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TITLE: An evaluation of Hooke's Constant K degradation from sling usage

Summary

Hooke's law does an accurate job of assessing spring behavior for small weights and when the position of motion has not stretched the spring immensely. However, springs do stretch, so the equation fspring = -k * x will not hold true for bungee cords or other big forces. This equation can still be used if k can be more accurately modeled. To observe how strong forces impact k, weights were hung from different initial heights. K values were then found graphically on weight(y-value) vs displacement (x-value) graphs. Finally, equilibrium length was plotted against k-values to observe a best-fit model.

K-values found decreased because of increased equilibrium length. Natural tare of the string was observed as some values for displacement were greater after testing than before. Although, this type of analysis should be observed further in a different experiment. As equilibrium position increased, k values observed were 6.3878, 3.244, 2.4256, and 1.5276. This implies that at bigger equilibrium positions, the spring force exerts lower magnitude values. Uncertainty was observed as linear regressions did not include every data point. In fact, different regressions may fit all the displacement and weight graphs better than linear ones. Linear models represent an average K. The graph of these k-values to equilibrium positions was best fit with a power equation, supplying a way of computing k. Further experiments should test the validity of the found equation y= 1.7786x^-0.892 for different equilibrium positions and strings.

Diagram

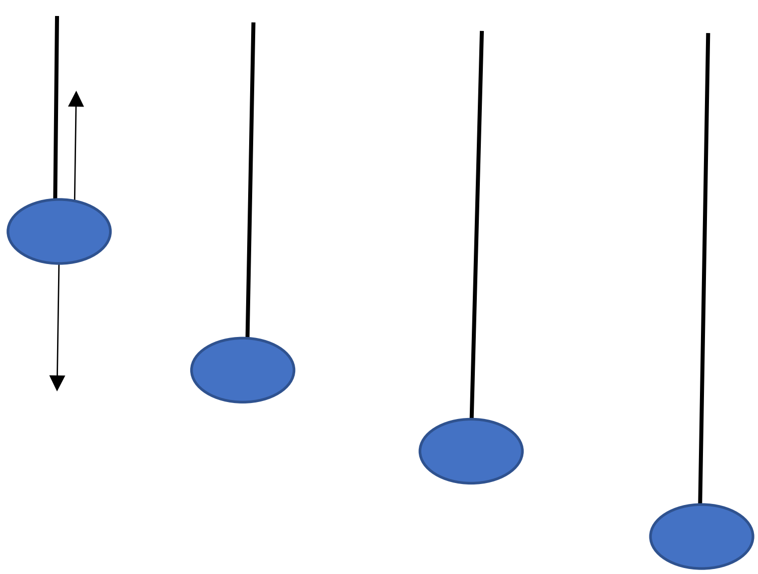
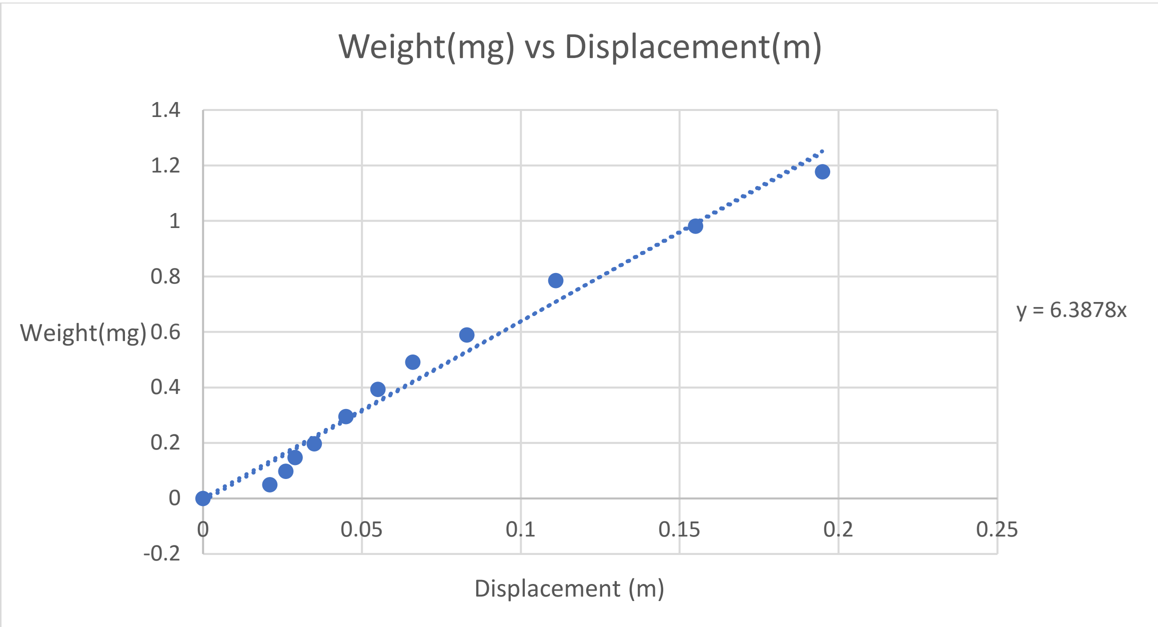


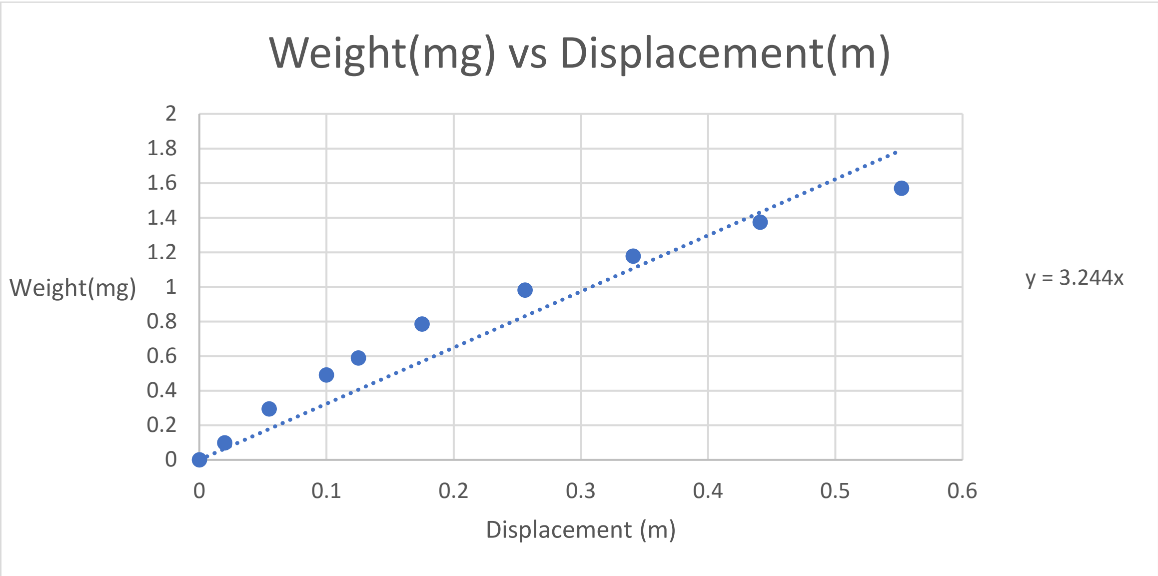
Diagram 1: Equilibrium position of weight. The top arrow represents vector $\vec{F}$s. The bottom arrow represents vector m$\vec{g}$. At equilibrium these vectors counteract eachother. However, increasing weight may make the weight vector greater than the force of the spring. The four lines

represent the four equilbrium positions explored. Measurements were made by measuring distance of the hanging weight from the hang point. Displacement was found by subtracting this value from the equilibrium position.

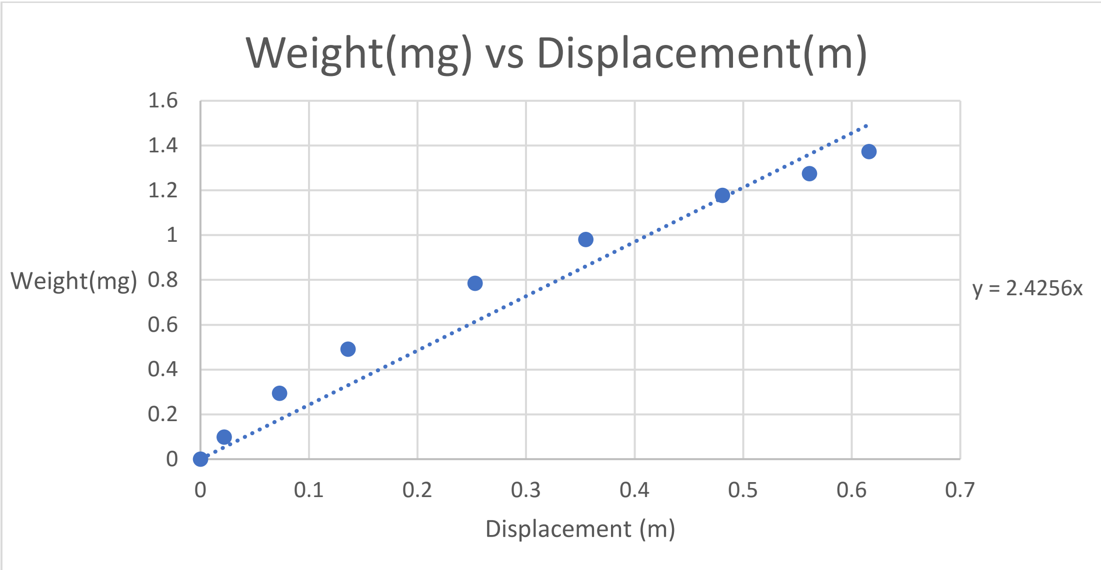
Quanitative Data and Analysis



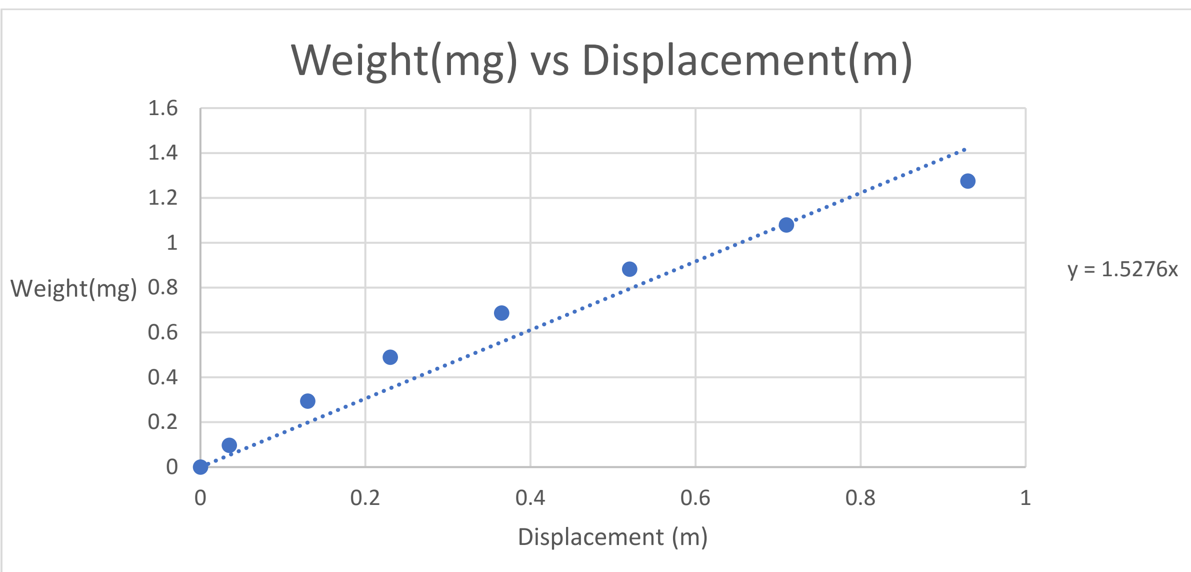
Graph 1: Weight vs Displacement graph for equilibrium position 0.245 m. Displacement values represent stretching by the string past the equilibrium point. The slope of this graph gives the k value, which equals 6.3878. Although a linear model made this slope analysis possible, another best fit line may represent the data better.



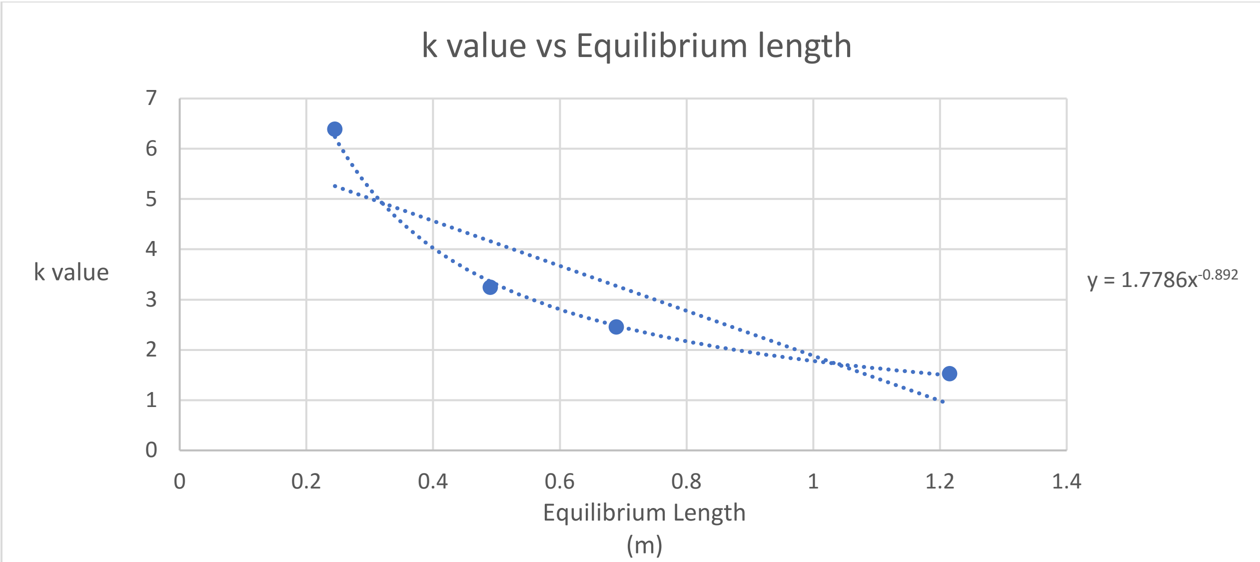
Graph 2: Weight vs Displacement graph for equilibrium position 0.49 m. Displacement values represent stretching by the string past the equilibrium point. The slope of this graph gives the k value, which equals 3.244.



Graph 3: Weight vs Displacement graph for equilibrium position 0.689 m. Displacement values represent stretching by the string past the equilibrium point. The slope of this graph gives the k value, which equals 2.4256.



Graph 4: Weight vs Displacement graph for equilibrium position 1.22 m. Displacement values represent stretching by the string past the equilibrium point. The slope of this graph gives the k value, which equals 1.5276.



Graph 5: The change of k-values depending on equilibrium length. K-values were found using slopes from linear models. A comparison of these constants to equilibrium length shows an equation to calculate k. Neglecting degradation from trials, k-values seem to decrease in a power fashion.

The experimental value of interest is the equation $y = 1.7786x^{-0.892}$ which estimates k from an equilibrium position. This equation provides an approximate k for Hooke's Law. K values seem to change as spring force increases. The equation above explains how force of the spring interacts with k values. Uncertainty comes from the usage of average k values. Other scatterplot approximations do not include easy ways to compute k. Because graphs 1-4 seem to have data that does not visually seem linear, the k slope value can be interpreted as an average k value for the dataset. The nonlinear scatter came from spring degradation caused by the trials themselves. Accuracy of this equation should be tested by comparing string degradation data points from a different trail to numbers computed from this equation. The equation should be able to estimate k values from trials accurately.

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