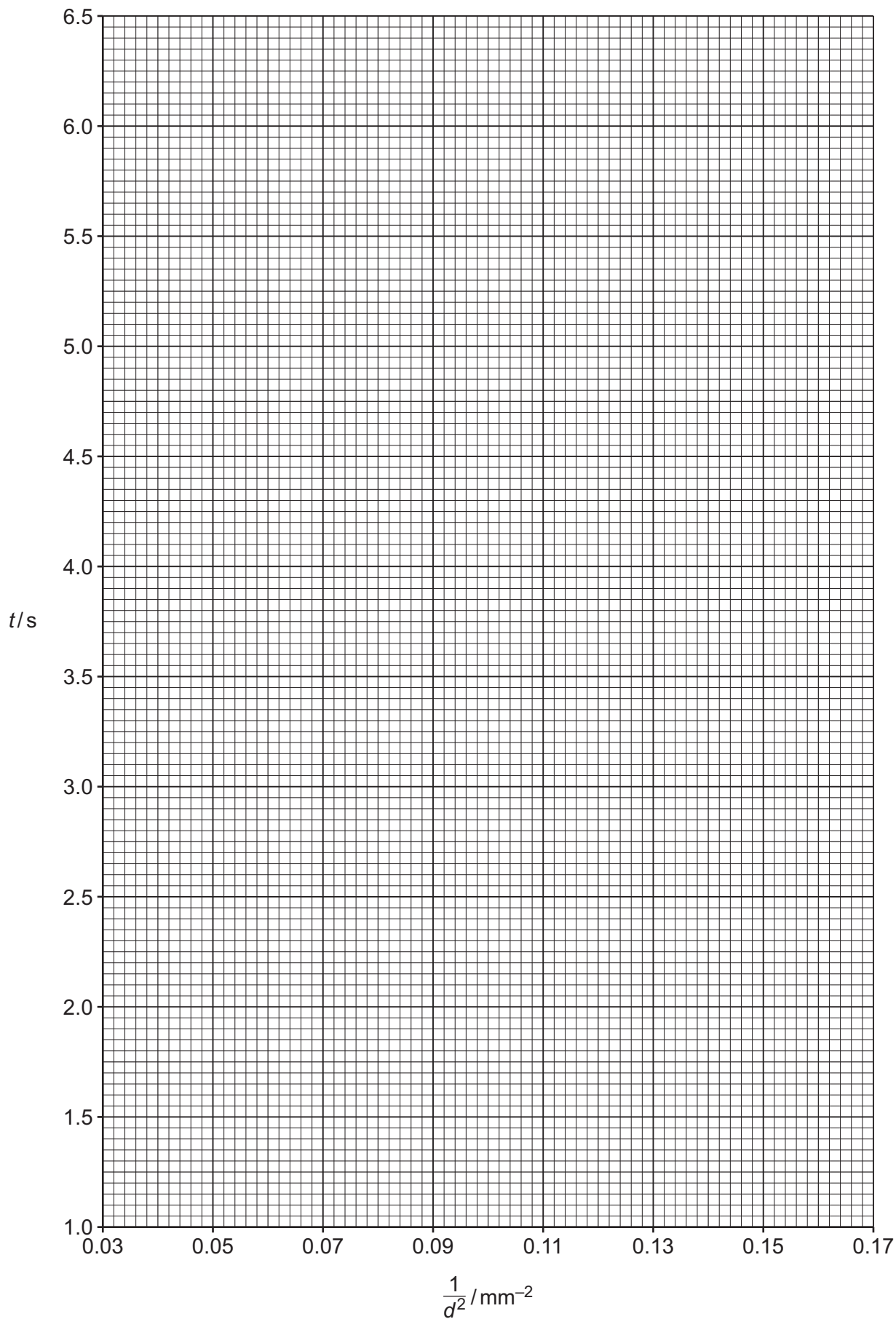
d/mm	$\frac{1}{d^2}/\text{mm}^{-2}$	t/s
2.6 ± 0.1		6.10
3.0 ± 0.1		4.40
3.4 ± 0.1		3.35
4.1 ± 0.1		2.25
4.4 ± 0.1		1.95
5.0 ± 0.1		1.45

Calculate and record values of $\frac{1}{d^2}/\text{mm}^{-2}$ in Table 2.1. Include the absolute uncertainties in $\frac{1}{d^2}$. [2]

- (c) (i) Plot a graph of t/s against $\frac{1}{d^2}/\text{mm}^{-2}$. Include error bars for $\frac{1}{d^2}$. [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]







- (d) The density ρ of steel is $(7850 \pm 50) \text{ kg m}^{-3}$.
The density σ of the liquid is $(1250 \pm 50) \text{ kg m}^{-3}$.

Calculate $(\rho - \sigma)$. Include the absolute uncertainty.

$$(\rho - \sigma) = \dots\dots\dots \text{ kg m}^{-3} \quad [1]$$

- (e) (i) Using your answers to **2(a)**, **2(c)(iii)** and **2(d)**, determine the value of β . Include an appropriate unit.

Data: $g = 9.81 \text{ m s}^{-2}$
 $z = (97 \pm 2) \text{ mm}$

$$\beta = \dots\dots\dots [2]$$

- (ii) Determine the percentage uncertainty in β .

$$\text{percentage uncertainty in } \beta = \dots\dots\dots \% [1]$$

- (f) The experiment is repeated using a steel ball with a diameter of $(1.20 \pm 0.01) \text{ cm}$. Determine the time t . Include the absolute uncertainty.

$$t = \dots\dots\dots \text{ s} [2]$$

[Total: 15]

