

## **A level Physics B**

**H557/03** Practical skills in physics

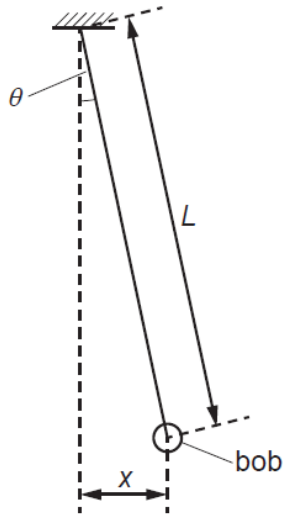
### **Question Set 10**

1 (a)

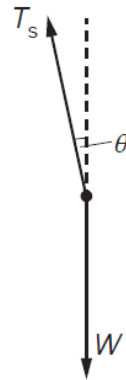
This question is about determining the acceleration due to gravity  $g$  using a simple pendulum.

The pendulum bob has mass  $m$  and the length of the pendulum string is  $L$ .

**Fig. 2.1a** shows the pendulum with angle of deflection  $\theta$  and bob displacement  $x$ .



**Fig. 2.1a**



**Fig. 2.1b**



**Fig. 2.1c**

**Fig. 2.1b** shows the free body diagram of the forces on the bob.

**Fig. 2.1c** shows the restoring (resultant) force  $F$  on the bob which is horizontal for **small** deflection angle  $\theta$ .

The weight of the bob is  $W$  and the tension in the string is  $T_s$ .

- (i) Explain why, for small angle  $\theta$  of deflection,  $F$  can be given by the expression

$$F \approx -\frac{T_s x}{L}.$$

[2]

- (ii) For small angle  $\theta$ ,  $T_s \approx mg$ . Therefore, the acceleration  $a$  of the bob can be given by the expression

$$a \approx -\frac{gx}{L}.$$

Use the equation for simple harmonic motion,  $a = -4\pi^2 f^2 x$ , to show that  $T^2 = \frac{4\pi^2 L}{g}$ , where  $T$  is the period of oscillation of the pendulum.

[2]

**(b)** A student measures the time taken for 10 oscillations of the pendulum bob to determine the period  $T$ .

She repeats this for 4 different pendulum lengths.

The results are shown in the table below.

Length of pendulum, $L/m$	Time taken for 10 oscillations, $t/s$	Period, $T/s$	$T^2/s^2$
0.300	11.33	1.133	1.284
0.400	12.70	1.270	
0.500	14.44	1.444	
0.600	15.41	1.541	

**(i)** State and explain the advantage of determining the period  $T$  by measuring the time for 10 oscillations.

**[2]**

**(ii)** Complete the table by calculating the three missing values of  $T^2/s^2$ .

**[1]**

- (iii) On Fig. 2.2, plot a graph of  $T^2$  (on the y-axis) against  $L$  (on the x-axis) and draw a straight line of best fit through the data points.

[4]

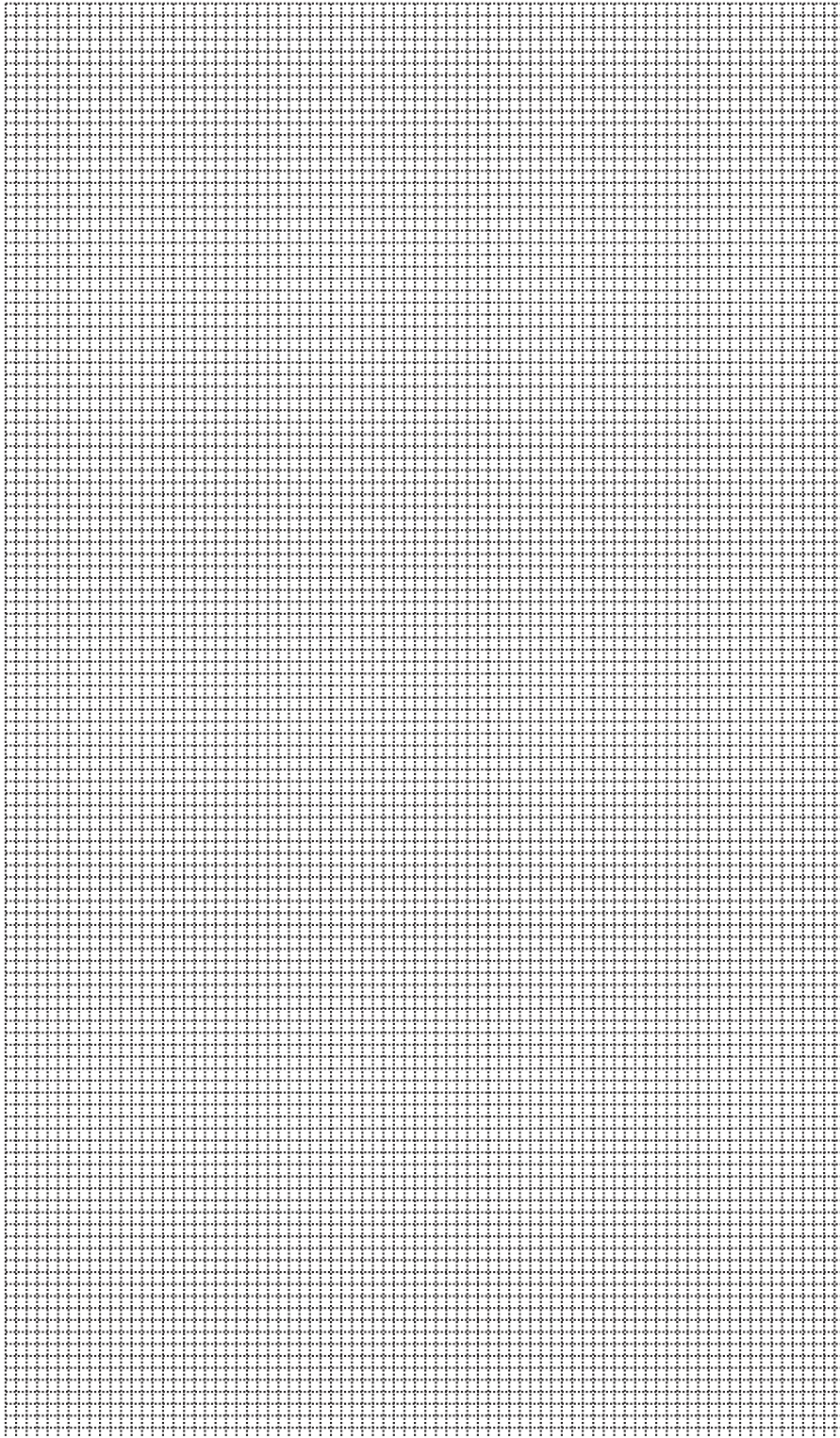


Fig. 2.2

(iv) Use the graph to determine a value for the acceleration due to gravity  $g$ .

Show your working.

$$g = \dots\dots\dots \text{ms}^{-2}$$

[2]

(c) The student is considering the uncertainty in her value for  $g$ .

She thinks that data collected for the shorter pendulums have greater percentage uncertainty than those for the longer ones.

Explain her reasoning.

[2]

**Total Marks for Question Set 10: 15**

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