Caroline Buckley (Harris Billings); Wednesday Afternoon; November 13 2016

## Displacement: linearly related to both cord length and mass


### *ABSTRACT:*

The purpose of our experiment was to find out if displacement is linearly related to both cord length and mass and if we can relate that relationship to finding the length of the cord we should use for our bungee experiment. In order to find this relationship, we varied cord length and kept mass constant and then recorded the stretch of the cord. We used a mass of 151.3 grams and then used various cord lengths between 0.14 to 0.46 meters. We hung the mass from the cord and then dropped the mass attached to the bungee and using a camera we recorded the maximum stretch of the cord (displacement). Then we graphed our data and found that there is a linear relationship between the displacement (stretch) and the cord length. In the last bungee lab, we also found that there was a linear relationship between displacement and mass, so now we have concluded that there must be a linear relationship between displacement and both cord length and mass. This linear relationship can help us to model what length our cord should be given a height and a mass, therefor we can predict the stretch of the cord and optimize our eggs bungee experience.


### *INTRODUCTION:*

Is the stretch of the bungee cord linearly related to both mass and cord length?

We want to optimize our eggs bungee experience by finding the length of cord to use to given a height and mass. We want to be able to model what our bungee cord is going to do so we can predict as closely as possible our eggs experience. Our goal for our lab is to find a model for displacement verse cord length. Since we previously found that displacement and mass are linearly related we want to see if the same is true for displacement and cord length. If displacement is linearly related to both mass and cord length, then we can use those graphs along with supplementary research from other labs to find the exact cord length that we should use to optimize our eggs bungee experience.

I expect the relationship between displacement and cord length to be linear.

### *METHODS*:

We are going to drop a mass attached our bungee cord and record the stretch of the bungee. We will keep the mass constant and then vary the length of our bungee cord. We want to figure out if the relationship between bungee cord length and the stretch of the cord.

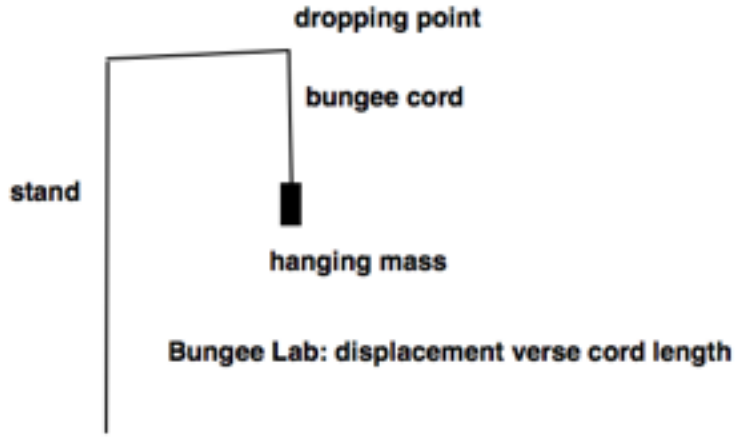


**Figure #1: Setup**

**Setup:**

- We will have a stand on a table where we will attach the bungee cord to the end of it
- We will hang a mass from the end of the bungee cord
- We will drop the mass from the top of the stand, this will be our zero point
- Hang a measuring tape next to where the mass is going to be dropped from the zero point so you can measure the maximum stretch of the bungee

**Procedure**:

1. Set up the experiment to the setup listed above
2. Drop the hanging mass from the zero point
3. Use a camera to record the fall
4. Analyze the video and find the maximum stretch of the bungee cord
5. Use video analysis tools to measure the maximum stretch of the bungee from the measuring tape next to where you are dropping the mass

***RESULTS***:

We found that there is a linear relationship between displacement and the stretch of the cord. We graphed this relationship in order to find an equation of the line.

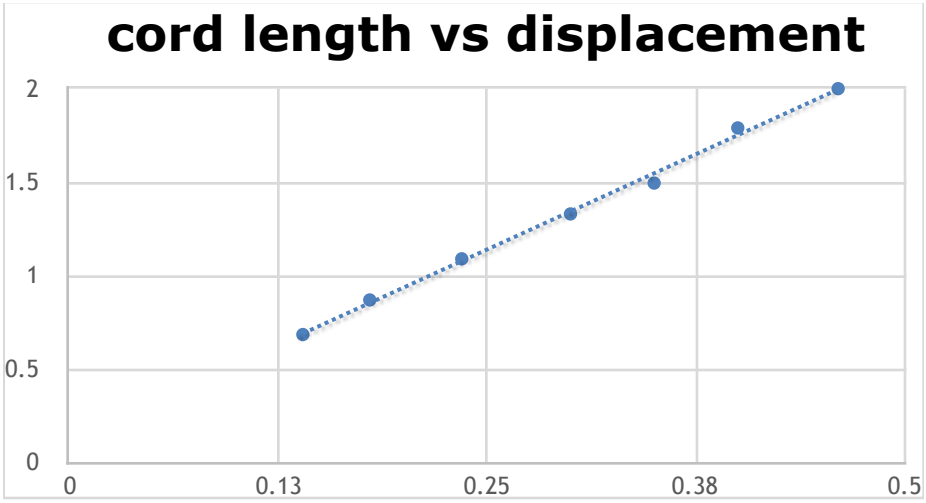


Figure #2: Relationship between cord length and displacement
Uncertainty: 1.5%

| cord length | X max |
|---|---|
| 0.14 | 0.685 |
| 0.3 | 1.33 |
| 0.46 | 2 |
| 0.35 | 1.495 |
| 0.18 | 0.87 |
| 0.235 | 1.09 |
| 0.4 | 1.79 |

Table 1: Cord length and Displacement (x max) as graphed in Figure #2
Uncertainty: 1.5%

y = 0.6202x + 0.1374

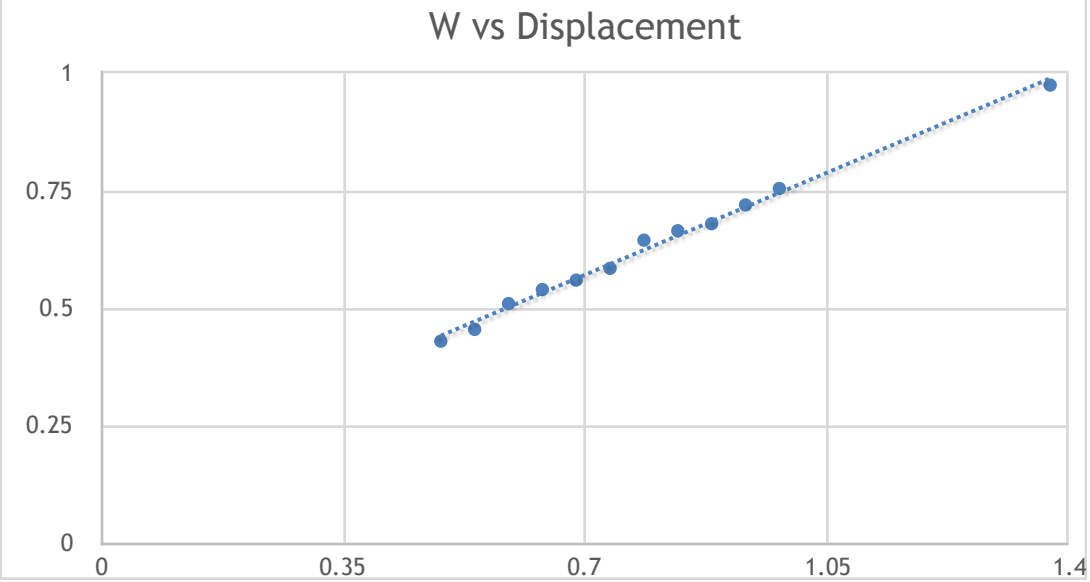


Figure #3: Relationship between Weight (mg) verse Displacement
Uncertainty: 1.5%

| W | xmax |
|---|---|
| 0.4905 | 1.19 |
| 0.53955 | 1.24 |
| 0.5886 | 1.31 |
| 0.63765 | 1.36 |
| 0.6867 | 1.4 |
| 0.73575 | 1.44 |
| 0.7848 | 1.52 |
| 0.83385 | 1.565 |
| 0.8829 | 1.6 |
| 0.93195 | 1.665 |
| 0.981 | 1.73 |
| 1.3734 | 2.195 |
| 1.4715 | 2.24 |

Uncertainty: 1.5%
Table #2: Weight verse Displacement (x max) as graphed in figure #3

Based on the relationships demonstrated in the graphs above displacement has a linear relationship with both mass and cord length. Since both of these are linearly related to displacement we can now relate that to finding what length we should make the bungee cord to optimize our eggs bungee experience. When analyzing our data we also found that the displacement verse mass and the displacement verse cord length graphs matched up. When we tested for possible length values in our equations for the above graphs they yielded the same result. This means that when we find our x value for how long we should make the bungee cord for our jump, when it is substituted into the equations it will yield the same result. Since the relationship is linear we can model how the bungee will react for longer cord lengths and given

our mass we can then see where the mass graph intersects the cord length graph to find the needed cord length to optimize our eggs bungee experience.

We found that displacement is both linearly related to both mass and cord length. The equations for both graphs yield the same result and therefore we can use them to find the appropriate bungee length to maximize our eggs experience.

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

Our findings of how displacement is linearly related to mass and cord length will be essential to our experiment. The linear graphs will allow us to match a set mass with a cord length and therefore we can find what length we should make our bungee in order to optimize our eggs experience. We will be given a set height of the balcony and the mass of the egg, so then we can use those two pieces of given information to match with our linearized graphs. Since the equations of the two graphs yield the same output value given a s=certain input value we know that mass and cord length must be directly related, thus helping us to find which cord length to use when given a set mass.
Error in our experiment could have come from our measurements. When we measured the stretch length on the camera the measurements were bound to be off by a tad bit because of video quality and how we can only slow down the video so much. However, the uncertainty values are pretty low and will not affect our overall experiment too much.

Our main results supported our hypothesis. It makes conceptual sense that displacement would be linearly related to both mass and cord length. If you are using a set cord length and various mass, as the mass increases so should the displacement. When you have a set mass and a varying cord length, as the cord length grows so should the displacement.

***CONCLUSION***:

The purpose of our experiment was to find out if there was a relationship between displacement, mass cord length. Our findings revealed that in fact there is a linear relationship between these things. Since there is a linear relationship and the equations of the lines match up with each other we will be able to relate this to our bungee experiment and find the length of the bungee cord we should use.

**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:***

**Caroline Anne Buckley**