Lab Report Outline—the Bones of the Story

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TITLE:

How does the length of the bungee cord effect the spring constant of the cord?

ABSTRACT: In this experiment my partner and I wanted to test how the length of the cord affected the spring constant of the cord in order to find the best length for the bungee cord to be for the final test. In order to do this, we used five different heights and measured how much the spring stretched at 5 masses. This allowed us to find a separate spring constant for each length and to compare them to their unstretched lengths. We graphed our data on Excel and linearized it. This graph showed us how the spring constant and the length of the cord are inversely related. It also gave us an equation that we can use to find the appropriate length for our bungee. In order to find this value, we must experimentally find the right spring constant based on work in Bungee II. By doing this experiment we were able to see how the length of the cord affects its force-displacement relationship and start finding the perfect length for the cord in order to let the egg drop as low as possible without hitting the ground.

INTRODUCTION*:* In this experiment, we tested how the length of the cord affected the spring constant of the cord in order to determine the best length of the cord for the final dropping of the bungee. If the bungee cord is too long, the egg will hit the ground and if the bungee cord is too short it won't be close enough to the ground so we need the perfect length in order to win the Bungee challenge.

Relevant equation(s) specific to this experimental purpose or setup, identifying variables:
We used Hooke's Law, Fs=kx, in order to find the k value of each length. We did this by varying the weight that was hanging on the mass and therefore changing the force on the spring and how much the spring stretched. The force of gravity equation, W=mg, was relevant also because this was the force that opposed the spring force and kept the spring in equilibrium. Therefore, the spring force was equal to the weight of the masses we used.

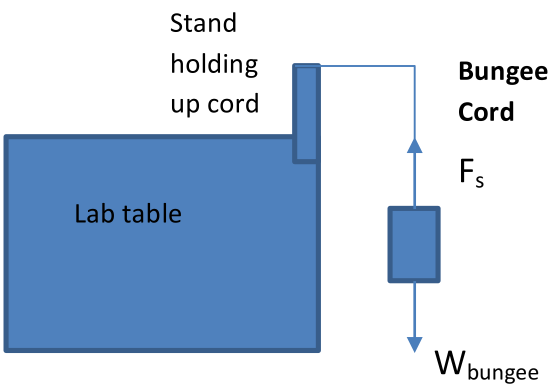
Basis or brief theoretical background, providing enough context that the reader understands where the equation(s) are from: Hooke's Law shows us how the spring constant is directly proportional to the spring force and inversely proportional to the displacement of the spring. So a spring that stretches more has a lower spring constant than a spring that stretches more when being applied by the same force.

Hypothesis (or expectations): I expect that at a bigger length, the spring constant of the cord will be smaller, which means that the spring constant and length of cord will be inversely related.

METHODS:In order to see how spring constant and length of cord relate, we found the spring constant of the cord at multiple lengths and looked at the relationship between the spring constants and their unstretched lengths.

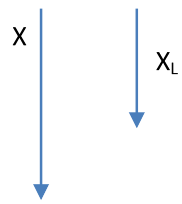
Diagram, This diagram shows the bungee cord that we hung up, added varying masses to, and eventually changed the length of the cord. There is a stand that we used to attach the bungee cord and it allowed us to change the length of the cord. We would then attach the weights to the bottom of the cord.

Bungee Cord System



This diagram shows how we measured the displacement of the bungee cord at the different masses

Stretch of cord= $(X-X_L)$



Describe setup: Our setup contained the hanging bungee cord and several masses that we hung on the cord varying from 50g to 300g.

Describe procedure, *including relevant or significant details* (may be bullets):

- We measured the initial length of the cord in centimeters
- With this length, we hung masses ranging from 50 grams to 300 grams and measured the different displacements of the cord by subtracting the stretched length by the unstretched length
- With these results we found the spring constant by graphing the force and displacement stretched at each mass and finding the slope, which represents the spring constant according to Hooke's Law
- We then varied the length of the cord to five different lengths and using the same masses we found how much the spring stretched at these different lengths. We then used the results to find the spring constant at each length, therefore making five different graphs of Spring Force vs. displacement
- To analyze our results, we made a graph of the spring constants of the cord at each different length vs. the unstretched lengths that we measured and linearized it

***RESULTS**.*

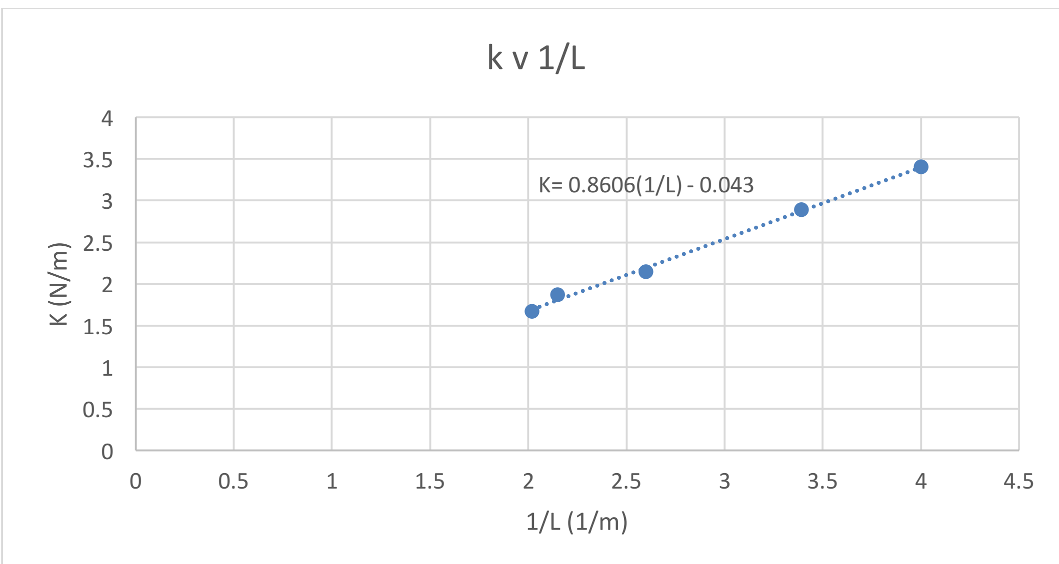
Introduce the Results section :The data we collected was the different spring constants and the corresponding lengths to each of the different spring constants. This data was analyzed by graphing k vs. 1/L and creating an equation for l in terms of spring constant in order to find the best length of the cord.

Table:

Unstretched Length (m) (+/-.005m)	1/unstretched length (1/m) (+/- .005m)	K (N/m)
0.25	4	3.4
0.295	3.389830508	2.89
0.385	2.597402597	2.14
0.465	2.150537634	1.87
0.495	2.02020202	1.67

Our table represents the spring constant of the bungee at the different lengths, the unstretched length of the bungee cord, and 1/the unstreched length which we used to linearize the graph. The unstretched lengths of the bungee cords were the initial lengths of the cord, which we varied 5 times to find the spring constant at each length. The spring constants were found by graphing the spring force, which equals the weight on the spring, and the stretch of the spring. The slope of this graph is the k-constant according to Hooke's Law.

***Linearized* graph:**



Our graph shows the linear relationship between the spring constant and (1/L)

Linear equation :K= .86(1/L) + -.043

uncertainty for slope= .86 (n/m)m % uncert= 3.5%

uncertainty for y-intercept=.09 % uncert= 202%

Value obtained = .86 (N/m)m-> the slope of this graph can be helpful when calculating the length of the cord when we calculate the right K value next bungee experiment

uncertainty of experimental value(s) = .03 (N/m)m % uncert= 3.5%

We got this uncertainty from the Excel regression analysis

Summarize Results

Our graph indicates how the spring force of the bungee is inversely related to the length of the cord. Although we don't have a numerical value for the cord yet, in the next bungee experiment we can find the spring constant of the cord based on work and find the right value for the length of the bungee. The equation from our graph shows that L=.806/(K). The fact that we got a y-intercept in our linearized graph can reflect the uncertainty of our system and can't be explained without more testing. If there was no error the relationship between K and (1/L) would've been perfectly linear and went through 0. But, we must make sure to include it in our k-value that we find in order to get the most accurate length.

DISCUSSION: *What do you make of your results? Evaluate them.*

Error analysis--Since our experiment was not based on any excepted value and we only looked at the relationship between the length of the cord and the spring force and how it effects the force-displacement relationship we don't have any values to compare.

The uncertainty of our value is reasonable because it correctly shows the relationship between spring constant and length of the cord and since the slope of the linearized graph has percent error less than 5%. In order to test the relationship between these two values we can repeat the experiment again with a different bungee cord and see if the same relationship between these two values permits. We also could just test it at a new height in order to see if it maintains the same relationship.

Sources of uncertainty: Our experiment required many data points, since we found the spring constant at each length which required many different masses that created different displacements, so there were many opportunities for error. For example, there could've been errors when measuring the displacements of the cords when first calculating the spring force of each length or the bungee cord could've been permanently stretched by the earlier masses so the equilibrium length is longer than before and therefore making all of the rest of the values longer than they should be. These errors could be rather significant, since they can affect the relationship between the spring constant and the length of the cord. These errors could possibly explain the y-intercept and the high percent uncertainty that came with it.

In a couple sentences**, describe whether your main results support your hypothesis.** How well were the results in agreement with theory, expectations, or otherwise deemed "acceptable"? Why/how so, or not?
Our linearized graph showed how spring constant and length of the bungee cord are inversely related and therefore in agreement with our expectations. With these results we are able to think about the right length for our bungee cord and with more experimentation, get an exact value. This data can be used in order to find the right length of a cord if the spring constant is already known, which can be applied to other experiments.

CONCLUSION: Since our graph showed that spring constant and length of the bungee cord are inversely related, our expectations were correct. The graph gave us the equation, K= .86(1/L) + -.043 which we rearranged to

L=(.86)/(k+-.043). This equation can be used once we find the right k value in next Bungee experiment based on work and energy. For the next Bungee experiment, we can find the k value using conservation of energy, where mechanical energy of the spring is conserved. The initial spring potential energy of the cord will equal the final kinetic energy, which we can equate to find the correct value for K.

Implications of these conclusions (e.g. the significance to larger questions), or next steps proposed:
Since we got a y-intercept in our linearized graph, which implies uncertainty and error, I think in order to make this experiment more accurate we would have to retest all of our values and compare the two. We could also use the k value at one of the equilibrium lengths, plug it into the experimentally determined equation and compare the experimental length to the actual equilibrium length of the bungee cord.
For Bungee II, we must use the equation we founded and figure out a value for k, which we can plug into the equation and get an exact value for the length our bungee should be.

Report Outlines are *individual assignments*. Cite any work not your own, acknowledge any aid, and pledge the report:

On my honor, I have neither given nor received any unacknowledged aid on this assignment.

Pledged: Kiely Hartigan