Formal Lab
Hooke's Law

Physics 4A

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Chapter 1

Purpose

To verify Hooke's law and calculate the spring constant.

Chapter 2

Theory

The force due to a spring stretched (or compressed) a distance Δx from the equilibrium position is given by the following expression:

$$\vec{F_s} = -k\Delta\vec{x}$$

where s = (force exerted by) spring
k = the spring constant (in N/m)

Chapter 3

Procedure

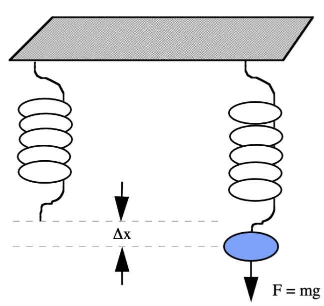
3.1 Procedure Equipment

The necessary equipment for this lab is as follow:

- Meter Stick
- Spring
- Weights
- Clamp
- Rods
- Suspension Clamp

3.2 Position Measurements

- The equipment is to be set up as shown below:



- Hang a weight from the end of the spring. For the lng spring use weights ranging from 0.5 kg to 2 kg and for the short spring use weights ranging from 2 kg to 4 kg. Make sure you do not select too heavy of a weight or the spring will permanently stretch.
- Measure the distance (Δx) the spring is stretched from its equilibrium position ($x = 0$).
- Repeat the above measurement for at least 7 more weights.

Chapter 4

Data

Data Collected					
Configuration of Mass	Mass in kg	Uncertainty $+-m$ based on meter stick	x_i in meters	x_f in meters	Uncertainty $+-m$ based on scale
#1	1.036	0.0005	0.782	0.784	0.0005
#2	2.033	0.0005	0.782	0.803	0.0005
#3	4.033	0.0005	0.782	0.876	0.0005
#4	6.032	0.0005	0.782	0.951	0.0005
#5	1.528	0.0005	0.782	0.786	0.0005
#6	3.527	0.0005	0.782	0.860	0.0005
#7	5.526	0.0005	0.782	0.933	0.0005
#8	2.530	0.0005	0.782	0.822	0.0005

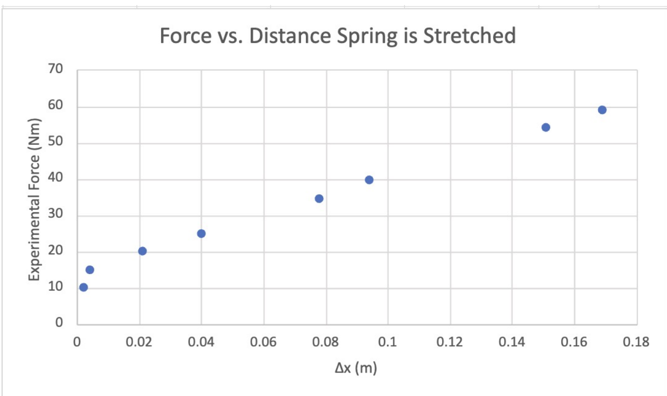
Chapter 5

Analysis

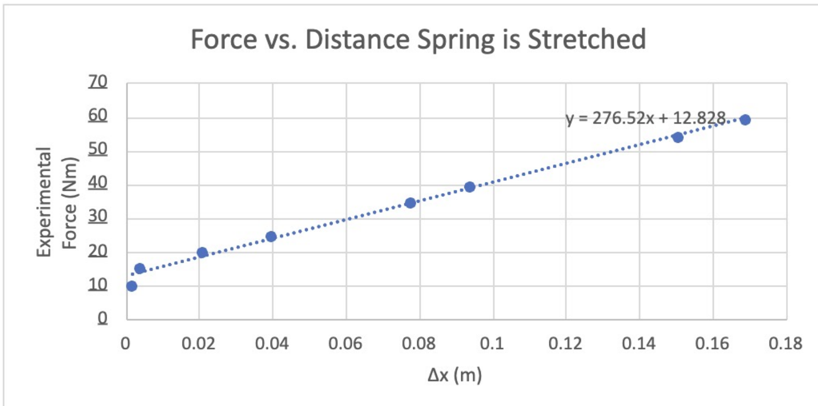
1. For each weight, calculate the force ($F = mg, g = 9.8\frac{m}{s^2}$) exerted on the spring by the Earth's gravitational force.

Force Calculated for each Configuration of Mass &Δx		
Configuration of Mass	Experimental F in Nm	Δx in meters
#1	10.153	0.002
#2	19.923	0.021
#3	39.523	0.094
#4	59.114	0.169
#5	14.974	0.004
#6	34.565	0.078
#7	54.155	0.151
#8	24.794	0.040

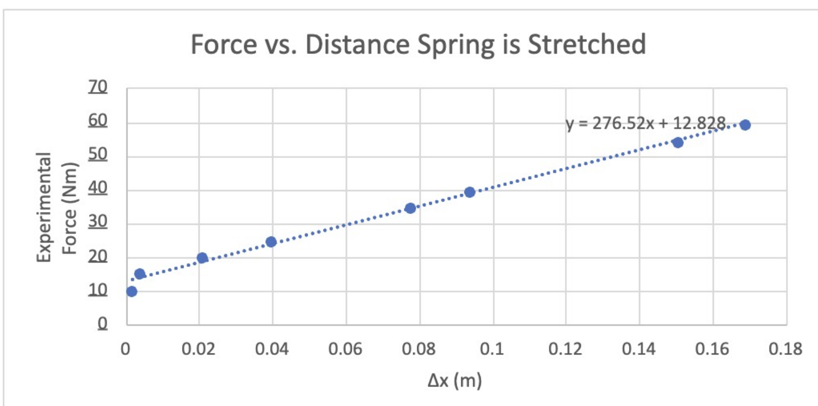
2. Plot the force F versus the distance the spring is stretched (Δx). Based on Hooke's law your graph should follow a straight line.



3. Draw a best-fit line between the points and calculate the slope of the line. The slope of the line will correspond to the spring constant k.



4. Draw a best-fit line between the points and calculate the slope of the line. The slope of the line will correspond to the spring constant k.



Using this graph, the spring constant $k = 276.52m$

5. Compare your experimental value(s) of k with the actual value(s) of k for your spring. (Long Spring k = 23 N/m & Short Spring k = 98 N/m)

The actual constant value of the spring is $278m$.
The experimental value of the spring is $276.52m$.
The difference between the two values is $1.48m$.

6. Do your results agree with Hooke's law (i.e. is F directly proportional to x)?

> The results obtained from the experiment were not exact, but are close enough to to agree with Hooke's law.

Chapter 6

Error Analysis and Procedural Errors

6.1 Front-End Error - RSS

For RSS, the greatest contributors are used. The greatest contributors are the lowest weighing mass configuration in kg, and the initial position of the spring in m.

$$RSS = \sqrt{\left(\frac{0.0005m}{0.782m}\right)^2 + \left(\frac{0.0005kg}{0.1036kg}\right)^2} \times 100\% = 0.08\% \ (0.080\%)$$

6.2 Back-end Error

Percent difference was employed on this experiment because the experiemtnal value was being compared with a known actual value. The goal of the experiment was to compare (or get the difference) between the two values. In general the experiemtnal spring constant k was very close to the acutal spring constant value

$$\%\text{difference} = \frac{|E_1 - E_2|}{\frac{E_1+E_2}{2}} \times 100\% = \frac{|276.52 - 278|}{\frac{276.52+278}{2}} \times 100\% = 0.53\% \ (0.534\%)$$

Chapter 7

Conclusion

Chapter 8

Suggestions for Improvement