

Springs, pendulums and simple harmonic motion

AP Physics 1 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

How does the period of a pendulum depend on its length, and can a few pieces of string and a stopwatch give a good value for g ? You measure the time for 20 oscillations at five lengths, plot T^2 against L and use the gradient to calculate the gravitational field strength.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 7

Aim

To investigate how the period of a simple pendulum depends on its length and to use the results to find the gravitational field strength g .

Equipment

- Thread about 1.5 m long and a small dense bob (for example a metal nut or a key)
- Clamp and stand, or a firm table edge
- Metre rule and a stopwatch or phone timer
- Protractor or a printed 10° mark, and a small fixed marker at the centre

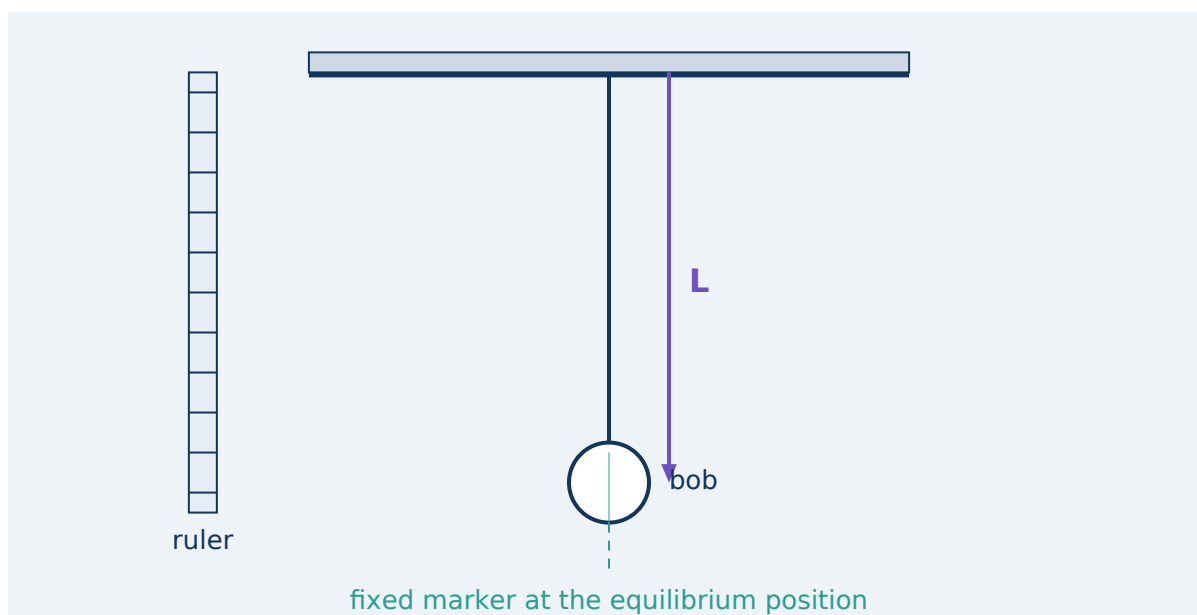
Safety

Safety

Keep the stand stable and clamp it to the bench. Keep the swing area clear of faces and fragile items. Do not use a heavy bob.

Method

1. Tie the bob to the thread and clamp the other end so that the length L from the pivot to the centre of the bob is 0.300 m. Measure L carefully.
2. Pull the bob aside through no more than 10° and release it without pushing.
3. Start the stopwatch as the bob passes the marker, then count 20 complete oscillations and record the time t .
4. Repeat for $L = 0.500, 0.700, 0.900$ and 1.100 m.
5. Calculate the period $T = t \div 20$ and then T^2 for each length.



Time the swings as the bob passes the fixed marker at the equilibrium position.

Results

Sample measurements taken by a student:

L / m	time for 20 oscillations t / s	T / s	T^2 / s^2
0.300	22.0	1.100	1.210
0.500	28.4	1.420	2.016
0.700	33.5	1.675	2.806
0.900	38.2	1.910	3.648
1.100	42.0	2.100	4.410

Analysis questions

Question 1 Why time many swings

Explain why the student times 20 oscillations instead of one, and why the timing starts at the marker.

Question 2 Check the table

Verify the T and T^2 values in the row $L = 0.700 \text{ m}$.

Question 3 Plot and describe

Plot T^2 (vertical axis) against L (horizontal axis). Describe the graph and say what it shows about the relationship between T and L .

Question 4 Gradient

Use a large triangle on the line of best fit, for example the first and last points, to find the gradient with its unit.

Question 5 Value of g

The theory gives $T^2 = (4\pi^2/g)L$. Use your gradient to calculate g and the percentage difference from 9.81 m/s^2 .

Question 6 Amplitude and mass

State what you expect to happen to T if the starting angle is 5° instead of 10° , and if the bob is twice as heavy. Justify each answer.

Question 7 Improving the lab

Suggest two sources of error and one improvement for each.