Formal Lab Experiment 2

Hooke's Law Experiment
Simple Harmonic Motion

Introduction:

No object is perfectly rigid. In other words, all objects tend to distort in response to forces applied to them. An object is said to be elastic if it returns to its original shape once the force being applied to it is removed. Nor does the object immediately return to its original shape. It tends to move back and forth "past" its original shape with a restorative force until it dissipates all of the energy that was added to the system. This motion is called "Simple Harmonic Motion" and can easily be demonstrated with the use of a spring.

Materials:

Weight set
Timer
Spring
Stand with length scale

Procedure:

This is a two-part experiment

Part 1: (ten minutes) Determining the spring constant *k* for this spring

NOTE: BE VERY CAREFUL NOT TO OVERSTRECH THE SPRINGS

1.) Carefully mass the holder on the end of the apparatus. Record this information. It may be useful to make a chart that includes the following information.
Trial number (total of six), Mass in grams, Mass in kilograms, Force in Newtons (F = mg), Displacement in centimeters, Displacement in meters

2.) First Zero the Apparatus. Then replace the holder and at eye-level note the displacement of the system with this mass.

3.) Carefully add 20 grams, 40 grams, 60 grams, 80 grams and 100 grams to the apparatus. Record the mass (including the holder) and the displacement each time.

4.) By Hooke's law, $F = -kx$. Therefore $k = F / -x$. Since x is in the negative y direction the value for *k* will be positive. From what we have learned about graphs the slope of a graph represents the y-axis divided by the x-axis or in this case, F / x. Therefore the slope of the graph of the force (x – axis) verses the displacement (y – axis) in meters is the spring constant *k*. Show this graph as well as the chart of data.

Part 2: (Fifteen minutes)

1.) Now create a new chart showing trial number, mass in grams, mass in kilograms, displacement in centimeters, displacement in meters, time for thirty oscillations, period.

2.) For this part you will use three different masses, not to exceed 100 grams (suggested masses are 40 g, 60g, 80 g plus the mass of the holder). Carefully set the system into motion by pulling the spring it down 5 centimeters and measure the time it task to go 30 oscillations. Repeat this three times for each of the three different masses. (A total of nine measurements)

Analysis:

Part 1:

Graph the force (y-axis) verses displacement (x-axis) and calculate your value for spring constant *k.*

What are the units of the spring constant? What does your k value tell you about your spring? Describe any other observations that you made during the experiment.

Part 2:

a) Calculate the ideal Period of the system for each of the three masses using your value from Part A for the spring constant and the following equation from the book, $T = 2\pi\sqrt{\frac{m}{k}}$

b) Calculate the speed of the mass by taking the displacement ½ T or more specifically .05 m divided by the answer you got just above.

c) Calculate the Potential Energy due to a spring for each of the three masses if the spring is extended to 5 cm and then released.

d) Calculate the potential and Kinetic energy of the system at 0 cm, 2 cm, and 5 cm from the equilibrium point

e) Calculate the speed of the system at 0 cm, 2 cm, and 5 cm from the equilibrium point.

   Again assume that the maximum amplitude is 5 cm by using the conservation of energy.

f) Compare your two speeds (parts b and e). Are they the same? If not, why not?

Created by Jeff Berndt 2001