Oxford Cambridge and RSA

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 θ and bob displacement x.

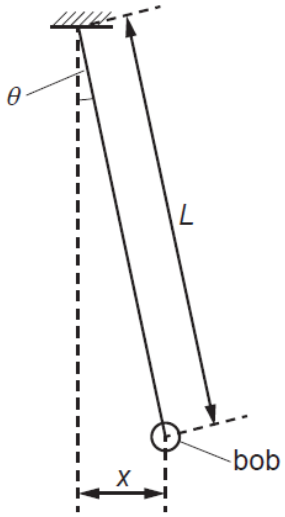

Fig. 2.1a

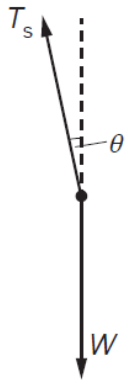

Fig. 2.1b

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 θ.

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

(i) Explain why, for small angle θ of deflection, F can be given by the expression

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

[2]

(ii) For small angle θ, $T_s \approx mg$. 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]**

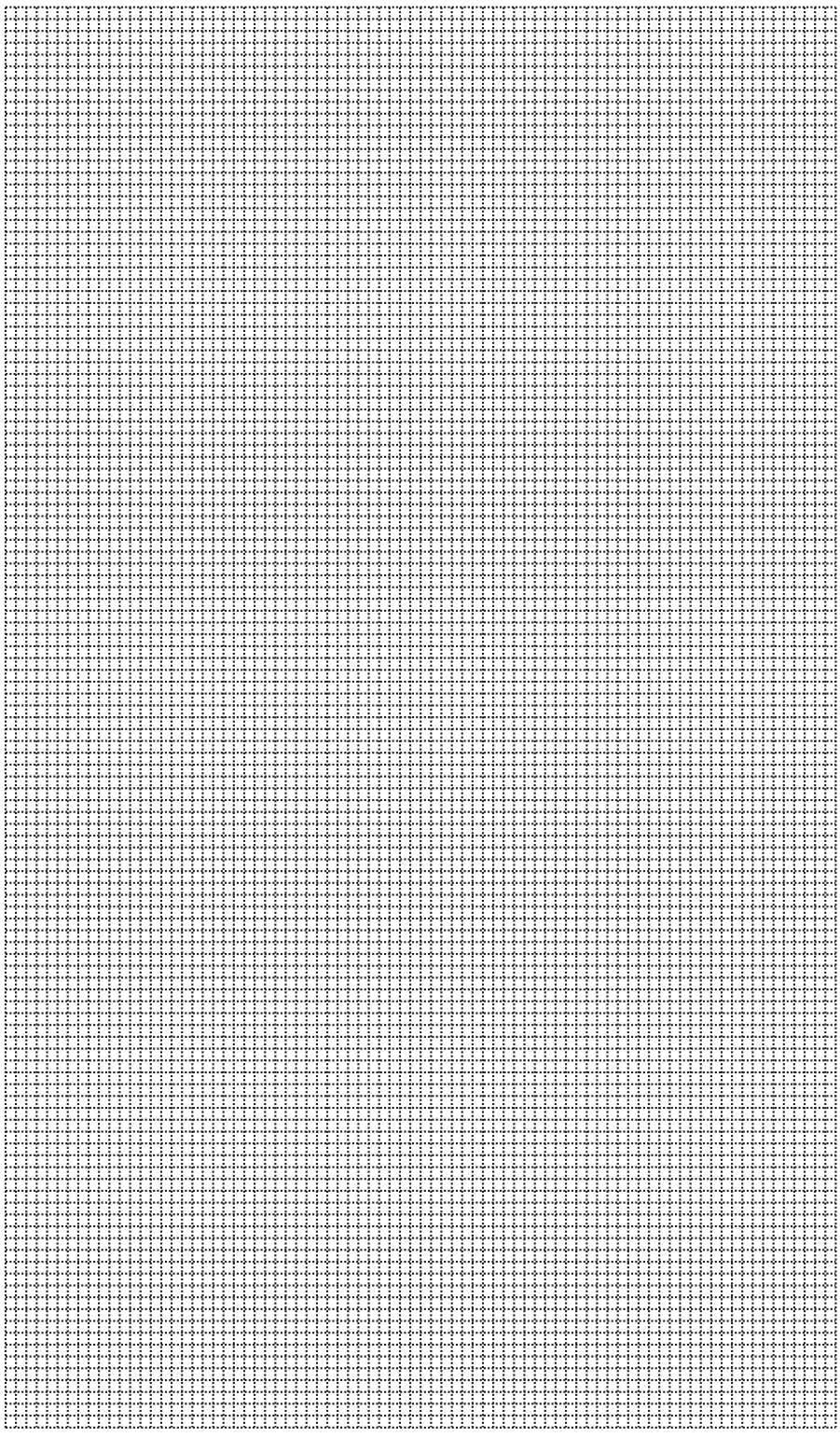

Fig. 2.2

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

Show your working.

g =.....m s^{-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