Spring-Mass Oscillator

Purpose: The student will demonstrate the skills they learned in PH 201 Laboratory by experimentally determining the spring constant of a coil spring using two methods. The student will then write up the experimental procedure, provide data and data analysis, compare the results of the two experiments, and write up a conclusion supported by the data.

Equipment and Materials: Laptop computer, spring-mass oscillator system, slotted masses, stopwatch, and meter stick.

Introduction: A spring-mass oscillator consist of a coil spring suspended vertically from a support beam or bench stand. A mass hanger is attached to the free end of the coil spring and slotted masses can be added or removed to change the total mass of the system. The restoring force in the spring is directly proportional to the amount the coil spring stretches. If the system is given a small displacement along the length of the coil, it will exhibit simple harmonic motion. The spring constant of the coil spring can be measured using two methods.

Experiment 1: The students' will determine the spring constant of the coil spring using the static force method. This requires analyzing the system using Newton's Laws and the restoring force of the coil spring, which follows Hooke's Law.

$$F_{spring} = -k\Delta x$$

Procedure 1: Perform a static force experiment using the following restrictions.

1) Starting with no less than 100 grams on the end of the coil spring.
2) Add no more than 600 grams to the end of the coil spring.
3) Take displacement measurements at equilibrium for each mass value.
4) Use steps of 50 grams.

Experiment 2: The students' will determine the spring constant of the coil spring and verify the power law relationship by analyzing the simple harmonic motion of the system. It can be shown for a spring-mass oscillator exhibiting simple harmonic motion that the oscillatory period of the system is proportional to the square root of the mass attached to the coil spring.

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Procedure 2: Perform a simple harmonic oscillation experiment using the following restrictions.

1) Starting with no less than 100 grams on the end of the coil spring.
2) Add no more than 600 grams to the end of the coil spring.
3) Take time data for **10** complete oscillations and compute the period of the system.
4) Use steps of 50 grams.

Analysis: Perform the following analysis.

1) Generate appropriately labeled and formatted data tables for both experiments. There should be one for ***each*** experiment.
2) For experiment 1, analyze the data using a linear plot and using the best fit to determine the spring constant of the coil spring.
3) For experiment 2, use linearization by logarithms to extract a value for the spring constant for the coil spring ***and*** to verify the power law relationship of the spring-mass oscillator.
4) Compare the two results using a percent difference calculation.

Write up: Instead of a post-lab or pre-lab exercises, you are to prepare a lab report on this experiment. You are to prepare a document in Word and print it out and bring it your next lab. Your write up should have the following sections:

1. Introduction – this should describe what you did generally (you will do a procedure later, so do not write that here), why you did it, what basic physics was used to analyze the data, etc. Be as specific as possible about what your experiment was for. Hint: "because they made me do it" is unlikely to be a good reason for your experiment.

2. Methodology/Data Collection – this should describe how you did the experiment (i.e. a brief procedure. Avoid trying to write a step by step procedure. Describe what data your collected, why you collected that data instead of other data.

3. Data and Analysis – this is where you would put data and plots you created. Show any sample calculations if necessary.

4. Discussion/Conclusions – provide a clear concise statement about what you found and provide any comments to describe the quality of the results.