33/O/N/10 Q1

1. In this experiment, you will investigate how the motion of a pendulum bob is affected by the height of the bob above the bench.

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

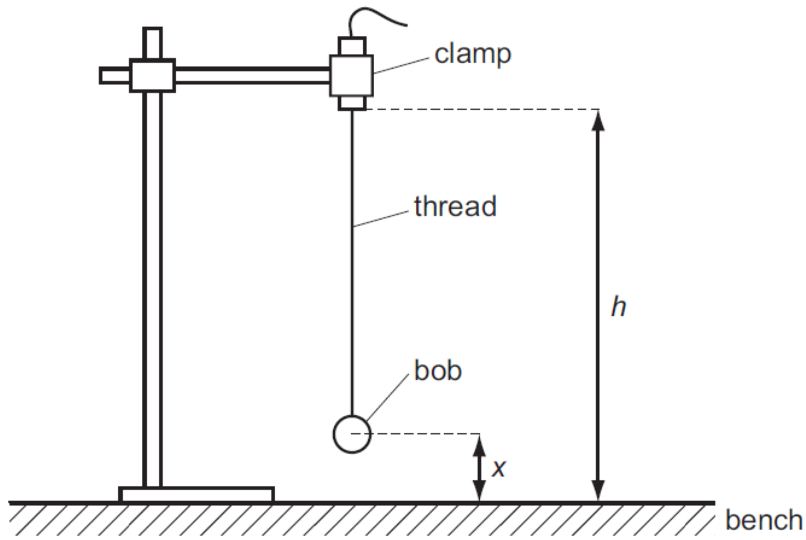

Fig. 1.1

The distance h from the point of suspension to the bench should be as large as possible.

The distance x between the centre of the bob and the bench should be approximately 5 cm.

(ii) Measure and record distance h.

Throughout this experiment, do not change the distance *h*.

h = ...

(iii) Measure and record distance x.

x = ...

(b) Displace the bob a small distance to the left. Release the bob and watch the movement.

The time the bob takes for each complete swing, first to the right and then back to the left, as shown in Fig. 1.2, is T.

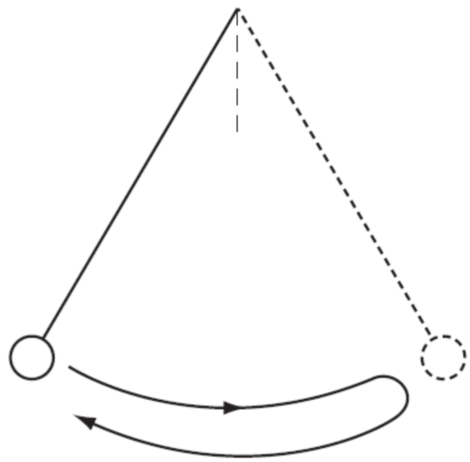

Fig. 1.2

By timing several of these complete swings, determine an accurate value of T.

T = ...

(c) Keeping h constant, change x and repeat **(a)(iii)** and **(b)** until you have six sets of values for x and T. Include values for T^2 in your table of results.

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

(ii) Draw the straight line of best fit.

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

gradient = ...

y-intercept = ...

(e) The quantities T and x are related by the equation

$$T^2 = A - Bx$$

where A and B are constants.

Use your answers to **(d)(iii)** to determine the value of $\frac{A}{B}$.

Give an appropriate unit.

$\frac{A}{B}$ = ...

31/M/J/12 Q1

2. In this experiment, you will investigate how the motion of a pendulum whose swing is interrupted depends on its length.

(a) **(i)** Lay the pendulum next to the rule and use the pen to make a mark on the string so that the distance L is 0.180 m, as shown in Fig. 1.1.

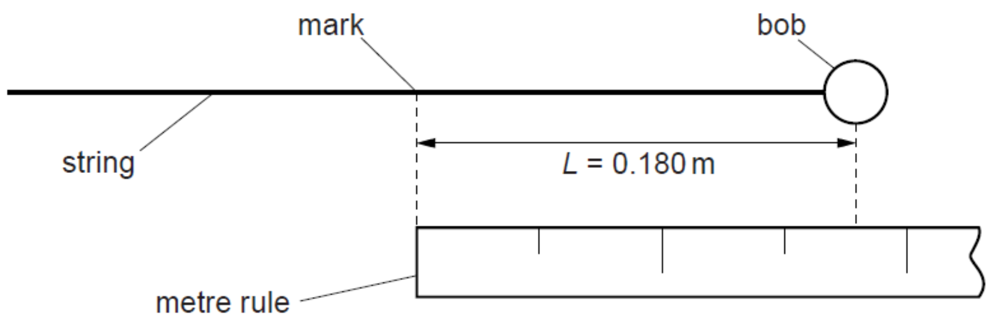

Fig. 1.1

(ii) Set up the apparatus, fixing the string in the split bung so that the string is just touching the wooden rod at the mark you have made.

Fig. 1.2 shows a side view and a front view of the apparatus.

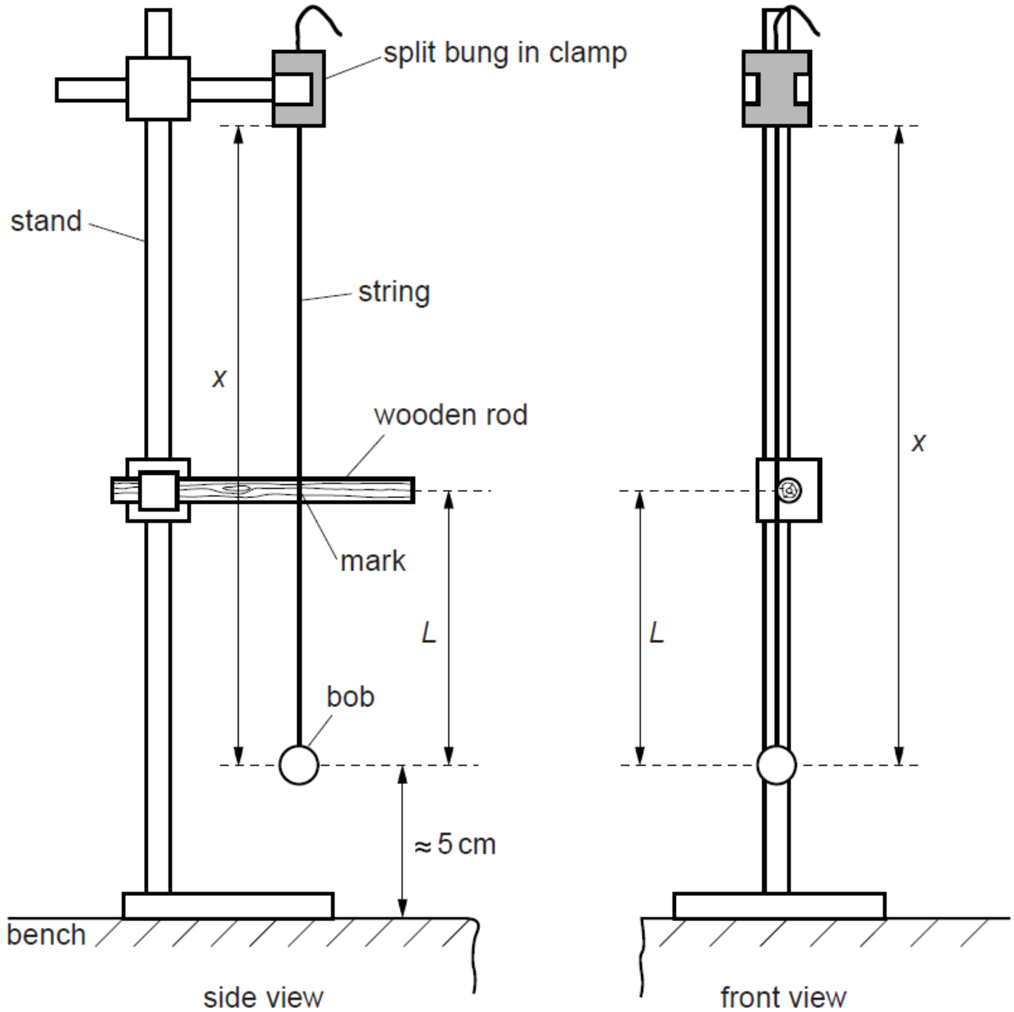

Fig. 1.2

The centre of the bob should be approximately 5 cm above the bench.

The distance *x* between the bottom of the bung and the centre of the bob should be approximately 55 cm.

The mark on the string should be level with the centre of the rod.

(iii) Measure and record the distance *x*.

x = ... m [1]

(b) (i) Move the bob sideways through a distance of approximately 5 cm, as shown in Fig. 1.3.

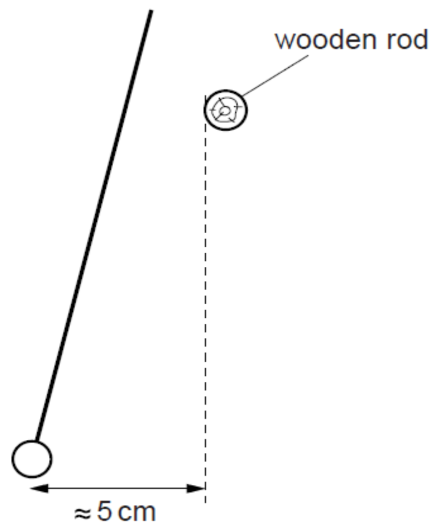

Fig. 1.3

(ii) Release the bob and watch its movement. The bob will move to the right and then to the left again completing a swing, as shown in Fig. 1.4. Let the pendulum swing to and fro, counting the number of swings.

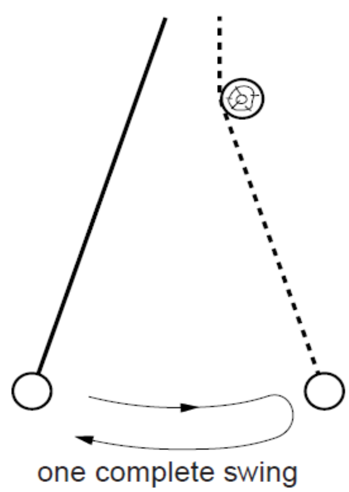

Fig. 1.4

Measure and record the time for at least 10 consecutive swings.

Record enough readings to determine an accurate value for the time T taken for one complete swing.

T = ... [2]

(c) Reduce the distance x. Keep L constant, by adjusting the height of the wooden rod if necessary. Repeat **(a)(iii)** and **(b)** until you have six sets of values of x and T.

Include values of $\sqrt{x}$ in your table.

[9]

(d) **(i)** Plot a graph of T on the y-axis against $\sqrt{x}$ 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]

Type text here

(e) The quantities T and x are related by the equation

$$T = P\sqrt{x} + Q$$

where P and Q are constants.

Using your answers from **(d)(iii)**, determine the values of P and Q.

Give appropriate units.

P = ...

Q = ...
[2]

3. In this question you will investigate how the period of oscillation of a loaded steel blade varies with the length of the blade and use the results of your experiment to determine a value for the Young modulus of steel.

(a) Use the G-clamp and the small blocks of wood to clamp the steel blade to the bench as shown in Fig. 1.1. The blade has two small 50 g masses attached to one end. You should not disturb the position of these masses during the course of the experiment.

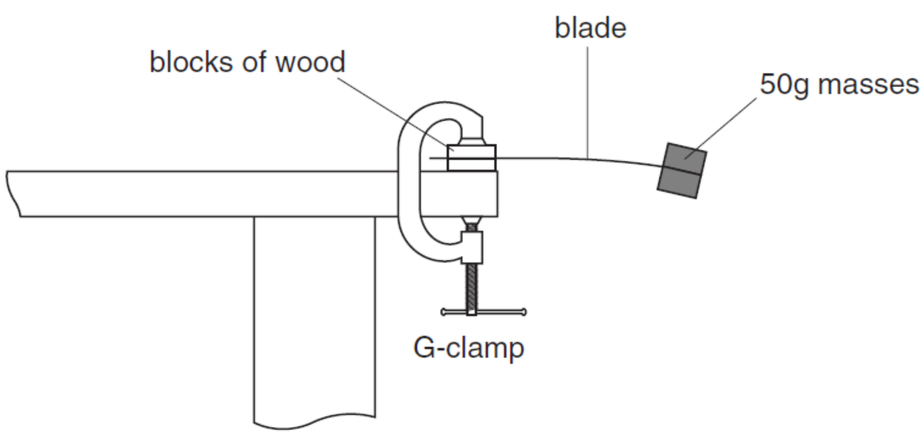

Fig. 1.1

(b) (i) Measure and record the distance *d* from the centre of the masses to the edge of the blocks as shown in Fig. 1.2. You will need to hold the blade horizontal when you make the measurement of *d*.

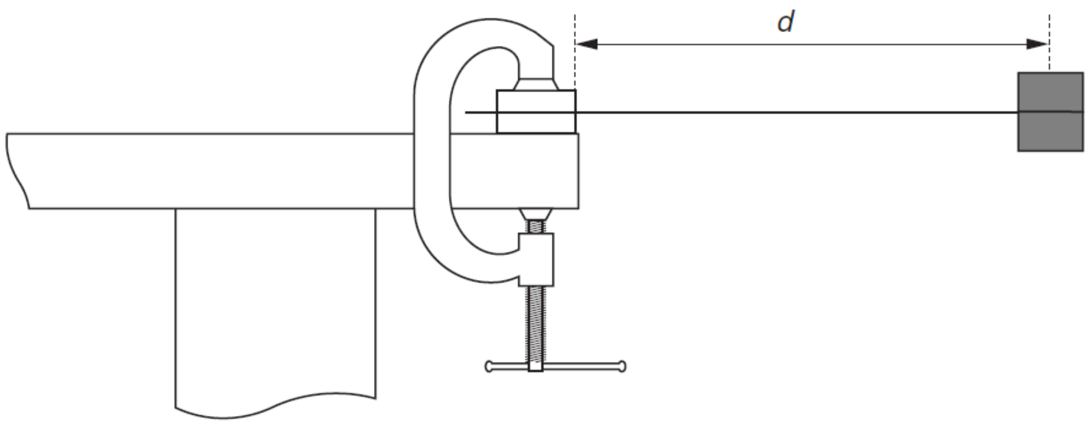

Fig. 1.2

d = ... m

(ii) Displace the end of the blade from its equilibrium position and release it so that the strip performs small oscillations in a vertical plane. Make and record measurements to determine the period T of oscillation of the blade.

T = ... s

(c) Change the value of d and repeat **(b)(i)** and **(ii)** until you have six sets of readings of distance d and period T for values of d in the range $0.130\,\text{m} < d < 0.250\,\text{m}$.

Include in your table of results all six sets of values for lg (T/ s) and lg (d/ m).

(d) **(i)** Plot a graph of lg (T/ s) (y-axis) against lg (d/ m) (x-axis).

(ii) Draw the line of best fit.

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

gradient = ...

y-intercept = ...

(e) Theory suggests that T and d are related by a simple power law of the form

$$T = kd^n$$

where n and k are constants.

Use your answers from **(d)(iii)** to find the values of n and k.

You need not be concerned with the units of these quantities.

n = ...

k = ...

A theoretical treatment of this oscillator suggests that

$$k = \sqrt{\frac{16\pi^2 M}{Ebt^3}}$$

where M is the mass attached to the end of the blade, E is the Young modulus, b is the width of the blade and t is the thickness of the blade as shown in Fig. 1.3.

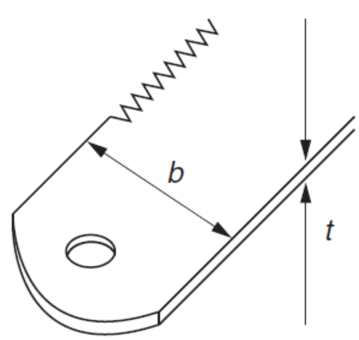

Fig. 1.3

(f) **(i)** Measure the values of b and t. The measurement of t should be made on a part of the blade where there is no tape.

b = ... m

t = ... m

(ii) State the name of the instrument used to measure t.

....

(iii) Estimate the percentage uncertainty in the value of t^3.

percentage uncertainty in t^3 = ... %

(g) Determine a value for E. Include an appropriate unit.

E = ...