



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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9702/31

October/November 2024

2 hours

You must answer on the question paper.

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

- 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 **16** 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 position of a wooden strip.

Some of the apparatus has been set up for you.

- (a)** • Set up the apparatus as shown in Fig. 1.1.

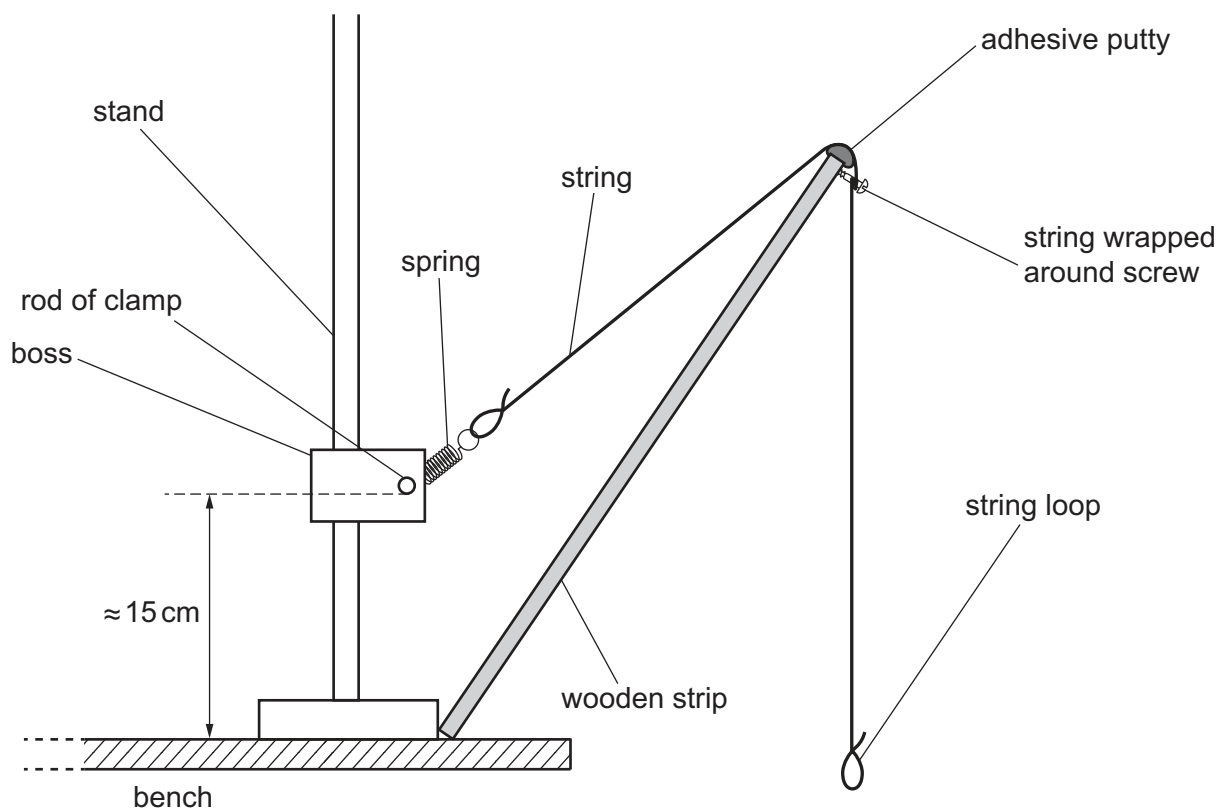


Fig. 1.1

- Ensure the rod of the clamp is approximately 15 cm above the bench.
- Arrange the wooden strip so that the bottom of the strip rests against the base of the stand.
- Use adhesive putty to fix the string centrally on the wooden strip in line with the spring.
- Wrap the string around the screw.



- Arrange the block and protractor as shown in Fig. 1.2.

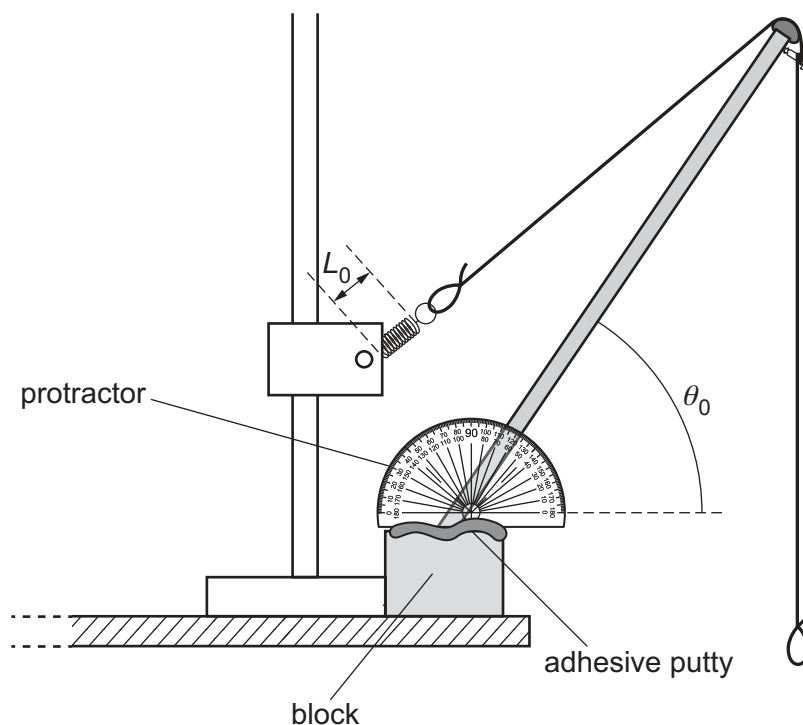


Fig. 1.2

- The length of the coiled section of the spring is L_0 , as shown in Fig. 1.2.

The angle between the lower edge of the wooden strip and the horizontal is θ_0 , as shown in Fig. 1.2.

Adjust the apparatus until θ_0 is between 75° and 85° . You may wish to move the protractor along the block.

- Measure and record L_0 and θ_0 .

$L_0 =$

$\theta_0 =$ $^\circ$
[1]



- (b) • Make a hook from one paper clip and hang nine paper clips from it as shown in Fig. 1.3.

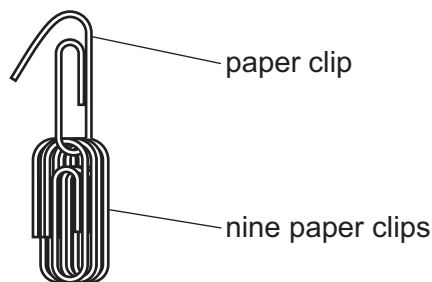


Fig. 1.3

- The mass of all ten paper clips is m .

Measure and record m .

$m = \dots\dots\dots$ [1]

- (c) • Using the mass hanger and slotted masses, hang a mass of 40g from the string loop.
- Hang the paper clips from the string loop as shown in Fig. 1.4.

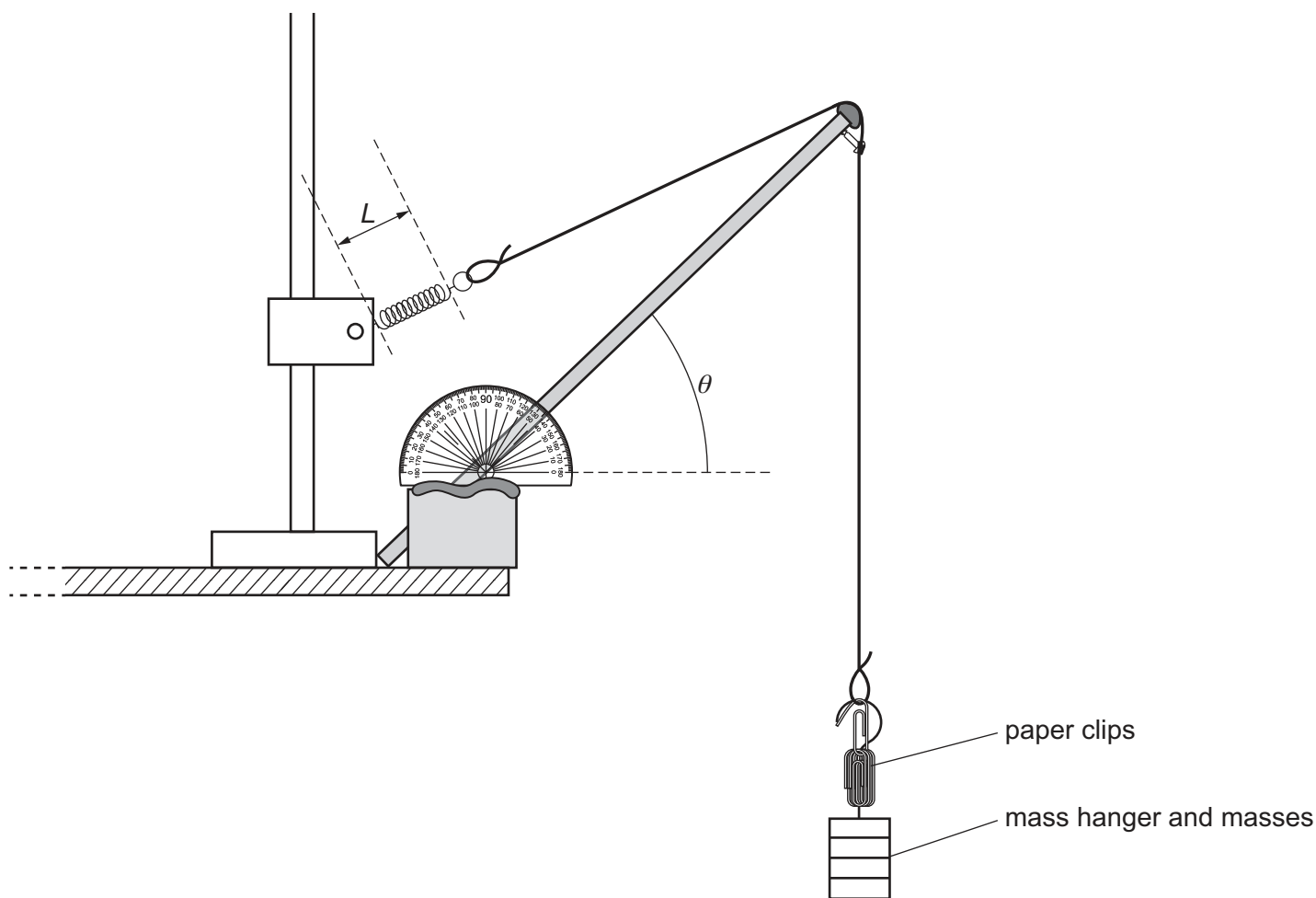


Fig. 1.4



- The total mass hanging from the string loop is M .

The angle between the wooden strip and the horizontal is θ , as shown in Fig. 1.4.

The length of the coiled section of the spring is L , as shown in Fig. 1.4.

Determine and record M .

$M =$

- Measure and record θ and L .

$\theta =$ °

$L =$

- Calculate e where

$$e = (L - L_0).$$

$e =$ [1]





- (d) Vary M . The total mass M may be made from slotted masses only or from m and slotted masses. For each value of M , measure and record M , θ and L . Repeat until you have six sets of values.

Record your results in a table. Include values of e and $\sin \theta$ in your table.

[9]

- (e) (i) Plot a graph of e on the y -axis against $\sin \theta$ on the x -axis.

[3]

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

[1]

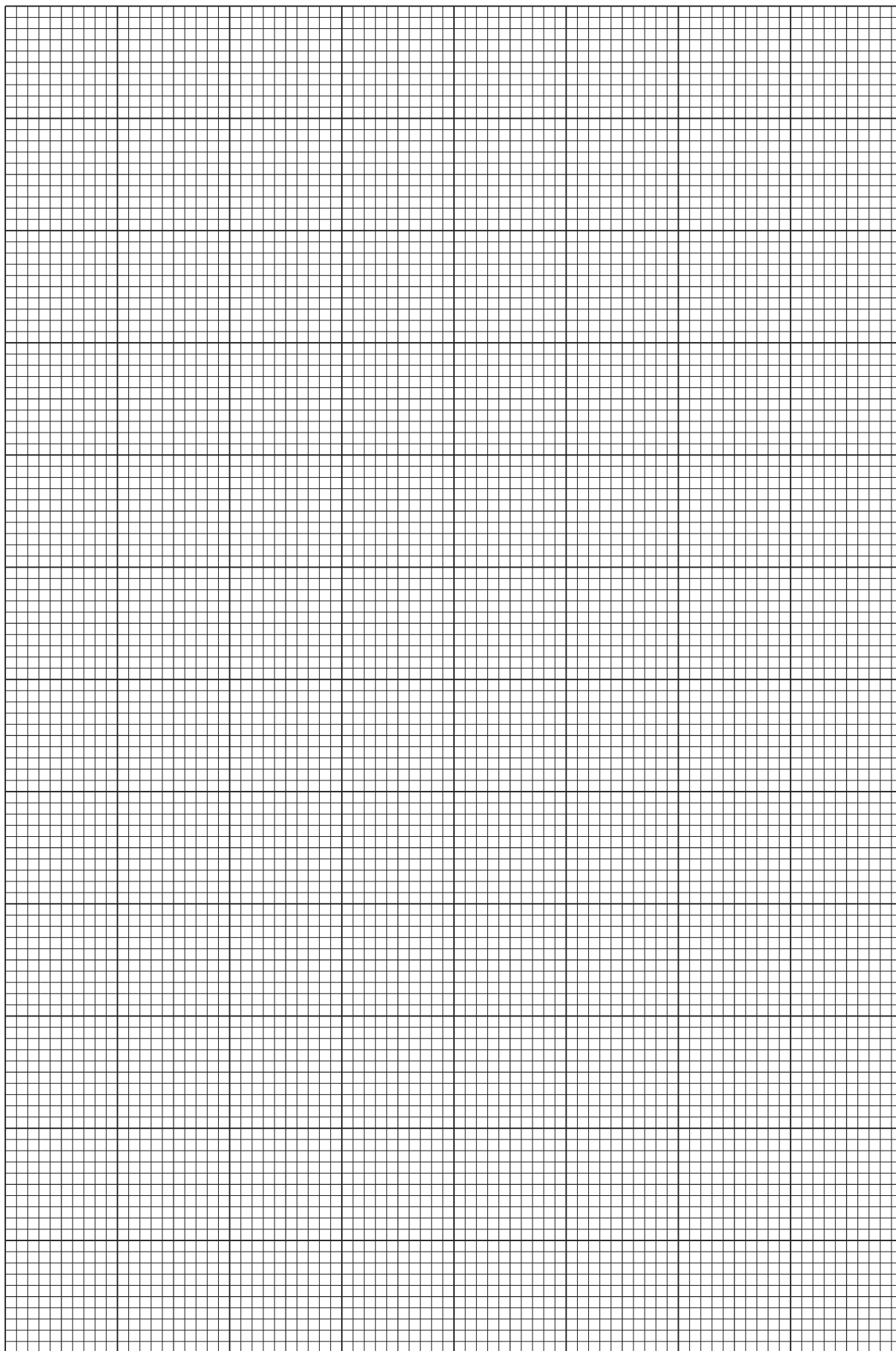
- (iii) Determine the gradient and y -intercept of this line.

gradient =

y -intercept =

[2]







8



(f) It is suggested that the quantities e and θ are related by the equation

$$e = P \sin \theta + Q$$

where P and Q are constants.

Using your answers in (e)(iii), determine the values of P and Q .
Give appropriate units.

$P =$

$Q =$ [2]

[Total: 20]





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

2 In this experiment, you will investigate oscillations.

(a) You have been provided with a board of width w and thickness x , as shown in Fig. 2.1.

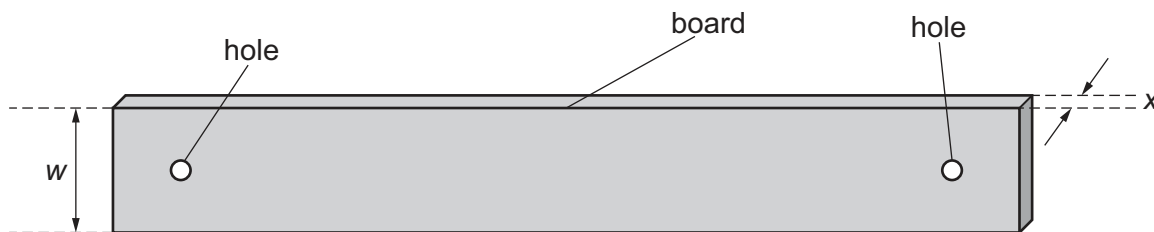


Fig. 2.1 (not to scale)

Measure and record w and x .

$w =$

$x =$

[1]

(b) (i) • Set up the apparatus as shown in Fig. 2.2.

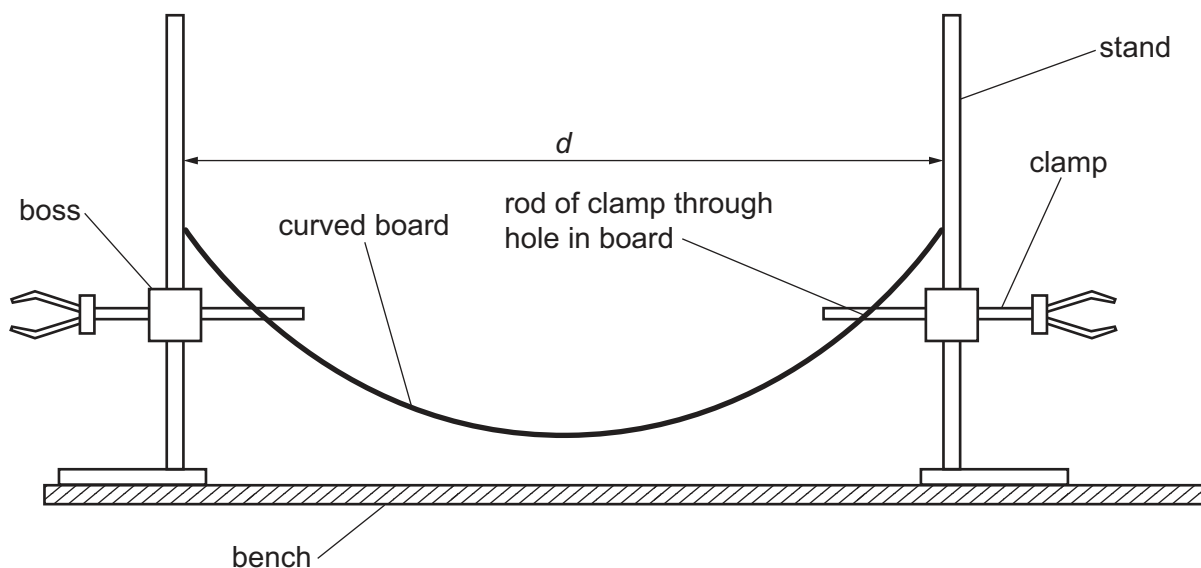


Fig. 2.2

- Ensure the rods of the clamps are the same height above the bench.
- Slide the rods of the clamps through the holes in the board as shown in Fig. 2.2. Ensure that each end of the board touches a stand.





- The distance between the inside edges of the stands is d , as shown in Fig. 2.2.
Adjust the apparatus until d is in the range 92 cm to 99 cm.
- Measure and record d .

$d = \dots\dots\dots$ cm [2]

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

percentage uncertainty = $\dots\dots\dots$ % [1]

- (c)
- Place the spring in the middle of the curved board.
 - Displace the spring a short distance to one side, as shown in Fig. 2.3.

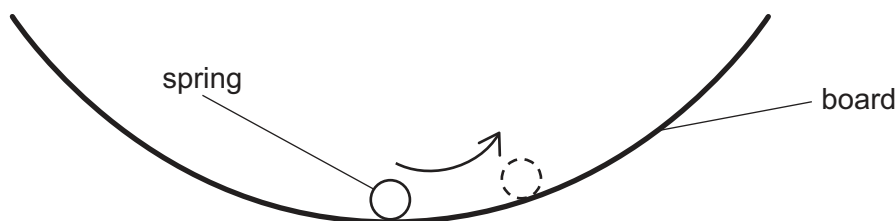


Fig. 2.3

- Release the spring. The spring will roll from side to side on the board.
- Take measurements to determine the period T of these oscillations.

$T = \dots\dots\dots$ s [2]





- (d) • Adjust the apparatus until d is in the range 66 cm to 74 cm. Ensure that the board does not touch the bench.

- Measure and record d .

$d =$ cm

- Repeat (c).

$T =$ s
[3]

- (e) It is suggested that the relationship between T and d is

$$(T - a) = kd$$

where a is 0.70 s and k is a constant.

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

first value of $k =$

second value of $k =$
[1]

- (ii) Justify the number of significant figures that you have given for your values of k .

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

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- (f) It is suggested that the percentage uncertainty in the values of k is 10%.

Using this uncertainty, explain whether your results support the relationship in (e).

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..... [1]





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

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1

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2

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3

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4

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[4]

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

1

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2

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4

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[4]

[Total: 20]





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