LAB 9: The Simple Pendulum*

Equipment List:

a long string (2 m)
a mass to act as the bob of the pendulum
stop watch timer
a two meter stick
one long rod and one short rod and one right-angle clamp

Purpose: To investigate relation between the length of a simple pendulum and the period of its swing and learn about simple harmonic motion.

Theory: The equation for the period of a simple pendulum is

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

where T is the period for one oscillation, L is the length of the pendulum arm, and g is the gravitational acceleration. Rearranging this expression we can see that there is a direct proportionality between T^2 and $4\pi^2 L$ with a constant of proportionality g:

$$4\pi^2 L = gT^2 \,.$$

Procedure:

1. Construct the apparatus as shown in Figure 1.

2. Choose a mass of at least twenty grams for the bob and use that same mass for the different pendulum lengths. Tie the string to it. The string should be long enough so that the first pendulum length that you use is 1.5 meters long. Measure the length of the pendulum string with the two meter stick from the pivot point to the center of mass of your bob.

3. Set the pendulum swinging by pulling the mass back through a small angle (less than $\sim 20°$) and release the mass. One person should hold the stopwatch and begin timing when the mass passes through the lowest point in the swing. You will see it pass the vertical support when this happens. Another person counts out ten full oscillations. On the tenth one, when the bob swings back through the position where the string is vertical, stop the stopwatch. The time on the stopwatch should be the total time for 10 periods. Record the time on the stopwatch and the period in the table in your lab book. Repeat this three times and calculate the average time.

*Based on the labs by Prof. Newton and Prof. Luna.

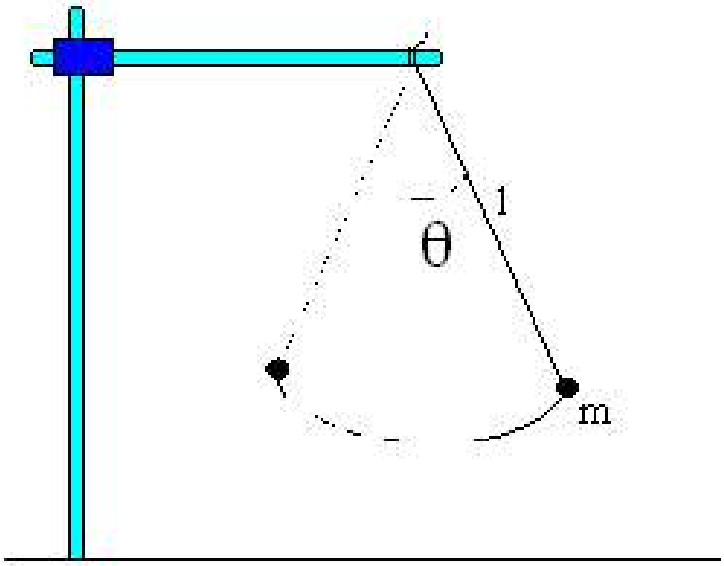

Figure 1: The rods arranged to support the pendulum.

4. To calculate the actual period of oscillation, divide the average time for ten oscillations by ten.

5. Repeat the above steps for for the six different lengths: 50, 70, 90, 110, 130 cm. (If your lengths are not exactly these, that is fine, but record the lengths you use as accurately as you can measure them.) To make it easy to change different string lengths, you need only wrap the string around the upper pole a few times, which will save you from tying and untying a knot on the pole.

6. Using a spreadsheet enter the data and plot a graph of T^2 on the horizontal axis vs. $4\pi^2 L$ on the vertical axis and obtain the equation of the best-fit line.

7. Compare the slope of the line to g.