UFP Physics: Practical Lab 1 Academic Year 2022-23

Table of Contents

1. Introduction and aim

"In this experiment, the spring constants of two different springs as well as spring constants of springs in parallel and series configurations were examined." (Lab manual., n.d.).

"When the stress-strain relationship was investigated in the 19th century when studying springs and elasticity, English scientist Robert Hooke found that many materials had a similar property. An empirical physical law known as Hooke's law describes the linear relationship between a spring's restoring force and the spring's deviation from its equilibrium length. A spring is referred to as a Hookean spring if it abides by Hooke's law. In addition to springs, Hooke's rule is frequently used as a useful model for different physical systems that tend to swiftly recover to equilibrium after interruption" (Walker, 2017).

"Up to its elastic limit, a material's strain is inversely proportional to its applied stress, according to Hooke's law" (Cox, 2014).

Atoms and molecules temporarily deform due to the applied stress before reverting to their original states when elastic materials are stretched.

Mathematically,

$$F = -kx \quad (1)$$

Here,

F = Spring force,

x = Extension in length of spring,

k = The constant of proportionality known as the spring constant.

Hooke's Law is used when a metal wire that has elasticity is stretched by an applied force because the amount of length that follows from the small increase in length doubles every time the force applied to the metal wire is doubled. A solid object can be deformed by stretching, compressing, squeezing, twisting, or bending it.

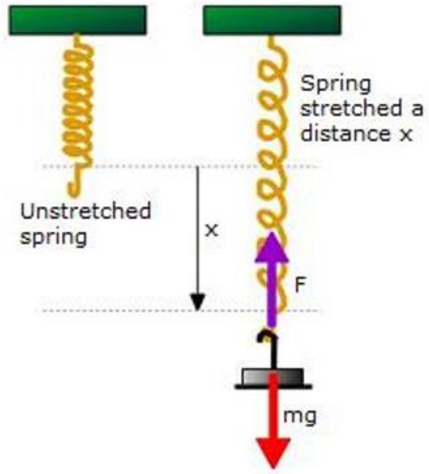


Figure 1:Spring (Lab manual., n.d.)

As shown in the figure 1, when the mass was attached to the spring, spring was stretched a distance x. The spring mass system was in the force equilibrium, Therefore

$$\sum The\ sum\ of\ the\ force\ down = 0$$

Or

$$(Spring\ force) - (Weight\ force) = 0$$

Or

$$Kx - mg = 0$$

Or

$$kx = mg \quad (2)$$

2. Apparatus and diagram

Two springs	Two Rulers (1m and 30 cm)
One Clamp stand	Four Boss
Five different slotted masses	Four clamps

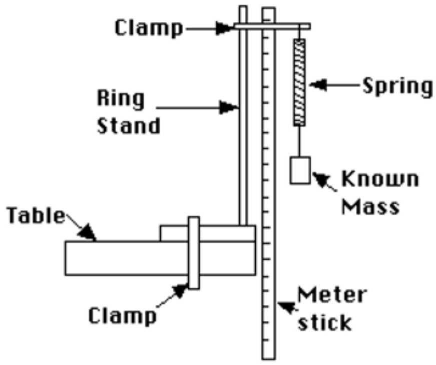


Figure 2: Experimental setup (Lab manual., n.d.)

Th rulers were used to measure the extension. It is easy tot measure the extension with the rulers. To get the accurate and precise result, Weight must be loaded and unloaded cautiously. When the pointer's tip has had time to settle, reading should be noted. The scale's surface shouldn't come into contact with the pointer's tip. The elastic limit shouldn't be exceeded during loading.

3. Variables

An independent variable could be directly under the control of an observer or experimenter. The dependent variable depends on the independent variable, as suggested by its name. The dependent variable is frequently the quantity you want to measure or the result of the experiment or test.

One that the scientist keeps constant (controls) during an experiment is referred to be a controlled variable.

Independent variable: - *Force (F)* (The variable that is changed throughout an experiment).

Dependent variable: - *Extension of the spring (x)* (The variable being examined or assessed in an experiment).

Controlled Variable: - *Cross-Sectional Area of the spring and material of the spring* (These two variables were kept constant during this experiment).

4. Method

1. Arranged the boss, clamp, and stand and checked that the stand was stable and unlikely to topple.

2. Hanged the spring from the clamp while precisely measuring its length while it wasn't unstretched.

3. Measured the spring's new length, calculated its extension, and then record the information in results table after attaching the mass hanger to the end of the spring.

4. Increased the mass hanger's weight until it reached the highest mass that the spring was capable of supporting.

5. After the masses were taken out, determined the spring's final length and recorded it.

6. Repeated the preceding steps to find the spring constant for two identical springs connected in series.

7. Applied the same procedures for two parallel springs to obtain the spring constant for two series springs that were identical to one another.

5. Safety

1. To avoid any mishaps caused by the weights bouncing off the spring, put on safety eyewear.
2. Maintain a clear distance from the equipment.
3. Verify that the clamp is securely attached to the spring.
4. Never mess with the masses or the springs.
5. To avoid the trap of clothing with experimental setup or apparatus, refrain from wearing loose clothing and accessories during the experiment.

6. Result Table

Table 1: Data for spring 1

Mass attached to Spring / Kg- independent Variable	**Length of Spring /m Dependent Variable**	**Extension /m**	**Force /N**
0.1	0.105	0.060	0.981
0.2	0.125	0.080	1.962
0.3	0.145	0.100	2.943
0.4	0.160	0.115	3.924
0.5	0.180	0.135	4.905

Table 2: Data for spring 2

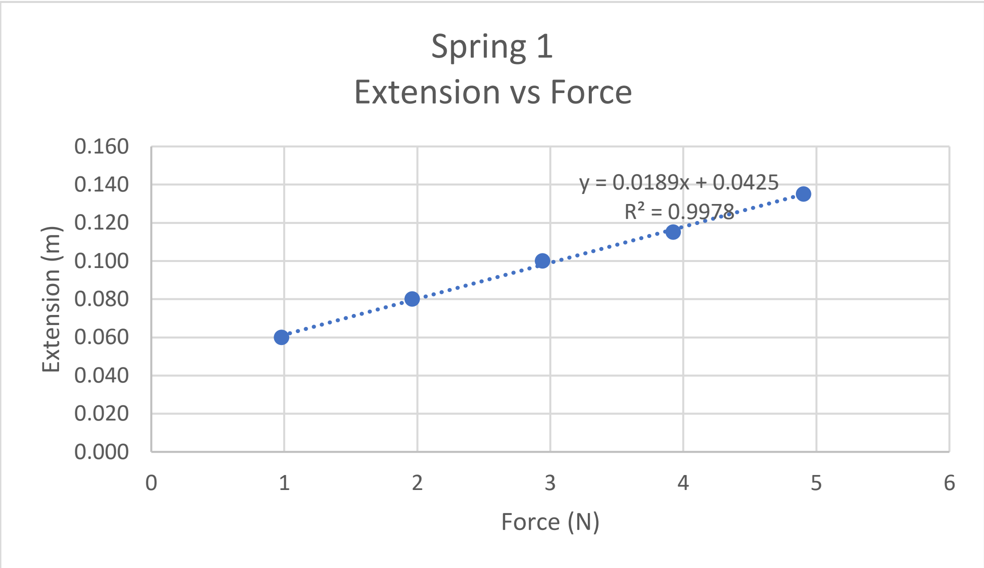
Mass attached to Spring / Kg- independent Variable	**Length of Spring /m Dependent Variable**	**Extension /m**	**Force /N**
0.1	0.100	0.055	0.981
0.2	0.126	0.081	1.962

0.3	0.143	0.098	2.943
0.4	0.162	0.117	3.924
0.5	0.182	0.137	4.905

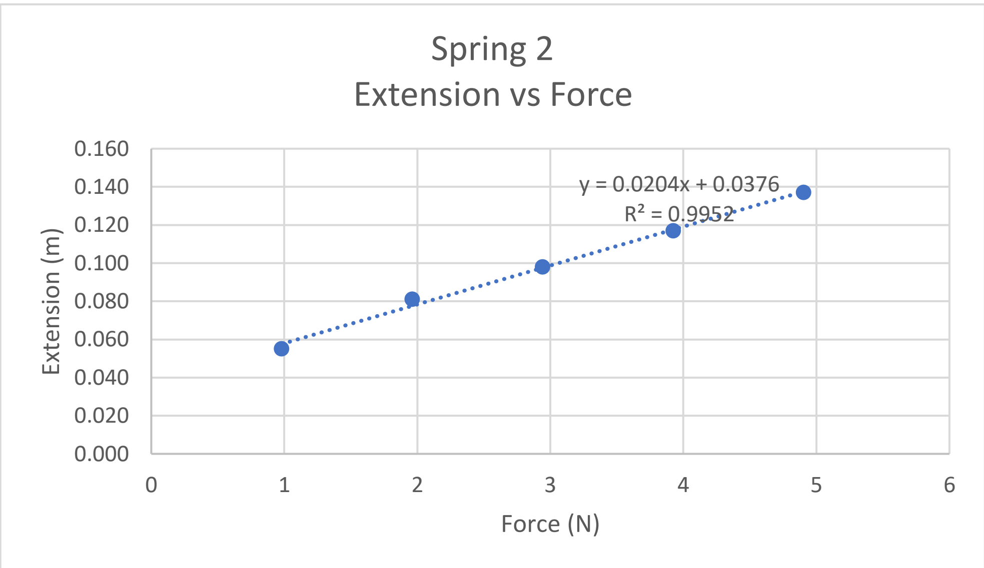
Sample calculation:

$$Force = mg \ = 0.1 * 9.81 = 0.981\ N$$

7. Result Graph



Graph 1: Extension vs Force for spring 1



Graph 2:Extension vs Force for spring 2

8. Gradient calculation

Spring 1

From the graph 1,

$$The\ gradient\ of\ the\ graph\ 1 = \frac{Extension\ x}{Force\ F} = \ 0.0189\ \frac{m}{N}$$

From the equation 1,

$$\frac{1}{K_1} = 0.0189$$

Or

$$K_1 = \frac{1}{0.0189}$$

Or

$$\boldsymbol{K_1 = \ 52.910\frac{N}{m}}$$

Spring 2

From the graph 2,

$$The\ gradient\ of\ the\ graph\ 2\ \frac{Extension\ x}{Force\ F} = \ 0.0204\ \frac{m}{N}$$

From the equation 1,

$$\frac{1}{K_2} = 0.0204$$

Or

$$K_2 = \frac{1}{0.0204}$$

Or

$$\boldsymbol{K_2 = 49.019\frac{N}{m}}$$

Table 3: Result

Spring constant	**Experimental (N/m)**
Spring 1	52.910
Spring 2	49.019

9. Critical analysis of results – Conclusion

This experiment was designed to investigate the spring constants of two separate springs as well as springs arranged in parallel and series. The data for the extension of the spring was increasing with the increase of the attached weight. Graphs between the extension and force were plotted for spring 1, spring 2. Thes graphs were showing the linear trends which was theoretically (Hook's law) also true. It proved that the extension of the spring is proportional to the spring force. The experimental values of spring constant were 52.910 $\frac{\mathrm{N}}{\mathrm{m}}$, 49.019 $\frac{\mathrm{N}}{\mathrm{m}}$,for spring 1, spring 2, respectively.

10. Evaluation of scientific investigation

To avoid any mistakes brought on by reading the ruler from a different angle than eye level, attach a fiduciary marker to the coil spring's bottom. When measuring the length of the spring, make sure it is not in motion. To improve the accuracy of the result, Vernier callipers must be used in place of the ruler. The main sources of error can be the wind effect on the spring or error during the measurement of the extension of the spring. The wind effects the stability of the spring which makes difficult to measure the extension of spring. The wrong measurement of the extension gives the wrong value of spring constant. The largest error in this experiment was reading the extension of the spring. The metre rule scale should be visible straight across from the pointer at eye level.

11. Referencing

Aristotle and Reeve, C.D.C. (2018). *Physics*. Indianapolis: Hackett Publishing Company, Inc.

Cox, J. (2014). *Mechanics*. Cambridge: Cambridge University Press.

Lab manual. (n.d.).

Walker, J.S. (2017). *Physics*. Boston: Pearson.