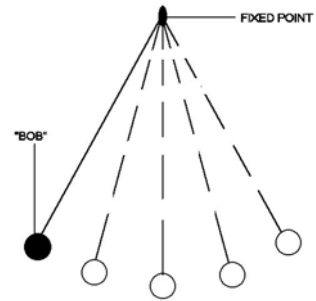# Pendulums

Theory:

A swinging pendulum keeps a very regular beat. It is so regular, in fact, that for many years the pendulum was the heart of clocks used in astronomical measurements at the Greenwich Observatory.

There are at least three things you could change about a pendulum that might affect the *period* (the time for one complete cycle):

- the amplitude of the pendulum swing
- the length of the pendulum, measured from the center of the pendulum bob to the point of support
- the mass of the pendulum bob

To investigate the pendulum, you need to do a *controlled* experiment; that is, you need to make measurements, changing only one variable at a time. Conducting controlled experiments is a basic principle of scientific investigation.

Procedure:

1. First, you need to set up your pendulum. Hang a string from the crossbar in the table, and tie a weight to the end.

    NOTE: You can use a stopwatch or a photogate to measure the following time.
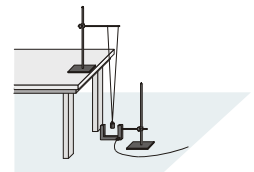
2. You will do 9 total trials. In each trial, you will set the pendulum in motion at less than 10 degrees amplitude and time how long it takes to make **ten** periods (remember, *one period is one **back and forth** motion – it is the time it takes to get back to its original point).* You will then divide the time by 10 to get the time of one period. Record these numbers in the table on the back.

3. For the first three trials, you will use the same mass and a length, but measure **3 different angles** between 3° and 15°.

4. For the next three trials you will keep the length from trials 1-3 and use the largest angle from trials 1-3. This time use **3 different masses**.

5. For last three trials use the same mass as in trials 1-3 and use the largest angle from trials one through 3. What is different about this set is that you need to change the length of the string to **3 different lengths**.

6. Record all measurements in MKS units.

7. Compute the period of your pendulum using your measurements and then compare your answer to the actual answer you got from the stopwatch. Do a percent error between the two periods.

8. Calculate the Average Deviation from the Mean (a.d.) and the Average Deviation of the mean (A.D.) for the first three and the second three sets of data.

9. Answer the questions below when complete

Name:_____   Date:_____

Neatly show any work and have units for every number on an attached separate sheet of paper.

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9
Angle=									
Mass of Bob =									
L =									
t (10 periods)=									
t (1 period) =									
THEORETICAL $T = 2\pi\sqrt{\dfrac{l}{g}}$									
EXPERIMENTAL T (stopwatch)=									
% Error Between Periods									
Average Deviation from the mean									
Average Deviation of the mean									

Name:_____   Date:_____

Prelab:

1. Make a pendulum by tying a 1-m string to a mass. Hold the string in your hand and let the mass swing. Observing only with your eyes, does the period depend on the length of the string? Does the period depend on the amplitude of the swing?

2. Try a different mass on your string. Does the period seem to depend on the mass?

Questions:

Q1. Comment on your percent error. What range did you have? Where did the error come from?

Q2. How does the initial angle affect the period of a pendulum?

Q3. How does mass affect the period of a pendulum?

Q4. How does the length of the string affect the period of a pendulum?