PHY 122 LAB 4: Springs

Introduction

In this lab we will measure the static behavior (stretch vs. force) of simple springs, and practice linear fits.

Theory

An ideal spring is massless and linear. That is, it obeys Hooke's law:

$$F(X)=-k(X-X_0) \qquad \text{Eq. 1}$$

where F is the force exerted by the spring (it opposes the stretch) and $(X-X_0)$ is the stretch, measured from the resting position (zero force at X_0). In this lab, the force arises from calibrated weights hung vertically. Hence, we have F = mg. F is in Newtons for "m" in kg and $g = 9.80\ m/sec^2$. Real springs have mass and are non-linear. In this case, it is useful to define a local or differential spring constant in terms of the derivative

$$k_{loc}(X)= dF/dX. \qquad \text{Eq. 2}$$

Note that k_{loc} varies with stretch.

Procedure

Measure displacement vs applied force for each spring. Uncertainties in F will be small, let's all call this 1% for uniformity. Uncertainties in X are not as small. They are best determined by independent repeated trials. Thus, you should tabulate data as you first add weights up to the maximum, then as you remove the same weights. The stretch should match at identical values of "m". The scatter in these pairs of points will serve as error bars.

Analysis

Do all the following for each spring separately.

1. Are the errors in X more nearly proportional (to X) or constant?
2. Plot the data in GA and find the spring constant "k" from eq. 1.
3. Is the spring linear? (ie: is the model function a good fit to the data?)
4. According to your data, does the rubber band get stronger or weaker as the force is increased? (Hint: consider k_{loc}, in eq. 2).

Abstract:

Summarize all.

Pre-lab quiz, PHY122 Lab4.
Yourname________________________ Section day/time___________________

1. Do the Graphical Analysis tutorial in “Lab0-GraphAna.pdf” Note that the graphic in this file does not print well unless you use a postscript printer, such as at computing commons.
2. Hand in your hardcopy of the graph.
3. Question: Is this model function a good fit to the data? See handout Fits.pdf.