Lab Report Outline—First Bungee Test

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TITLE: First Bungee Test – Modeling the bungee cord as a spring

ABSTRACT: This lab is intended to determine the behavior of a bungee cord and the relationship between the length of the cord, the force on the cord, and how far it stretches. Our hypothesis is that it will follow Hooke's law for springs, and exhibit a linear relationship between stretch and force. We tested the stretch of bungee cords of different lengths by hanging different masses on them and measuring the length and displacement resulting. We found that the relationship was not linear, but slightly parabolic, and found a quadratic equation that describes the relationship between the percent stretch and the force on the cord.

% stretch = 21.1 x^2 + 21.4 x

Where x is the force in Newtons.

INTRODUCTION: In this report, we will attempt to use Hooke's Law To model the spring qualities of an elastic material to be used as a bungee cord in the egg drop experiment. Hooke's Law states that the force of a spring is

Fspring = -k∂x

Where k is a constant and ∂x is the displacement from equilibrium. Our interest and purpose is in experimentally determining this constant k for a variety of different length of the cord and seeing how the cord behaves in general, in order to predict the behavior of a bungee jump system containing this element.

METHODS: In order to find this Hooke's law constant for several lengths of the cord, we will test the displacement of cords of different lengths with different masses hung from them. We test four lengths and eight different masses. These lengths are 49.7 cm, 56.1 cm, 70.8 cm, and 91.5 cm, and the masses are 0, 25, 50, 70, 105, 150, 170, 200. The setup is shown below

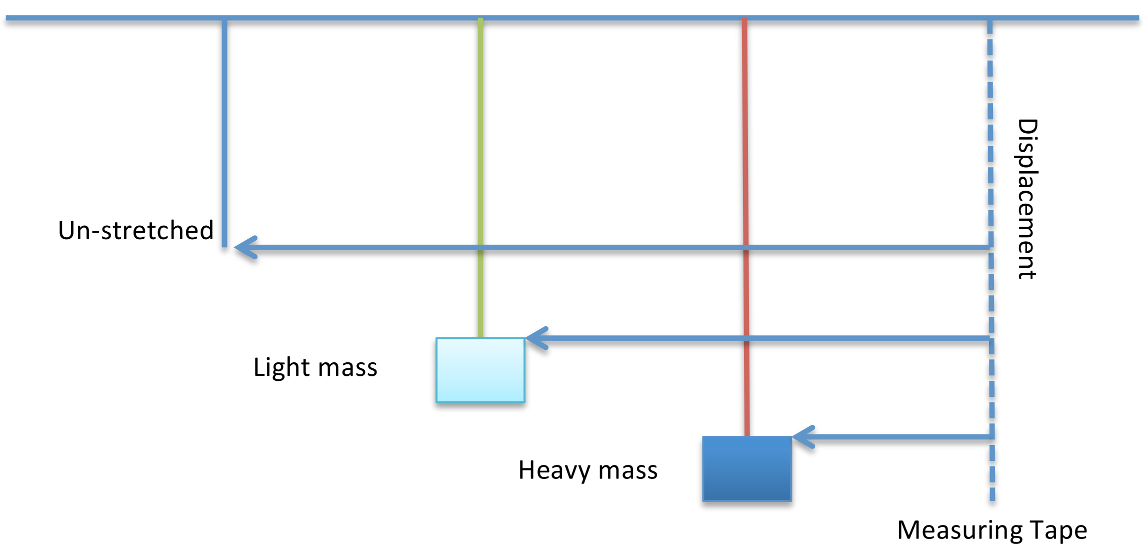

Figure 1*: The bungee cord is suspended from a hook mounted on a pole a little more than 2 meters above the ground. A mass is attached to the other end and allowed to reach its equilibrium position.*

RESULTS: The data is omitted as there is a lot of it, but the graph of all the data points Is shown below (Figure 2). Each line shows how a cord of a different length responds to different forces stretching it. Clearly there is a consistent positive correlation between mass added and stretch (as expected), but it is also clearly not linear.

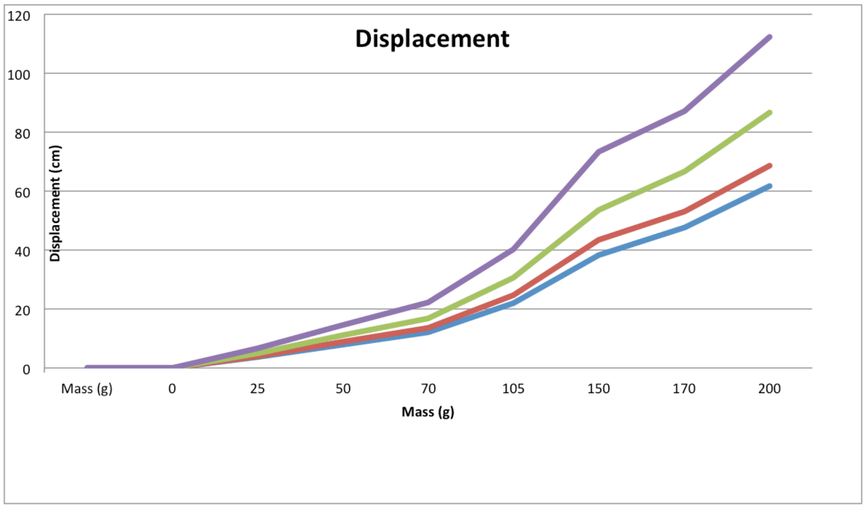

Figure 2: *Displacement vs Weight Graph*

We noticed that the displacement for a given mass was proportional to the length of the cord, so we decided to convert everything to a percent stretch form, which gave us consistent values between different lengths. This is calculated simply by dividing the displacement by the length of the cord at displacement equal to 0 (results, Figure 3 and Figure 4). This is graphed below; along with the best-fit equation calculated.

Force (N)	% Increase in length
0.00	0.00
0.25	7.12
0.49	15.8
0.69	24.2
1.03	43.9
1.47	77.6
1.67	95.0
1.96	123

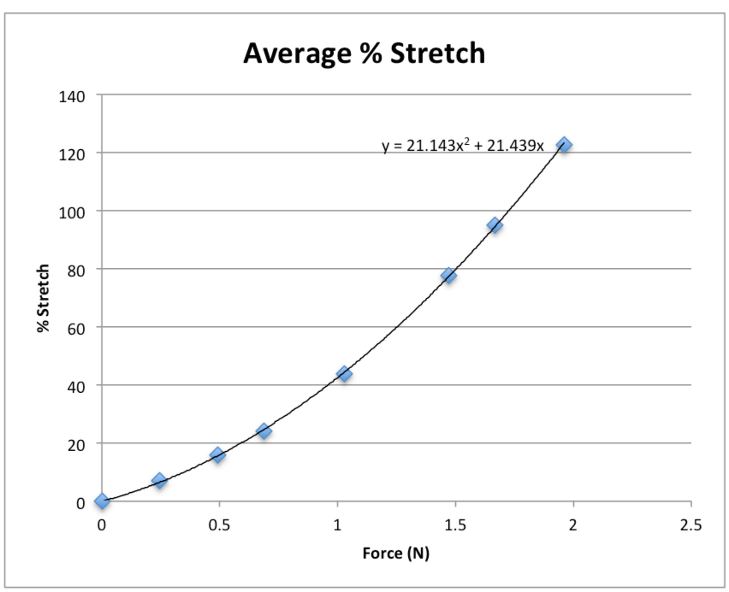

Figure 3 and 4*: Table and graph of calculated percent stretch*

DISCUSSION: The equation that we found best fit this behavior was

% stretch = 21.1 x^2 + 21.4 x

Where x is the force in Newtons.

Notice that this is not a linear equation such as Hooke's law would have us suppose, but this is the way in which this particular cord and setup behaved. This non-linearity could be caused by the way in which the cord was tied or more likely by actual non-linearity of the spring. Through all of this we estimate ± 0.2 cm in length measurements, and assume the masses are accurate to the gram.

Extra Error could be caused by

- Small mass errors (note the weird bump in the first graph at 150 g)
- Knot tying differences
- Incomplete knowledge of the behavior of the string (ex. didn't test breaking point/breakdown point)

CONCLUSION: Overall, we were able to determine and quantify the behavior of the cord under these circumstances. Though it may be more convenient to use a linear relationship, we found that a quadratic did a better job of describing the relationship between stretch and force.

For the next part of the lab we will use this relationship between length, stretch and force of in order to determine the behavior of a falling mass attached to this type of spring. Future work will include testing critical points for the spring material like stretch tolerance falling behavior, and testing of the static string to insure that we can assume no stretch in it.

Report Outlines are individual assignments. Cite any work not your own, acknowledge any aid, and pledge the report: *We consulted a few other students, the TA and Professor in the early stages of this experiment, and used Microsoft Excel, Word, and NI LabVIEW for the next part of the experiment (not covered here, but helped to reflect on this part).*

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

Pledged: *Simon Marland*