Period of an Oscillating Object

I. Background (refer to your textbook!)

Simple harmonic motion occurs when the net force acting on an object is proportional to the displacement and is in the opposite direction, $F_{net} = -kx$. In that case the position as a function of time is oscillating and given by $x(t) = A\sin(\omega t + \delta)$, where

$$\omega = 2\pi f = \sqrt{\frac{k}{m}} \quad \text{and} \quad T = \frac{1}{f} = 2\pi\sqrt{\frac{m}{k}} \quad .$$

Since the force on a mass on a spring is $F = -kx$, the constant k above is just the spring constant.

II. General Experimental Information (procedures starts in the next section):

For this lab you will investigate a mass-spring system. You will be able to use the Science Workshop interfaced with a photogate to measure the period of oscillation. The mass on the end of the spring will pass through the photogate and the time for one full cycle is measured. (This is the time between every other blockage of the beam.)

A. Once the photogate probe is connected and displaying information in a table, just click on MON and the table shows the period as it is measured. You can then record the period in an excel spread sheet.

1. Open Science Workshop (remember to make sure the interface box has been turned on).

2. Drag a digital probe to the image of the interface box. From the list of possible probes select photogate—pendulum. Drag a table over to the photogate icon it will give you the option to display, among other things, the period of oscillation have it do so.

3. Position the photogate so that the mass will pass through the gate as it oscillates. **SPECIAL NOTE**: Have the photogate offset from the center of the mass slightly. If not, the gate may stay blocked by the weight hanger stem after the mass passes through the beam.

4. Click on the MON button.

5. Start the oscillation. Make sure you are getting a reading in the table. If you are not, readjust the photogate.

6. When you are satisfied with the measurement for the current value of mass or amplitude click STOP and record the period in your spreadsheet.

7. Adjust your system to the next value (mass, length) and repeat steps 3-6.

III. Procedures for Period of a Mass-Spring System

A. Measure the spring constant of your spring.

Note that starting from a point of equilibrium, the spring constant is the additional force necessary to stretch the spring an additional distance from the equilibrium divided by that distance. While a single measurement is enough to get a ball park figure for the spring constant you should take measurements for a number of mass positions and fit the resulting Force vs. Position graph with an appropriate curve to

find the spring constant.

B. Variation with Amplitude

With your spring and an appropriate mass (enough so that the coils are separated throughout the oscillation) determine whether the period depends on the amplitude of oscillation.

C. Variation with Mass

1. Vary the hanging mass. Use at least five different masses where the largest is at least 5 times the smallest and measure the period for each.

2. Analysis: You should do this with a spreadsheet. You can print one copy of tables and graphs for your group.

   a. Calculate the theoretical value for the period (based on the mechanical properties) and compare to the measured values.

   b. Graph your data in a way that it is immediately obvious weather the theoretical and experimental results are consistent. If you are uncertain how to do this be sure to ask.

   c. Fit the theoretical curve to the graph and determine the fit parameters. How do they compare to that predicted by theory? How do you explain any discrepancies between your measurements and theory in your comparisons above?