Hooke's Law and the spring constant

OBJECTIVE:

1. To measure the spring constant, k, of a spiral spring from Hooke's Law.
2. To determine the mass of the spring.

APPARATUS:

Stand with a clamp, a set of slotted masses, ruler, geometry box.

THEORY:

Hooke's Law

A spring with a varying amounts of force applied is proportional to its displacement. This proportionality constant is called the spring constant, k, and the entire relation is referred to as Hooke's Law:

$$F = -kX. \tag{1}$$

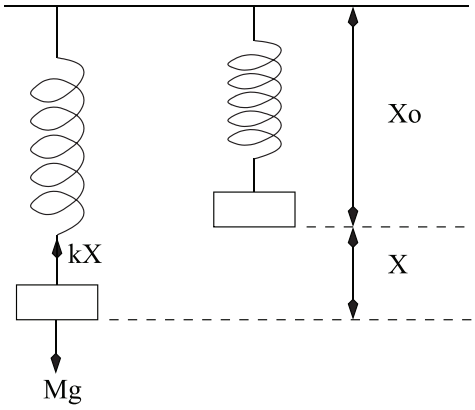

Figure 1: Hooke's Law Setup.

The minus sign is only used to describe the "restoring" force. This force opposes the applied force on the spring and tries to return the spring to equilibrium. In figure 1, X_o is the length of the spring with the mass holder hanging at rest at the equilibrium point. The displacement, X, is measured relative to the equilibrium point.

Hooke's Law becomes invalid only when the elastic limit of the spring is surpassed.

In this experiment, mass is added to the holder and the elongation (or stretch) is measured to determine the spring constant k. This value is obtained from the slope of the graph of Force Applied vs. Total Elongation.

PROCEDURE:

Hooke's Law

1. Hang the spring vertically from the clamp, and record the lowest point of the spring with meterstick. Let's call this position X_0 and record it in Table-1.
2. Add masses, one at a time, beginning with 50 grams. Increment the mass by 20 grams and record the lowest point of the spring, X, in each case and write theses in the third column in Table-1.

3. Compute the total elongation of the spring, $L = |X - X_0|$ for each added mass. Record the data in the fourth column in Table 1.

4. Determine the Force Applied in Newtons for each mass added and record it in the second column in Table-1.

5. Plot the Force Applied (F) vs. Total Elongation (L), and determine the slope of of the line. Write this below Table-1.

6. Using the slope of the graph determine the value of the spring constant, k. Record this value under Table 1.

Lab Report

Name of the Experiment	:	Determination of **Spring Constant** and **Effective Mass** of a spring using Hooke's Law
Your Name	:	
Your ID #	:	
Name of the lab Partner	:	
Date	:	

Table 1. Static Determination of the Spring Constant, k

Position of the lowest point of the spring, $X_0 =$ _____ (m).

Mass Added to the spring (kg)	Force, F (N)	Spring position, X (lowest point) (m)	Elongation, $L = \|X - X_0\|$ (m)

Table 2. Spring mass determination (from graph)

Y intercept	
Effective mass of the spring, m (kg)	
Actual mass of the spring, M (kg)	
Ratio of the masses, m/M	

Calculation page:

Calculate spring constant, k:

Calculate Effective Mass, m:

QUESTIONS:

1. To what extent does your graph agree with Hooke's Law?

2. How does your calculated and measured values of the spring mass compare?

3. Did the graph pass through the origin? If not, interpret the meaning of the y-intercept.

4. From your understanding of the Hook's law and the graph you plotted, explain why the position of the equilibrium does not effect the graph.

5. What do you mean by *"Effective Mass"* [Hint: Search wiki]

Guideline for plotting graph

0. Use pencil to plot graph.
1. Name it at the botton of the graph. (e.g.: *Y vs X graph*)
2. Label the dimension with proper unit of each axis. (e.g.: Mass(kg), Time Period (sec)).
3. Use full graph paper with maximum area to plot the graph
4. Choose origin properly.
5. Scale the axes before plotting the points.
6. Do not use data points to calculate slope. Use any arbitrary two points.
7. Mark/highlight the data point and slope point with different symbol.
8. If necessary, indicate the Y intersection point clearly.
9. Show the calculation of slope at one isolated corner of your graph.
10. Use ruler to draw straight line
11. Learn to draw “Best-fit line”
12. Do not forget to write your name+id no. in the graph.

Prelab:

1. A force of 5 N to is required to compress an industrial spring by 0.0001 meters, how much force is required to compress this spring by 0.0003 meters?

2. You have a certain set-up of a vertical spring, and when hung freely the equilibrium position reading is 30 cm on earth. If you take the same set-up on the moon surface, would the equilibrium position be more than, less than or equal to 30 cm? Explain.