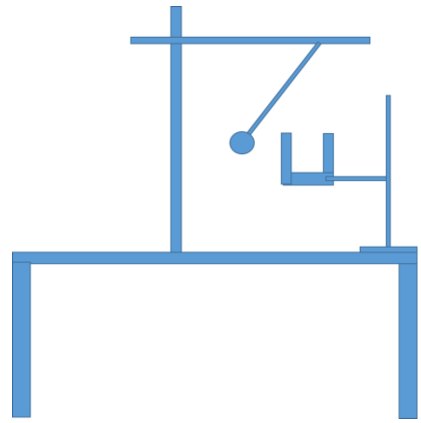
Name:____________________________________

Pendulum Lab

I. Introduction

In this lab you will model how varying the length of a pendulum affects the period.

II. Procedure



Set up your pendulum and photogate such that the bob of the pendulum passes through the photogate at the bottom of its swing. Make sure the data-logger reads “Blocked” at the bottom). Set the data-logger to “pendulum” mode. The data-logger will calculate the period of the pendulum based on the time between “blocked” and “unblocked” states. You will determine the period of the pendulum for ten different lengths. For each trial, collect three readings of the period (*i.e.* let the data-logger record data for a number of cycles), then take the average of the three readings. Record all your data in the attached data tables.

Make sure the cross-bar to which the pendulum is tied does not move while collecting data (you may want to hold it in place).

Name:___________________________________

III. Data Table

3. Period of Pendulum with different lengths. The lengths should be spaced between roughly 0.05 m (5 cm) and 1 m (100 cm).

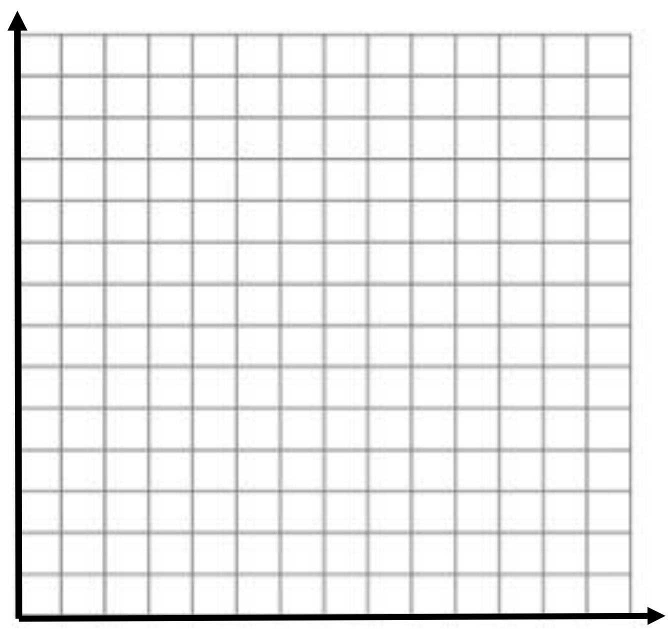
Length (m)	**Period (s)**
L_1 =	
AVERAGE =	
L_2 =	
AVERAGE =	
L_3 =	
AVERAGE =	
L_4 =	
AVERAGE =	
L_5 =	
AVERAGE =	

Name:___________________________________

IV. Questions

1. Based on your data, try to estimate the length of a pendulum that could act as a stopwatch, whose period was exactly 1 sec.

2. Does the length of the pendulum vary DIRECTLY with the period? If so then a graph of the PERIOD vs LENGTH would be a straight line. Plot your data points on the graph below (make sure to indicate your units) and see if they form a straight line. You might want to use software to make this plot.



3. Your graph for #2 probably (hopefully!) wasn't straight (it might be hard to see the curvature so you could fit a least-squares regression line and that could make curvature easier to observe). The period of a pendulum does not vary directly with the length. Instead it varies directly with THE SQUARE ROOT OF THE LENGTH. Here's the equation for calculating the period of a simple pendulum (if your lengths are measured in meters, then $g \approx 9.81\ m/s^2$):

$$T = 2\pi\sqrt{L/g}$$

Name:____________________________________

This can be re-written as:

$$T = \left(\frac{2\pi}{\sqrt{g}}\right)\sqrt{L}$$

Where $\left(\frac{2\pi}{\sqrt{g}}\right)$ is a constant. Thus T and $\sqrt{L}$ vary directly! If we square both sides of this equation we get:

$$T^2 = (4\pi^2/\,g)\,L$$

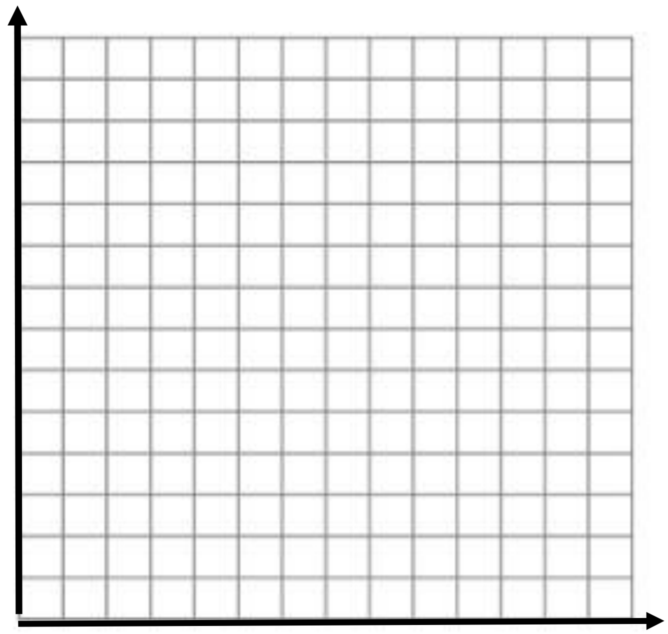
Since $(4\pi^2/\,g)$ is a constant, this shows that the square of the period (T^2) varies directly with the length (L).

This means that a graph of the PERIOD SQUARED vs LENGTH (T^2 vs L) should be a straight line! Let's see if your data shows this. Complete the table below using the lengths you used in the lab and the SQUARE of the corresponding period.

Length (cm)	Average Period (s)	Period ^{2} (s^2)
L_1 =		
L_2 =		
L_3 =		
L_4 =		
L_5 =		

Name:___________________________________

Now graph the data by plotting the LENGTH along the X-AXIS, and the PERIOD SQUARED along the Y-AXIS. Is it a linear relationship, *i.e.*, does it make a straight line? Again, you might want to consider making the graph using technology.



4. According to what was stated in question 3 above, the slope of the graph of PERIOD^2 vs LENGTH should equal $4\pi^2/g$. Find the slope of the line using your graph above and set it equal to $4\pi^2/g$. Now solve for g. Is your value close to 9.81 m/s^2? If you wish, you could find the equation of the least-squares regression line using technology and use the slope here.

________ $= 4\pi^2/g$

(slope)

Name:____________________________________

5. Remember question #1 when you tried to estimate the length of a pendulum that would give a period of exactly 1 second? Use the equation for the period of a pendulum to find out EXACTLY how long it would have to be. Compare it to your estimate in question #1. Were you close?

The equation is:

$$T = 2\pi\sqrt{L/g}$$