



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

1 In this experiment, you will investigate the oscillations of a pendulum.

- (a) • Assemble the apparatus as shown in Fig. 1.1 with the nail held securely in the cork. Check that the wooden rod can swing freely.

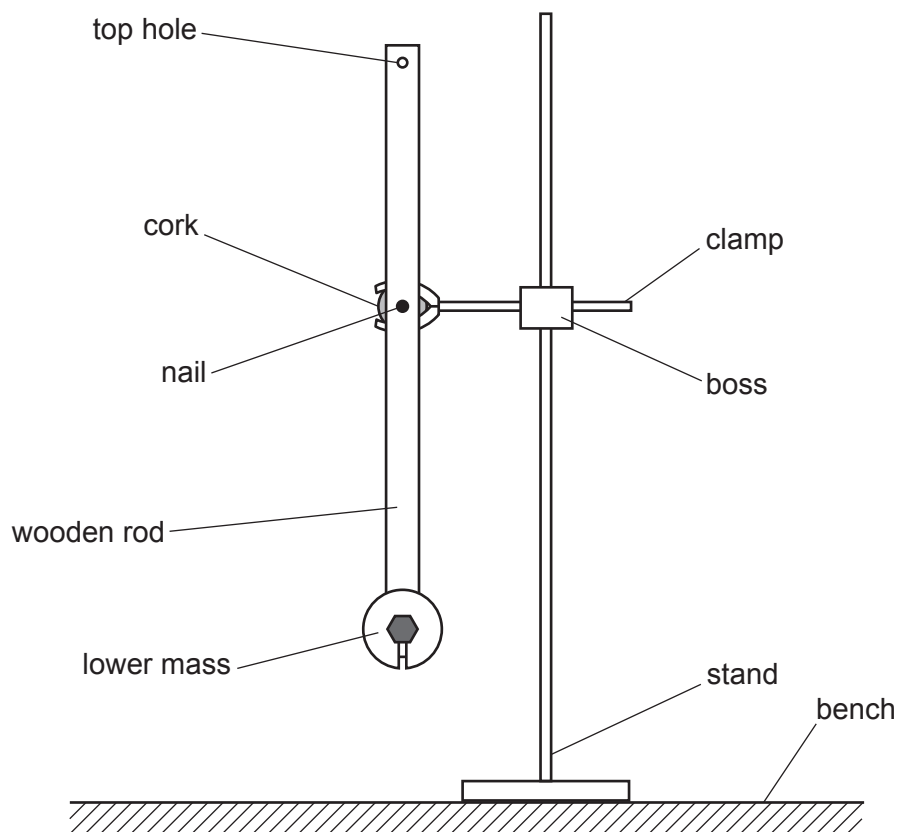


Fig. 1.1

- You have been provided with one 50 g and four 10 g slotted masses. Use the bolt and nut to attach some of the 10 g slotted masses to the top hole.
- Record the total mass M of the slotted masses that are attached to the top hole.

$M =$

- Push the bottom of the wooden rod a small distance to one side.
- Release the wooden rod so that it oscillates.
- Take measurements to determine the period T of the oscillations.

$T =$

- (b) Change M and determine T . Repeat until you have six sets of values of M and T . Do **not** change the lower mass.

Record your results in a table. Include values of M^2 and T^2 in your table.

[9]

- (c) (i) Plot a graph of T^2 on the y -axis against M^2 on the x -axis.

[3]

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

[1]

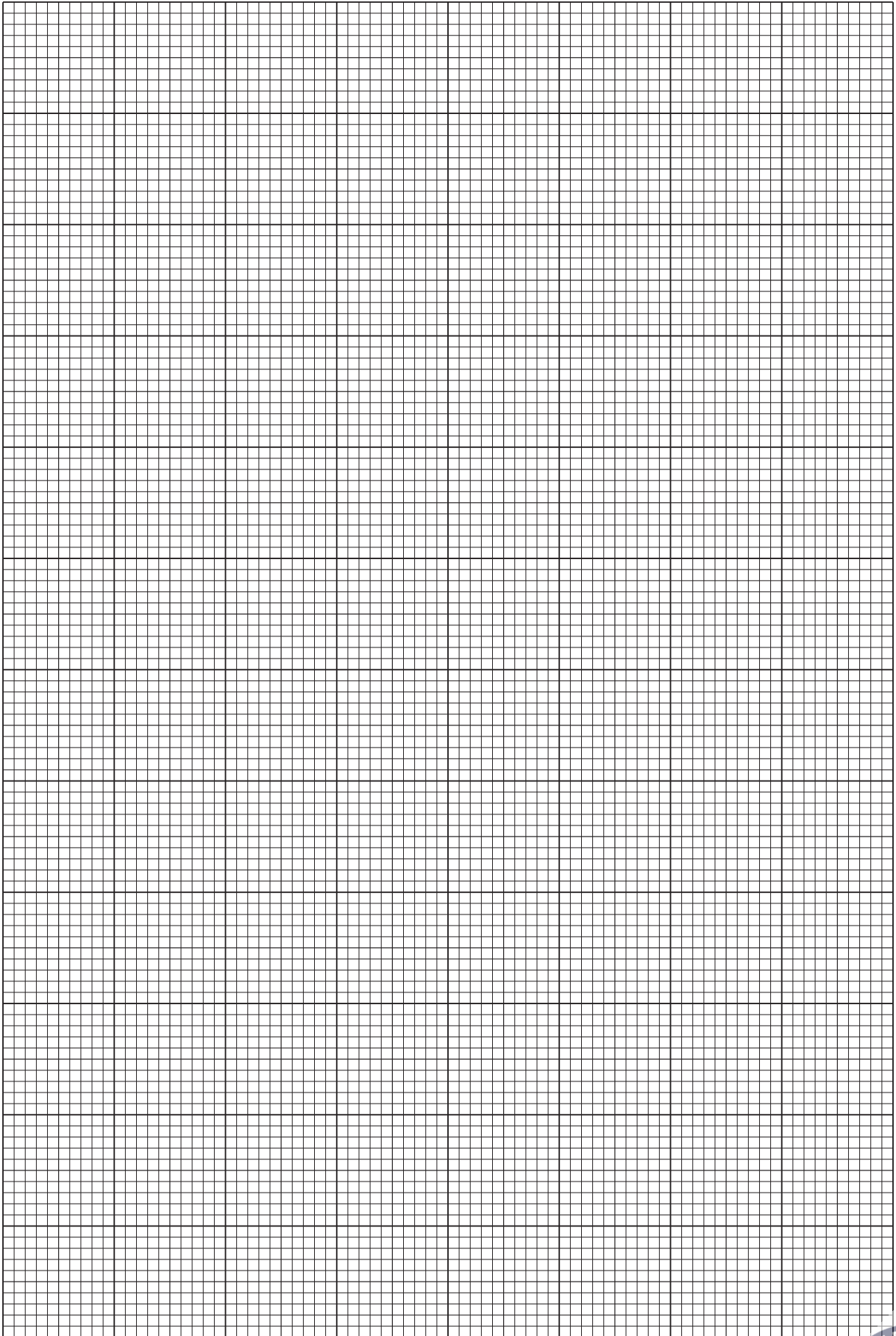
- (iii) Determine the gradient and y -intercept of this line.

gradient =

y -intercept =

[2]





(d) It is suggested that the quantities T and M are related by the equation

$$T^2 = aM^2 + b$$

where a and b are constants.

Using your answers in (c)(iii), determine the values of a and b .

Give appropriate units.

$a =$

$b =$

[2]

[Total: 20]

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

2 In this experiment, you will investigate the thermal expansion of plastic.

(a) You have been provided with two plastic pipes. Each pipe has a string loop attached at each end, as shown in Fig. 2.1.

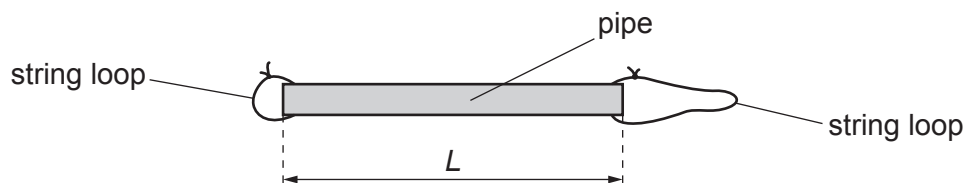


Fig. 2.1

- Measure and record the length L of the **longer** pipe, as shown in Fig. 2.1.

$L =$

- Place the thermometer on the bench. Record the room temperature T_0 .

$T_0 =$

[2]

(b) (i) You have been provided with a wooden rod supported by a pin.

- Using the longer pipe, assemble the apparatus as shown in Fig. 2.2.

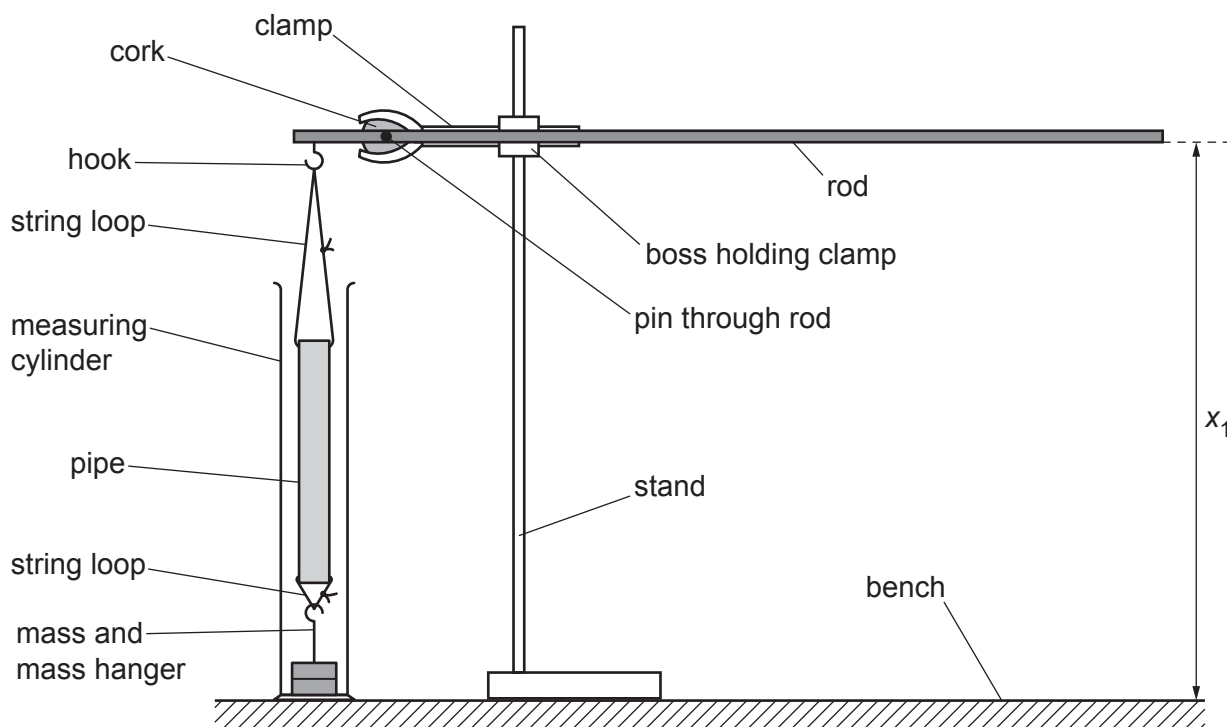


Fig. 2.2

- Adjust the apparatus so that the rod is parallel to the bench and the mass hanger rests on the bottom of the measuring cylinder.
- Measure and record the height x_1 of the end of the rod above the bench, as shown in Fig. 2.2.

$$x_1 = \dots\dots\dots [1]$$

- (ii)
- Slowly pour boiling water into the measuring cylinder until it covers the pipe.
 - Place the thermometer in the water. Record the temperature T .

$$T = \dots\dots\dots$$

- Remove the thermometer from the water.
- The expansion of the pipe causes the end of the rod to move down. Measure the new height x_2 of the end of the rod above the bench.

$$x_2 = \dots\dots\dots$$

- Carefully remove the pipe and mass hanger (the masses will be very hot) and pour the hot water into the sink.

[2]

- (iii) Calculate $(x_1 - x_2)$.

$$(x_1 - x_2) = \dots\dots\dots [1]$$

- (iv) Estimate the percentage uncertainty in your value of $(x_1 - x_2)$. Show your working.

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

- (c) • Measure and record the length L of the **shorter** pipe.

$$L = \dots\dots\dots$$

- Repeat (b)(i), (b)(ii) and (b)(iii) using the shorter pipe.

$$x_1 = \dots\dots\dots$$

$$T = \dots\dots\dots$$

$$x_2 = \dots\dots\dots$$

$$(x_1 - x_2) = \dots\dots\dots$$

[2]

- (d) It is suggested that the relationship between x_1 , x_2 , L , T and T_0 is

$$k(x_1 - x_2) = L(T - T_0)$$

where 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]

- (e) It is suggested that the percentage uncertainty in the values of k is 20%.

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

.....

 [1]

- (f) (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

.....

2

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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

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2

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3

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4

.....

[4]

[Total: 20]

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