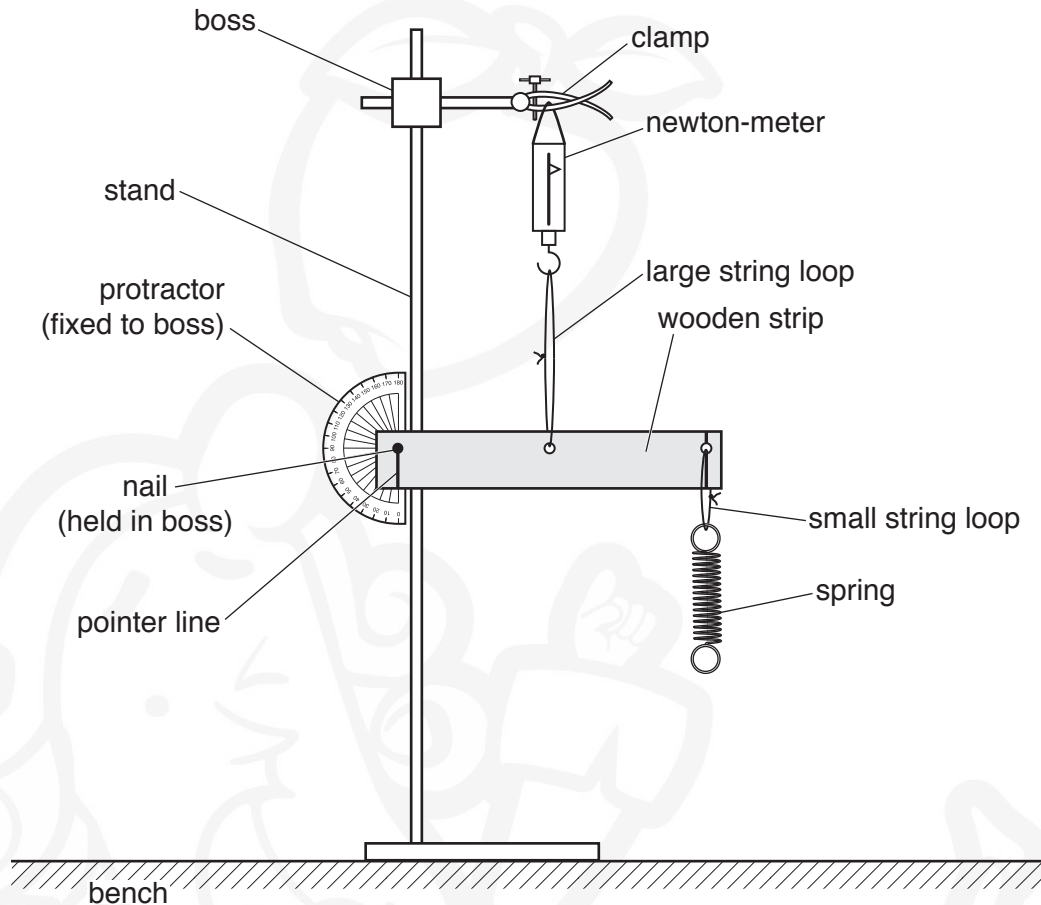




**You may not need to use all of the materials provided.**

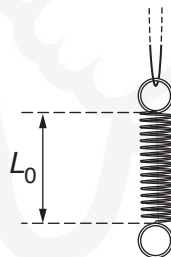
**1** In this experiment, you will investigate a system in equilibrium.

**(a)** • Assemble the apparatus as shown in Fig. 1.1.



**Fig. 1.1**

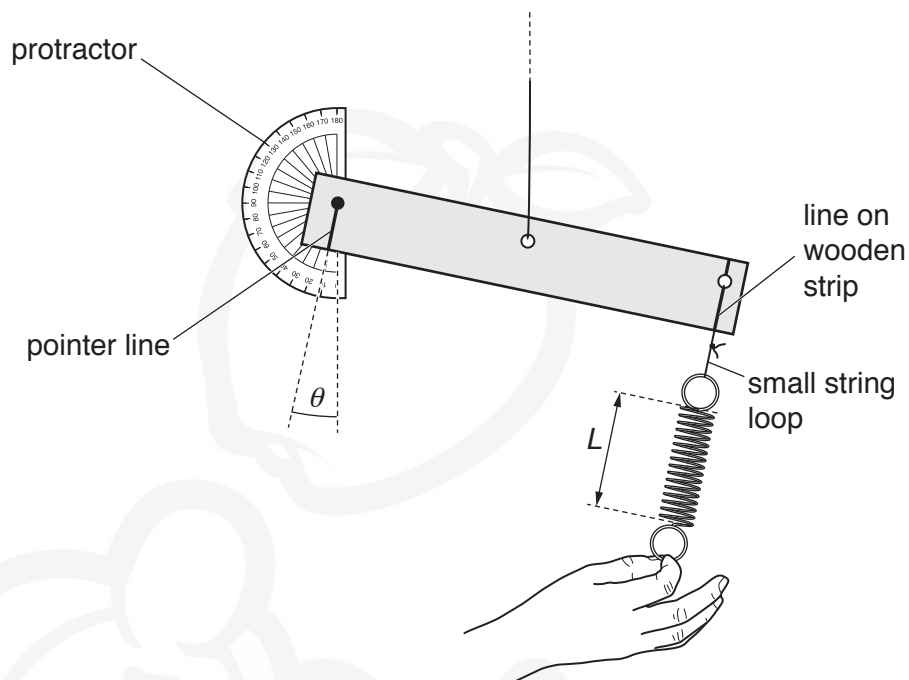
- Adjust the apparatus so that the wooden strip is horizontal, the large string loop and newton-meter are vertical, and the pointer line is aligned with the zero line on the protractor.
- Measure and record the length  $L_0$  of the coiled part of the spring, as shown in Fig. 1.2.



**Fig. 1.2**

$L_0 = \dots\dots\dots$  [1]

- (b) • Pull the spring down a short distance, keeping the small string loop aligned with the line on the wooden strip, as shown in Fig. 1.3.



**Fig. 1.3**

- Measure and record the length  $L$  of the coiled section of the spring, as shown in Fig. 1.3.

$L =$  .....

- Read and record the angle  $\theta$  of the pointer line from the vertical, as shown in Fig. 1.3.

$\theta =$  ..... [1]

- (c) Repeat (b) using different values of  $\theta$  less than  $45^\circ$  until you have six sets of values of  $\theta$  and  $L$ .

Record your results in a table. Include values of  $(L-L_0)$  and values of  $(\sin \theta)(\cos \theta)$  in your table.

[10]

- (d) (i) Plot a graph of  $(L-L_0)$  on the  $y$ -axis against  $(\sin \theta)(\cos \theta)$  on the  $x$ -axis. [3]

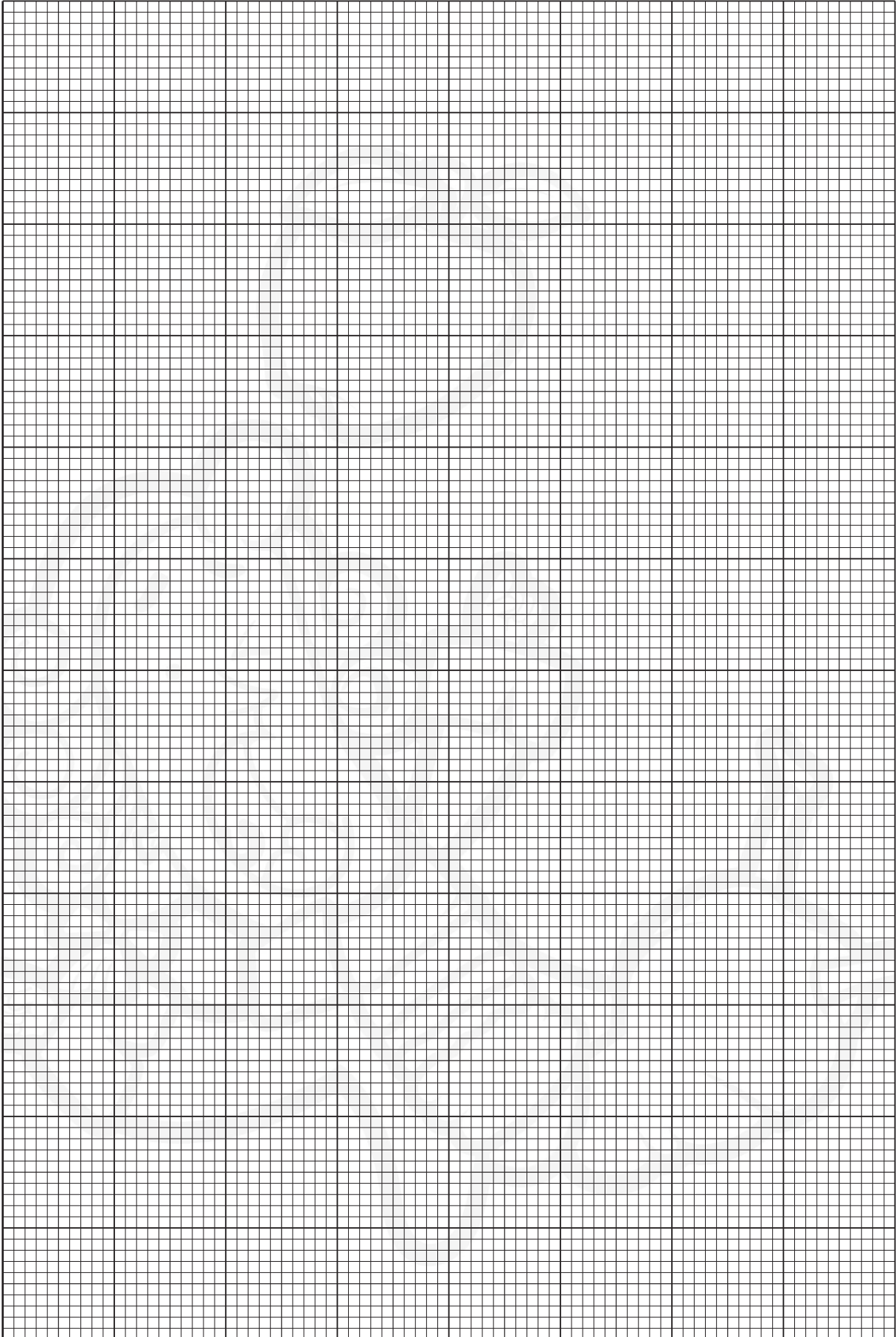
- (ii) Draw the straight line of best fit. [1]

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

gradient = .....

$y$ -intercept = .....

[2]



- (e) It is suggested that the quantities  $L$  and  $\theta$  are related by the equation

$$(L - L_0) = a (\sin \theta)(\cos \theta) + b$$

where  $a$  and  $b$  are constants.

Use your answers in (d)(iii) to determine the values of  $a$  and  $b$ .  
Give appropriate units.

$a =$  .....

$b =$  .....

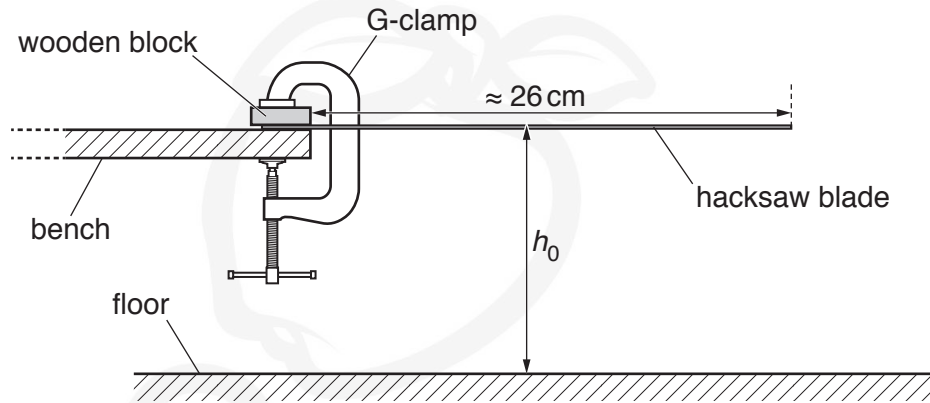
[2]

[Total: 20]

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

**2** In this experiment, you will investigate the motion of a hacksaw blade.

- (a)** • Assemble the apparatus as shown in Fig. 2.1.



**Fig. 2.1** (not to scale)

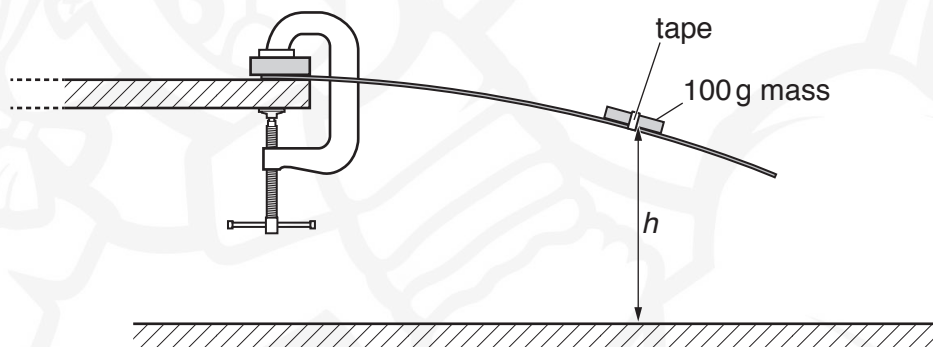
- The vertical distance from the floor to the top surface of the hacksaw blade is  $h_0$ , as shown in Fig. 2.1.

Measure and record  $h_0$ .

$h_0 = \dots\dots\dots$  [1]

- (b) (i)** • Place the 100g mass on the blade with its centre approximately 19 cm from the bench and tape it in position.

When released, the hacksaw blade will bend down, as shown in Fig. 2.2.



**Fig. 2.2** (not to scale)

- The vertical distance from the floor to the top surface of the hacksaw blade at the centre of the mass is  $h$ .

Measure and record  $h$ .

$h = \dots\dots\dots$  [1]

(ii) Calculate  $y$ , where  $y = h_0 - h$ .

$y =$  ..... [1]

(c) Estimate the percentage uncertainty in your value of  $y$ .

percentage uncertainty = ..... [1]

(d) Push the end of the hacksaw blade down a small distance and then release it. The blade will oscillate.

Determine the period  $T$  of the oscillations.

$T =$  ..... [2]

- (e)
- Move the slotted mass approximately 3 cm further from the bench and fix it with tape.
  - Measure and record  $h$ .

$h =$  .....

- Repeat (b)(ii) and (d).

$y =$  .....

$T =$  ..... [3]

- (f) It is suggested that the relationship between  $T$  and  $y$  is

$$T = c\sqrt{y}$$

where  $c$  is a constant.

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

first value of  $c =$  .....

second value of  $c =$  .....

[1]

- (ii) Explain whether your results support the suggested relationship.

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

- (g) Theory suggests that an approximate value of the acceleration of free fall  $g$  is given by

$$g = \frac{4\pi^2}{c^2}.$$

Using your second value of  $c$ , calculate  $g$ .  
Give an appropriate unit.

$g =$  ..... [1]

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

1. ....  
.....
2. ....  
.....
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. ....  
.....
2. ....  
.....
3. ....  
.....
4. ....  
.....

[4]

[Total: 20]



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