# VIBRATORY MOTION

(L-17)

This is a relatively simple lab designed to allow you to play with the idea of vibrational motion. To do this lab, you will need a spring, a stop watch, a ring stand and pendulum clamp.

## PROCEDURE--DATA

**Part A:** (relationship between spring's amplitude and period of motion)

**a.)** Make a data table that allows you to record the following data: displacement from equilibrium (the amplitude); time for ten oscillations; period.

**b.)** Pick a spring and hang it from a ring stand using a pendulum clamp. The stiffness of the springs we have available vary, so you need to determine what mass is required to make the spring elongate approximately .5 meters from it's un-stretched position. Once you find that mass, you will leave it on the spring for the rest of this section.

**c.)** With your mass attached and gently lower to its equilibrium position, lower the mass an additional .1 meters and release (in this case, the .1 meters will be the amplitude of the oscillation). With the release, it will oscillate up and down. Use a stopwatch to determine the period of its motion. (Note: The easiest way to do this is to get the bob oscillating, measure and record the amount of time it takes the bob to oscillate through, say, ten full cycles, then divide that number by ten to get the period—this will be the time required to make one oscillation.)

**d.)** Repeat *Part c* for an initial displacement of .15 meters, .2 meters, .25 meters, .3 meters and .35 meters (assuming your spring can accommodate that kind of displacement). Put all your data in your data table.

**e.)** Record the mass you used in this part.

**Part B:** (determine spring constant)

**f.)** Make a data table that will allow you to record the following data: the amount of mass placed on the spring; the force that mass exerts on the spring (this will just be "mg"); the distance the spring elongates from its un-stretched position (call this *d*) due to the presence of that mass.

**g.)** With the spring in its un-stretched position, hang enough mass on the spring to make it elongate some measureable amount. Measure that displacement (call this distance *d*). Record the mass and the associated displacement on the data table from *Part f*.

**h.)** Repeat *Part g* for six additional, every increasing masses.

**<u>Part C</u>:** (how does mass affect period of oscillation)

**i.)** Make a data table that will allow you to record the following data: the amount of mass placed on the spring; the time for ten oscillations; the period of the oscillation.

**j.)** Place a mass on the spring. Once there, displace it so that it begins to oscillate. Using the *ten oscillations* approach, determine it's period. Put the mass and period into your data table.

**k.)** Add more mass and repeat this process for four more masses.

# <u>GENERAL GRAPHING INFORMATION</u>

General note: You are going to be drawing three graphs in this lab, one for each set of data you took in the three sections. Up until now, you haven't had to do this kind of thing as the computer has done that kind of work for you. That is why I'm giving you this bit of information, now.

YOU WILL LOSE POINTS, LOTS OF THEM, IF YOU DON'T INCLUDE ALL OF THE POINTS LISTED BELOW!

--All *graphs* should be <u>drawn with a straight edge</u> (not with a wavy line that you free-handed).

--All *graph grids* must be between half and three-quarters of a page in size.

--All *graphs* must be <u>scaled appropriately</u> (that is, assuming the data doesn't suggest a constant function, the graph should pretty well fill the grid).

--All *graphs* must have a title. (If you blurb the section, the blurb can count as a title).

--Do NOT assume that *zero* should be a part of your line.

--Each *axis* must be labeled. (Example for the first graph you do—the horizontal axis labeled as "displacement from un-stretched length" and the vertical axis the *period*).

--Each *axis* must have units. (Example for the first graph you do—the "displacement from un-stretched length" axis has the units of *meters* and the *period* axis has the units of *second/cycle*).

--Each *graph* must have a "best fit" line drawn "connecting" the data point.

--NO graph should have ordered pair coordinates attached to the data points that went into creating the graph.

If you are confused, come talk to me.

# CALCULATIONS

**Part A:** (relationship between spring's amplitude and period of motion)

**1.)** Using the data you took in *Part A*, draw a graph of the *period of oscillation* versus *amplitude of oscillation* (i.e., the initial displacement from equilibrium).

**2.)** Look at your resulting graph. From the graph, one of the following three statements should be, to a good approximation, true. Pick which one you think is true and print out its associated letter (a, b or c) here.

Your choices are:

a.) The period of the oscillation will become obviously greater as the amplitude of motion increases.
b.) The period of the oscillation will stay pretty much the same as the amplitude of motion increases.
c.) The period of the oscillation will become obviously lessened as the amplitude of motion increases.

**Part B:** (determine spring constant)

**3.)** Using the data you took in *Part B*, draw a graph of the *applied force* versus *stretch d*. (Note: this should be a linear graph—if it didn't come out that way, you goofed!)

**4.)** Pick a point in the-midsection of your graph to determine the spring constant for the spring. (Note that this isn't a slope—think about what the relationship is really saying, and if you are having trouble making sense of this, come talk to me.)

**Part C:** (how does mass affect period of oscillation)

**6.)** Using the data you took in *Part C*, draw a graph of the *oscillation period* versus *bob mass*. (Note: this should not be a linear graph—if it didn't come out that way, again, you goofed!)

**7.)** The period is supposed to be related to the bob's mass as $T = 2\pi\sqrt{m/k}$. Use the average spring constant you derived in *Part B* and a mass that is mid-graph, determine the right side of that equation and see if it matches up with the period predicted by the graph. Comment.