

Springs, pendulums and simple harmonic motion

AP Physics 1 (algebra-based) · Lab answers

Model answers use the sample data. Your own values will differ slightly, so compare the method and the form of the result, and compare your g with 9.81 m/s^2 .

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

Question 1 Why time many swings

Timing one swing (about 1.5 s) with a reaction time of 0.2 s gives roughly 13 % uncertainty; timing 20 swings (about 30 s) reduces it to under 1 %. Starting at the marker, where the bob moves fastest, makes the start and stop moments easier to judge. **20 swings reduces the percentage uncertainty about twenty-fold.**

Question 2 Check the table

$T = 33.5 \div 20 = 1.675 \text{ s}$ and $T^2 = 1.675^2 = \mathbf{2.806 \text{ s}^2}$, which agrees with the table.

Question 3 Plot and describe

The points lie on a **straight line through (or very near) the origin**. This shows T^2 is directly proportional to L , so T is proportional to $\sqrt{L}$, as $T = 2\pi\sqrt{L/g}$ predicts.

Question 4 Gradient

Gradient = $(4.410 - 1.210) \div (1.100 - 0.300) = 3.200 \div 0.800 = \mathbf{4.00 \text{ s}^2/\text{m}}$.

Question 5 Value of g

$g = 4\pi^2 \div \text{gradient} = 39.48 \div 4.00 = \mathbf{9.87 \text{ m/s}^2}$. Percentage difference = $(9.87 - 9.81) \div 9.81 \times 100 = \mathbf{0.6 \%}$.

Question 6 Amplitude and mass

For small angles T does not depend on amplitude, so T stays **unchanged**. It also does not depend on the mass, because the mass cancels from the equation, so a bob twice as heavy gives the **same period**.

Question 7 Improving the lab

Sources: (1) the length L is hard to measure to the centre of the bob, and (2) timing at the marker has human reaction error. Improvements: **measure L with a rule to the bob's centre using the bob's diameter, and film the swing and time it from the video frames** (or use more oscillations and repeat each length three times).