



Cambridge International AS & A Level

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PHYSICS

9702/54

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 thin sheet of cardboard is supported by four springs. Figure 1.1 shows a side view of the arrangement.

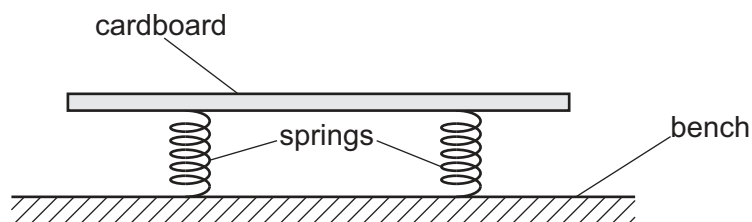


Figure 1.1

A steel ball of radius r is dropped onto the cardboard. The speed of the ball as it hits the cardboard is v .

As the ball hits the cardboard, the springs compress. The maximum compression of the springs is c .

Several steel balls of different radii are available.

It is suggested that c is related to r by the relationship

$$\frac{v^2}{c^2} = \frac{\alpha}{\pi \rho r^3} + Z$$

where ρ is the density of steel, and α and Z are constants.

Plan a laboratory experiment to test the relationship between c and r .

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for α and Z .

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

[illegible]



[15]



- 2 A student places a steel strip of thickness d and width w between two blocks that are fixed to the bench. A load is added to the strip as shown in Figure 2.1.

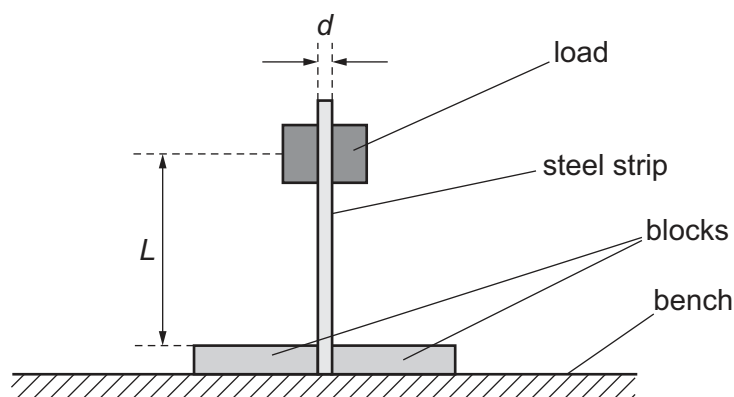


Figure 2.1

The distance between the blocks and the centre of gravity of the load is L .

The load is displaced a small distance and released so that it oscillates. The time t for 20 oscillations is measured. The period T of the oscillations is calculated.

The experiment is repeated for steel strips with the same thickness but different widths.

It is suggested that T and w are related by the equation

$$E = \frac{16\pi^2 ML^3}{wT^2 d^3}$$

where E is the Young modulus of steel and M is the mass of the load.

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

Determine an expression for the gradient.

gradient = ... [1]





- (b) Values of w , $\frac{1}{w}$ and t are given in Table 2.1.

Table 2.1

w/mm	$\frac{1}{w}/\text{m}^{-1}$	t/s	T/s	T^2/s^2
8.5	118	8.00 ± 0.08		
9.8	102	7.42 ± 0.08		
11.7	85.5	6.78 ± 0.08		
14.1	70.9	6.20 ± 0.08		
16.3	61.3	5.78 ± 0.08		
19.2	52.1	5.42 ± 0.08		

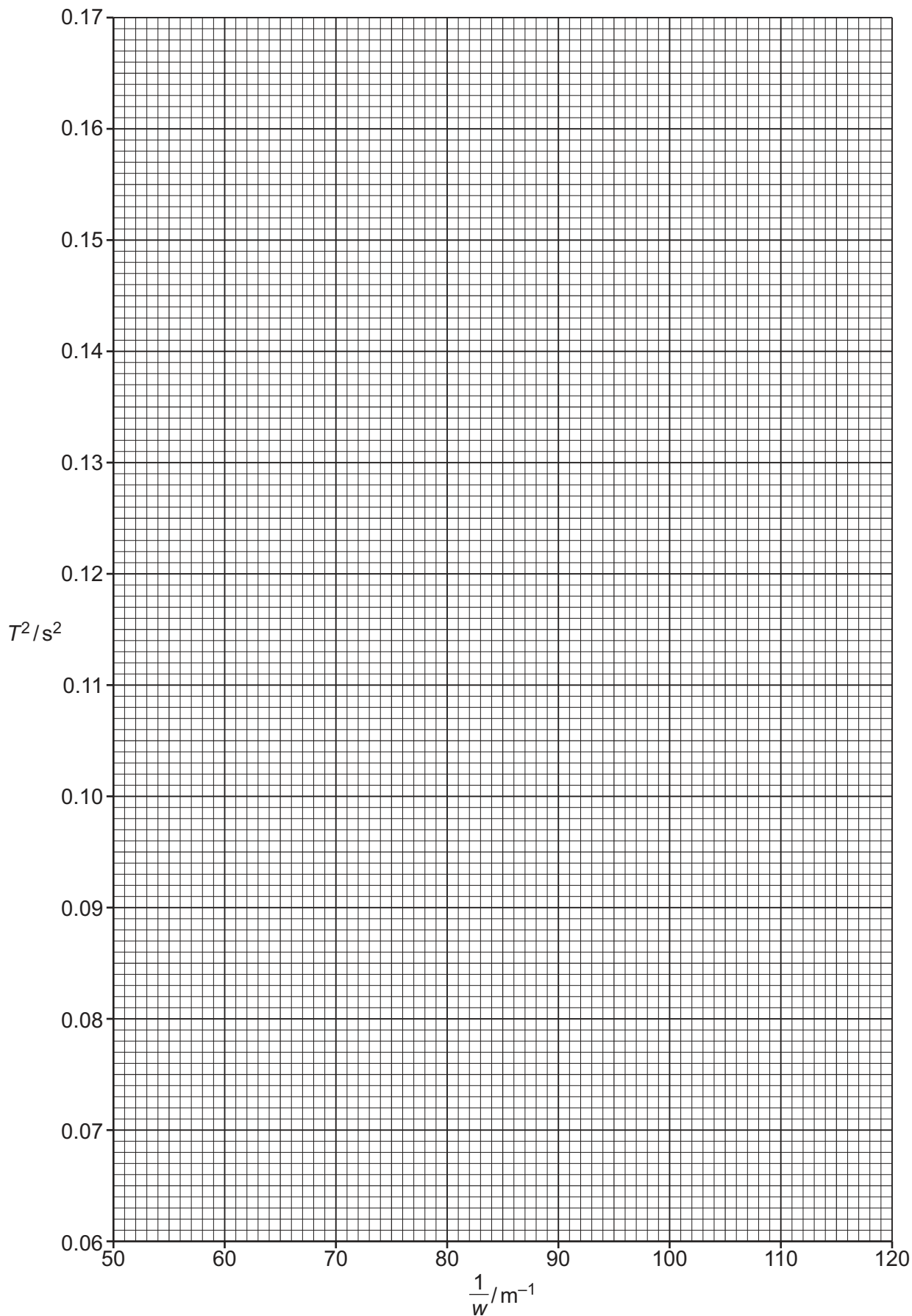
Calculate and record values of T/s and T^2/s^2 in Table 2.1. Include the absolute uncertainties in T and T^2 .

[2]

- (c) (i) Plot a graph of T^2/s^2 against $\frac{1}{w}/\text{m}^{-1}$. Include error bars for T^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 thickness of the strips is measured several times:

0.98 mm

0.99 mm

0.93 mm

0.97 mm

0.98 mm.

Determine the mean thickness d . Include the absolute uncertainty.

$$d = \dots\dots\dots \text{ mm [1]}$$

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

Data: $M = (100 \pm 5)\text{g}$
 $L = (26.2 \pm 0.2)\text{cm}$

$$E = \dots\dots\dots [2]$$

(ii) Determine the percentage uncertainty in E .

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

(f) The experiment is repeated. Determine the width w that gives a value of T of $(0.500 \pm 0.004)\text{s}$. Include the absolute uncertainty.

$$w = \dots\dots\dots \text{ m [2]}$$

[Total: 15]

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