Physics 110 **Fall 2010**

Hooke's Law & Oscillations

Introduction:

In this experiment we will investigate motion under the influence of a variable force. In particular, we first investigate the force that a spring exerts as it stretches more and more. We then study the oscillating motion that a hanging mass experiences once it is suspended from the spring. According to Hooke's law the force that a spring exerts when it is stretched or compressed is directly proportional to the distance over which it is compressed/stretched. Although this "law" is often an idealization for most elastic media, it is conceptually very useful. This is because understanding this law allows for a simple approximation of most forces that change as a function of position. So, by examining the motion under the influence of a spring that follows Hooke's criteria we could get a broad understanding of most oscillating systems.

Apparatus:

The experimental arrangement that we use in this lab is very simple. It consists of a spring (conical brass), assortment of hanging masses, clamps, ruler, and a force sensor connected to our DataStudio setup.

Procedure:

Part I: Hooke's law (*a review*)

- Hang the spring vertically from a clamp. Attach different hanging masses to the free end of the spring and record both the value of the hanging mass and the distance that the spring stretches under the weight of the hanging mass. Repeat this for at least five different hanging masses. ***Please take care not to hang too heavy a mass to cause a permanent deformation of your spring.***

- Plot the weight of the hanging mass versus the length that the spring stretches and from these data determine the force constant of the spring. Estimate the uncertainty in your measured and calculated values. (Please refer to your text for further explanation of the theory.)

Part II: Oscillation

- Hang a suitable mass, say 50g, from the spring, pull down on it to stretch the spring, and then release the mass to make it oscillate. ***Do not pull the mass so that you have a large amplitude when released and try not to let the mass wildly oscillate.*** Determine the period of this oscillation from the plot of the force versus time using the DataStudio setup. (Your instructor will show you how to fit a sine curve to these data and to obtain from it the period of oscillation of the mass.) Estimate the uncertainty in this measurement.

- Repeat this for four different masses ranging from 100g to 500g.

- Find a way to plot the period versus mass data so that the resultant plot is linear. If your data are linear, determine the force constant of the spring. Compare this with the one you obtained in part I.

- Does the y-intercept of your graph pass through the origin? Should it? If you have a non-zero y-intercept, what then, does it tell you about the oscillating mass-spring system?

- Does any part of the mass of the spring contribute to the period? If so, derive an expression for the fraction of the spring's mass that affects the period? What fraction of the spring's mass affects the period?