Lab Report Outline—the Bones of the Story

Justin Park

Does K vary as the length of the elastic band changes?

ABSTRACT:

The actual bungee challenge requires an egg to drop from a height of approximately 9 meters. We couldn't replicate the height within the classroom. As a result, we needed to know whether the K value varies as the length of the elastic band becomes longer. A elastic band is similar to springs connected to one another. As a result, we thought that the K value would change as the elastic band stretches more. We found that the K value is constant under a certain weight, but the K value varied as the length of the elastic band changed. We attempted to find a model, which could potentially help us the find the K value for the length of the elastic band that would be the height of the jump during the actual bungee challenge. It seems as if we found a model that could predict the K value as a function of the length of the elastic band.

INTRODUCTION:

We know that an elastic band is similar to springs connected to one another. We wanted to figure out whether the K value changed as the mass changed and if the K value changed as the length of the elastic band changed.

Relevant equation(s) specific to this experimental purpose or setup, identifying variables:

$F=-k\Delta x$
$F=M*A$
Acceleration is zero in this case as it is in equilibrium.
Therefore $m*g=k\Delta x$

Hypothesis (or expectations):

We expected the K value to change as the length of the elastic changed because the shorter the length of the elastic band, we expected the elastic band to be tighter and therefore have a higher K value. On the other hand, a long elastic band would be loose and have a lower K value.

METHODS: *How are you getting at the purpose or question?*

We designed the experiment so that we vary both the mass and the length of the elastic band.

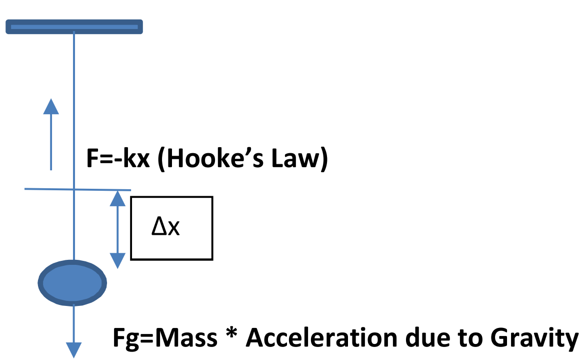


Figure 1, Design of the Experiment.

We first measured the length of the elastic band tied to a rod overhead. We connected the bottom of the elastic band with various masses, and measured the difference in the equilibrium position. We repeated the same procedure but we tied the elastic band at a different point to lengthen the length of the elastic band. We made sure that the elastic band didn't stretch three times its length to maintain the integrity of the band. We made sure the oscillation stopped in order to measure the distance from the original equilibrium position once the mass was added.

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

- **We used 3 different weights (50, 100, 150 grams)**
- **We used 3 different lengths of the elastic band, and found the equilibrium position with the 3 different weights.**

RESULTS: *What do you get? Report your data and analysis—**Just the facts**, but give all a reader needs to know! (No need to show calculations, though.) Refer to the* **Uncertainty Guide (UG)** *for details on finding uncertainties in data and equations. Refer to the* **Excel Guide (EG)** *for technical details on tables and graphs, and on **linearizing** a graph.*

Introduce the Results section in a sentence or so, to give the reader context—data collected, and how it is analyzed to get the relevant result:

We measured the equilibrium position without any masses on it, and after we added the masses, we found the new equilibrium position and found the change in displacement.

Tables and Graphs often need additional context *in the body of the report (outline), not just a caption--needs both. Don't worry about repeating yourself. The body of the report provides the story in a logical progression, while the captions provide quick context for the reader. Add context as needed along with the following.*

Table(s), inserted from *Excel*, **formatted and labeled according to the "Formalities" document** in Resources tab, including "raw" data and averages/standard deviations where appropriate, and **with columns or uncertainties identified further** in caption or in text after the table, if needed:

The tables below show the equilibrium positions when we added different masses. The displacement measures the difference between the length of the elastic band the equilibrium position with the masses added on.

Table 1. The length of the elastic band was .254 meters.

Mass (kg) ±0.005kg	Equilibrium Position (m) ±0.01m	Δx (m) ±0.01m
0	.254	0
.05	.274	.02
.15	.351	.097
.2	.409	.155

Table 2. The length of the elastic band was .741 meters.

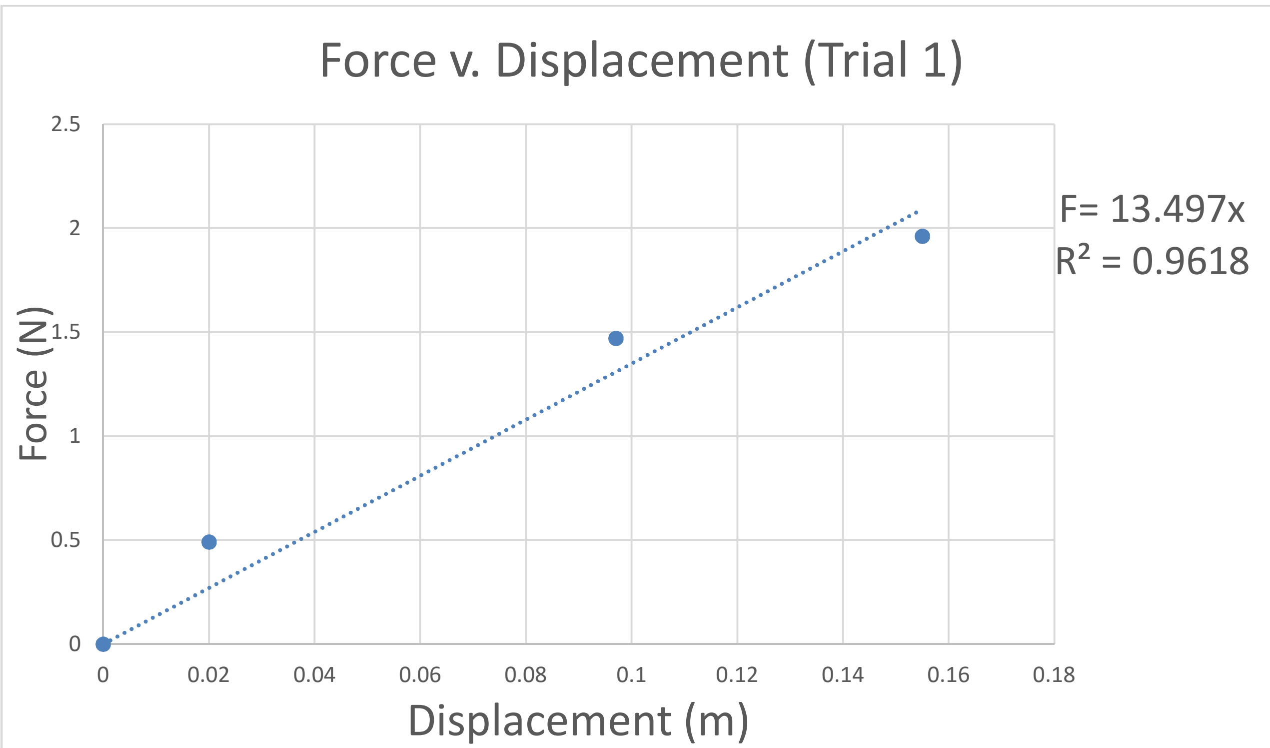
Mass (kg) ±0.005kg	Equilibrium Position (m) ±0.01m	Δx (m) ±0.01m
0	.741	0
.05	.913	.07
.15	.904	.161
.2	1.192	.449

Table 3. The length of the elastic band was .963 meters.

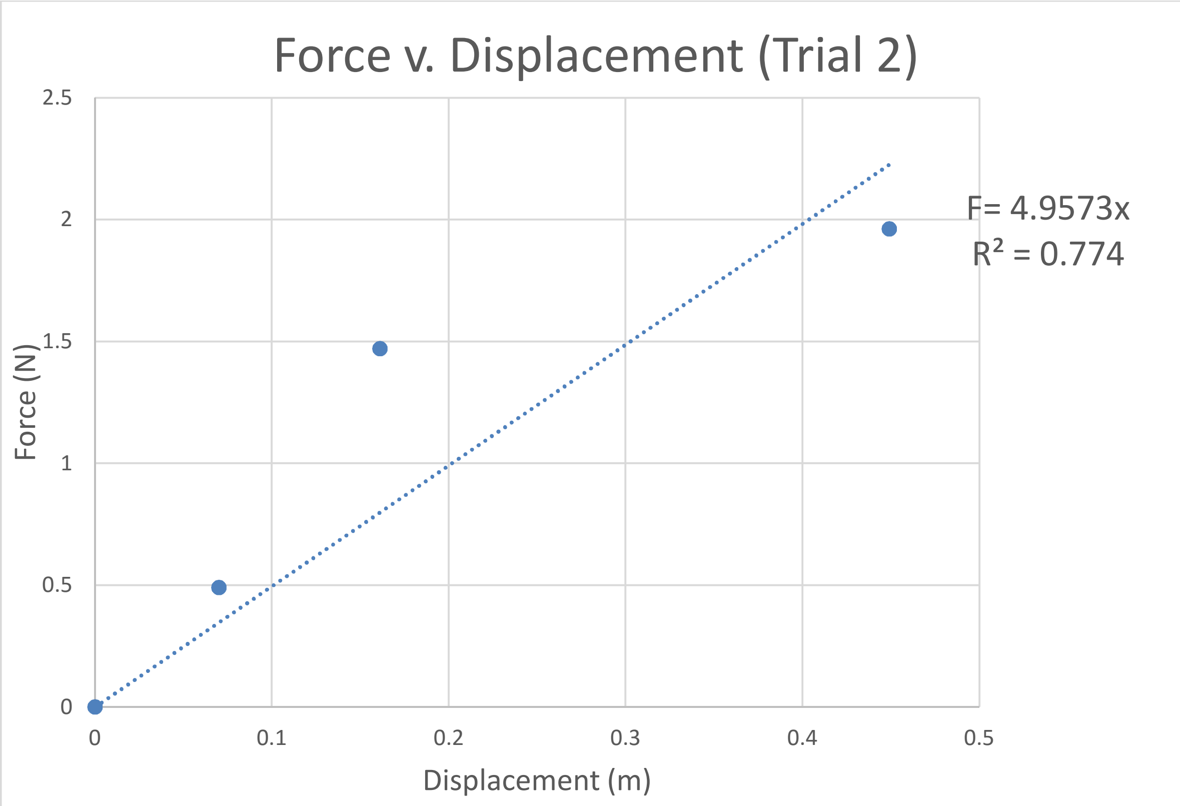
Mass (kg) ±0.005kg	Equilibrium Position (m) ±0.01m	Δx (m) ±0.01m
0	.963	0
.05	1.055	.092
.15	1.328	.365
.2	1.788	.825

We graphed Force vs. Displacement because force of gravity equals the force from the elastic band. Therefore, mg=-kx where the Force is mg. Therefore, graphing force vs. displacement would result in a slope k.

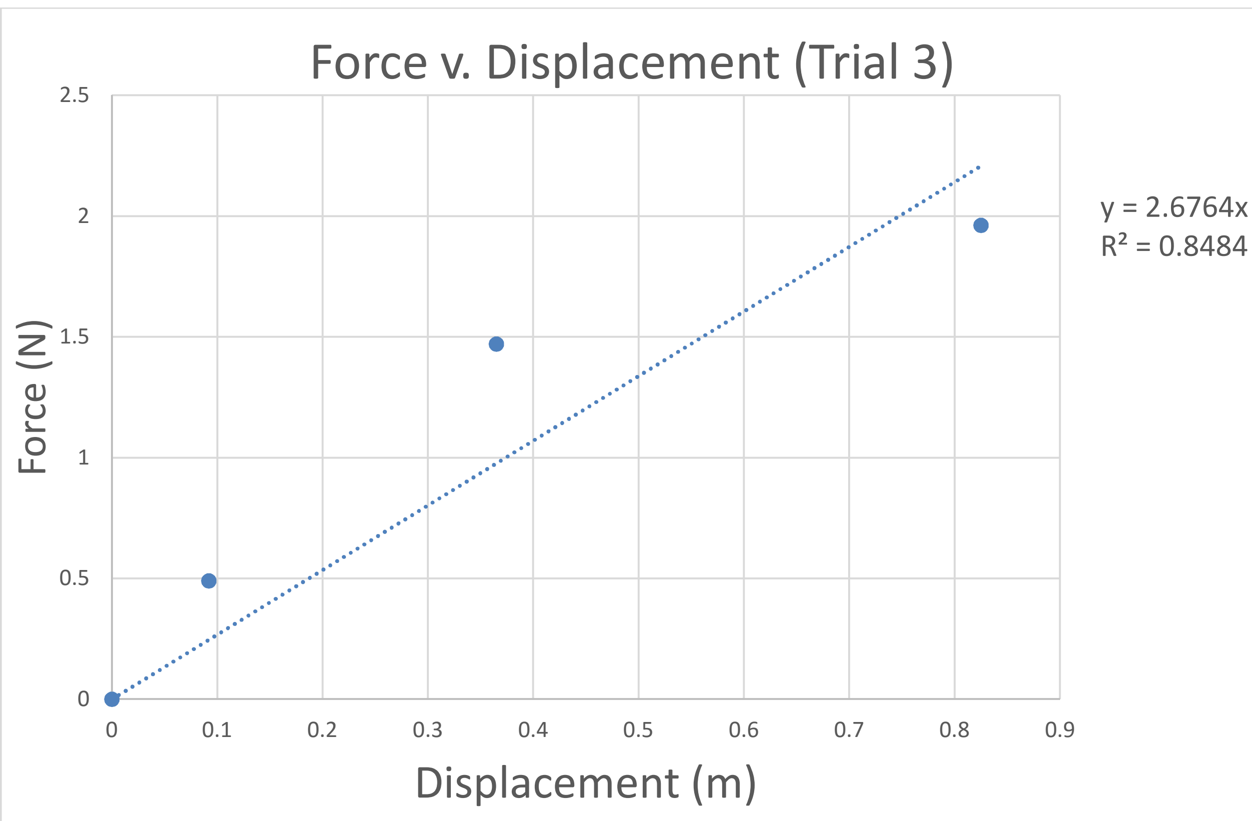
Graph, if applicable, inserted from *Excel*, **formatted and labeled according to "Formalities"** document, and with ***curve-fit*** (also known as "trendline" in *Excel,* this could be a linear or non-linear fit):



Graph 1. Force v. Displacement when the elastic band was .254 meters.



Graph 2. Force v. Displacement when the elastic band was .741m.



Graph 3. Force v. Displacement when the elastic band was .963 meters.

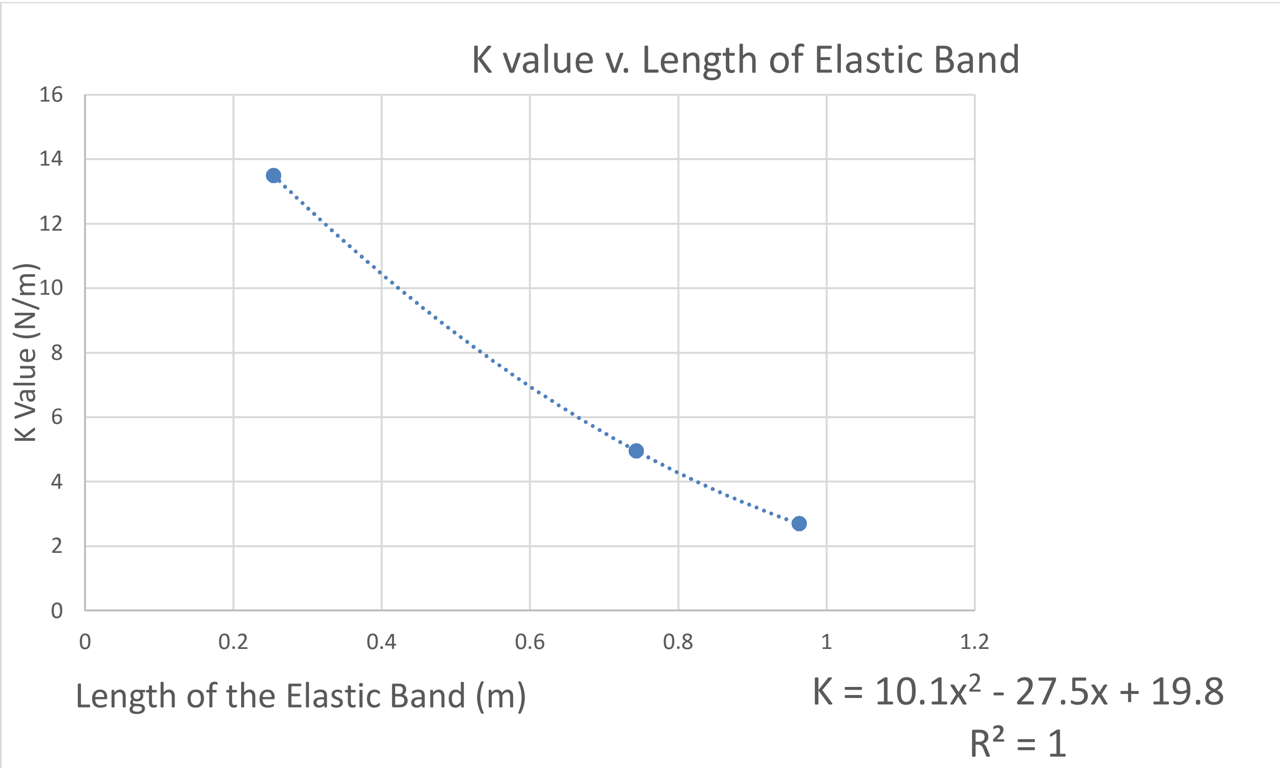
In these three graphs, we found three different K values.

K Value (N/m)	Length of the elastic band (m) ±0.01m
13.497	.254

4.96	.743
2.7	.963

Table 4. Length of the Elastic Band and the K Value.

Because the K values were different as the length of the elastic band was different, we realized that the K value changes. We graphed these three data points on a graph to see if the K value was linear or not.

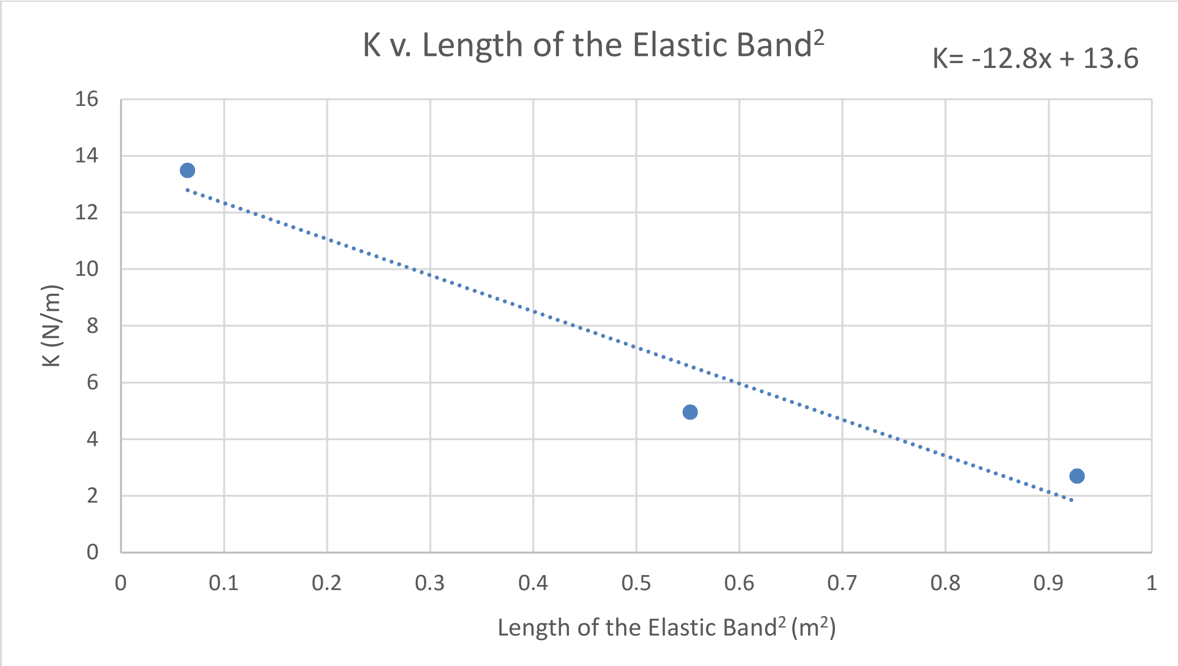


Graph 4. K value v. Length of the Elastic Band. Using the function of length of the elastic band, we thought this function would be a good model for lengths closer to 9 meters.

Equation of the curve-fit from the graph, if applicable (*substitute* your variables for *Excel's* y and x, and round coefficients and powers appropriately—also within graph):

$K = 10.1x^2 - 27.6x + 19.8$
X= length of the elastic band
K= the K constant

***Linearized* graph, if applicable**, inserted from *Excel*, labeled with axes and units (and supplied with linear fit):
Graph 5. Linearized graph.



Linear equation from linearized graph, if applicable (*substitute* your variables for *Excel's* y and x, and round coefficients and powers appropriately—also within graph):

K=-12.8x+13.6

X=length of the Elastic Band^2

Use *Excel* regression analysis on any graph that has a **linear** fit only (see EG), to obtain:

uncertainty for slope= 3.2 % uncert= 25%

uncertainty for y-intercept= 2.0 % uncert= 15%

This uncertainty is from Excel regression analysis.

Now you are ready *to interpret (not evaluate) your results in light of your purposes and conceptual background/theory. Here, identify, extract and calculate those experimental value(s) of interest from your graph(s) and equation(s)—usually embedded in the coefficients— that you can* later *(in Discussion) compare to accepted or expected value(s) for precision, accuracy, significance, etc. Report them…*

Identify experimental value(s) of interest, why it is of interest, and how/from where obtained, briefly:

value obtained = **The Function of K value. K=-12.8x+13.6**

uncertainty of experimental value(s) = ±3.2 for slope ± 2.0 for intercept % uncert= 25% slope, 15% intercept

name the technique used for propagation of uncertainty (see *UG*), or where/how uncert was obtained:

Excel regression analysis

Summarize Results (just the facts)—give the important, relevant results, and why/how they are relevant to the purpose, in a sentence or two, including main equations and quantitative results:

We found that K value changes as the length of the elastic band changes; as a result, we found a model for how the K value changes.

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

There is no accepted value, as the elastic band's K value vary from one another. Also, the length of the elastic band changes the K value so there aren't any accepted values from theory we could look up. However, we could see how accurate our model was by trying a test. Using the model we had, we predicted what the K value would be based on the length of the elastic band. We arbitrarily made the length of the elastic band .77m. Using the model, it predicted that the K value would 3.7. The experimental value we obtained was 5.1N/m, a value close to our certainty value. However, we also used the model that was not linearized and was closer to the experimental value at 4.5 N/m.

Sources of uncertainty and their relative significance (PLEEEASE don't say "human error." Identify *specific* sources of "error"—think of things that may add uncertainty or skew data, rather than "bad" things or "mistakes"):

The knot of the elastic band could have been a source of uncertainty as the knots can't be identical and we couldn't tighten too tight because we needed to be able to untie them.

Not having enough data could have also been a source of uncertainty. The Force v. Displacement seemed as if it was linear until the mass became around 150-200 grams. As a result, if we tried with different mass, we could have seen that it was linear until a specific value, then became more expontential.

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 results support our hypothesis; however, we wanted to find the model that would allow us to predict the K value when the length of the elastic band was too long for us to experiment. The test showed the our K value is within the uncertainty value; however, we are still not sure whether there is a length where our model would not work.

CONCLUSION: *What does this experiment reveal? Step back and look at the experiment's purpose and value*, *remembering that the only failed experiment is an inconclusive one.*

Clearly and definitively state the experimental outcome(s) in terms of your question or purpose:

The K value changes as the length of the elastic band changes. We have obtained an empirical model for the K value.

Implications of these conclusions (e.g. the significance to larger questions), or next steps proposed:

Using this model, we could predict the K value when the length of the elastic band is around 8-9 meters.

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: JUSTIN PARK