How do we determine the total maximum distance of a bungee system knowing the length of the bungee cord?

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ABSTRACT: Our goal for this experiment was to further understand our bungee cord. We decided to vary the length of the bungee cord and measure the maximum total distance of the bungee to find an equation to predict maximum total distance. We hypothesized that if we have different distances that we measured from different bungee lengths, we will find an accurate equation for total maximum distance of the bungee. We taped a section of the bungee cord to ring stand and let part of the cord rest. The rest of the cord we connected to a constant mass and dropped that mass from the position of the length of the cord. We measured the maximum distance that the bungee dropped for seven different lengths with five trials each. We recorded the lengths of the bungee, the distance for each trial, and the average distance for each length. When we graphed the data, we found the linear equation D=2.47L+.20 where D is the total maximum distance and L is the length of the bungee. We yielded a low uncertainty and we theorize the error to be low so our hypothesis was supported. Our results will help us determine the appropriate length in which to drop the egg for the Bungee jump and gives us further information about the nature of our bungee.

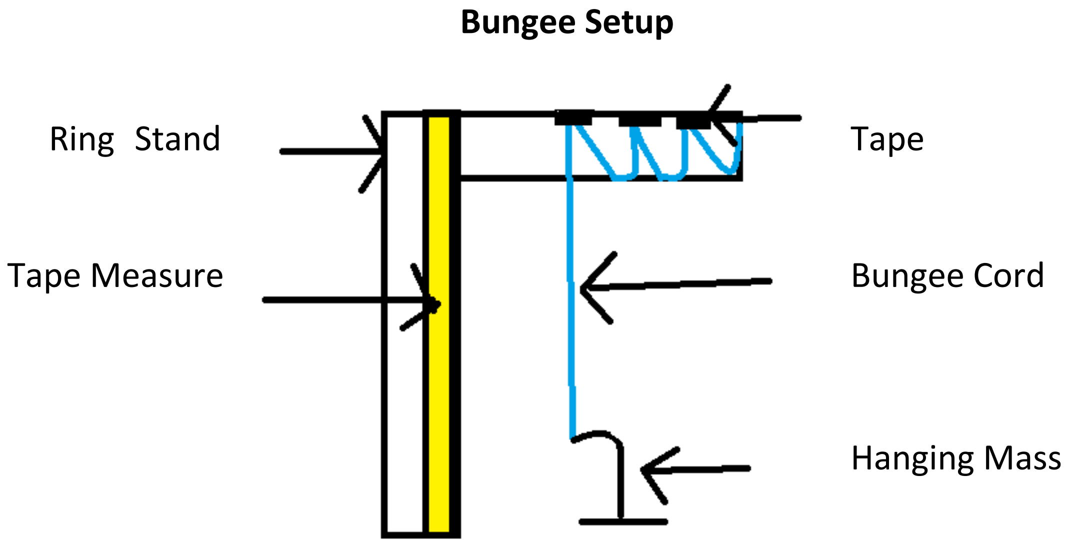
INTRODUCTION

In this lab, we wanted to understand how our bungee reacted when we varied its length. Our purpose was to calculate an equation that would predict the total maximum distance the bungee would travel when attached to a constant mass. We stated the independent variable(x-variable) is the length of the bungee used while the dependent variable(y-variable) is the maximum distance that the bungee drops. Hooke's Law equation F=-kx is relevant to understanding how our bungee works in this experiment. The equation identifies the force of the bungee on the hanging mass is opposite to the force that's stretching the bungee. Also, in Bungee I, we found an equation to find the spring constant k using weight and displacement (x in Hooke's Law) of the bungee. Even though our x is total maximum distance rather than displacement in this experiment, the information is important in designing an effective bungee cord. Our hypothesis is that if we vary the length of the bungee cord that the mass hangs from while keeping that mass constant, we can find an accurate equation to determine total maximum distance of the cord because the position of the bungee depends on its length.

METHODS:

We dropped a constant mass of 140g(about the size of the egg for final experiment) attached to a bungee cord. This was connected to a ring stand. We completed five trials for each of the seven lengths we measured to get an accurate total distance for different lengths of the bungee.

Figure 1



The diagram above demonstrates the setup for the bungee lab when the bungee cord is at its maximum distance.

We taped one-third of the bungee cord to the ring stand to keep it stabilized. We removed the tape when we wanted to decrease length and put it back once the length was determined. Another section of the bungee remained at rest. We attached a tape measure to the ring stand to measure the length of the bungee. To attach the cord and mass together we tied a loop around the cord and hooked the mass onto the cord. We taped the weights on the hanging mass down to keep the total mass stabilized.

We taped a section of a bungee cord to a ring stand while another section hung loosely. We measured the length of the bungee used for the experiment using a tape measure attached to the ring stand. We measured the length to be

.82 meters. We proceeded to loop the bungee cord and attach our hanging mass. We decided to have a total hanging mass of 140g. We dropped the mass from the position of the length of the bungee cord. We utilized an application called Coach My Video to record the precise position of the bungee when it reaches its total maximum distance. We repeated this for four trials. After we measured each distance for the length of .82 meters we repeated the procedure with a length of .72 meters. We continuously repeated recording five trials and measuring different lengths until we reached a length of.22 meters. We then recorded the data on Excel and graphed the results.

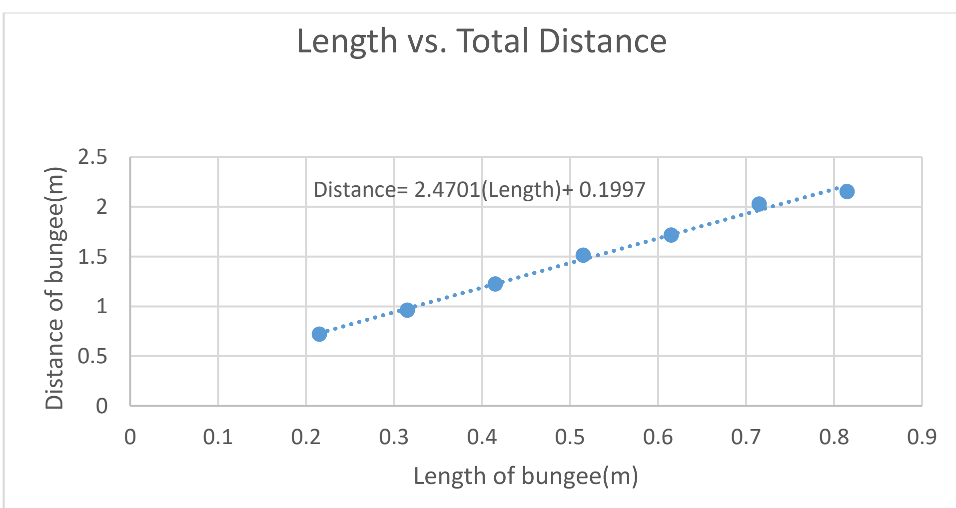
RESULTS:

We recorded the total distance of the bungee for five trials for seven different bungee lengths. Then we calculated the average maximum distance for each length and graphed length against average distance. We found an equation from the graph and observed the uncertainty.

Table: Length and Maximum Distance

Length(meters)	Trial 1 Distance(m)	Trial 2 Distance(m)	Trial 3 Distance(m)	Trial 4 Distance(m)	Trial 5 Distance(m)	Average Maximum Distance(m)
0.82	2.17	2.16	2.15	2.15	2.15	2.15
0.72	1.99	2.03	2.04	2.04	2.03	2.02
0.62	1.70	1.72	1.72	1.71	1.71	1.71
0.52	1.50	1.51	1.52	1.52	1.51	1.51
0.42	1.21	1.22	1.23	1.22	1.22	1.22
0.32	0.96	0.96	0.96	0.96	0.97	0.96
0.22	0.72	0.72	0.72	0.72	0.73	0.72

The length of the bungee and the maximum distances observed



The graph shows the relationship between the length of bungee and the average of the total distance found

Our equation from the graph is Distance=2.47(Length)+.20. This shows a linear relationship between length and maximum distance of bungee. The slope of the equation is 2.47 and the y-intercept is .20.

Regression Analysis of Linear Equation

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.199713	0.044573	4.480626	0.006515	0.085136	0.314291	0.085136	0.314291
X Variable 1	2.470071	0.080679	30.61621	6.98E-07	2.262681	2.677462	2.262681	2.677462

The regression analysis above shows that the uncertainty for the slope is .08 and the uncertainty for the y-intercept is .05 because standard error is uncertainty. We calculated the percent uncertainty for each when we divided uncertainty by the slope and y-intercept, respectively. Thus, the % uncertainty for slope is 3.27% and for y-intercept is 22.3%.

The experimental value of interest is 2.47 because that is the slope of the equation that signifies the relationship between length and maximum distance**.** The uncertainty and % uncertainty are .08 and 3.27%, respectively. We know this information because we found uncertainty for the slope.

Overall, our results gave us the linear equation that signifies the relationship between length and maximum distance and provided the uncertainty of this equation. We know the slope of 2.47 is the experimental value of interest because it helps us calculate distance with respect to length of the bungee.

DISCUSSION:

We don't know the error of the data because we don't know the accepted equation and slope for maximum distance and length of a bungee. However, we do know the uncertainty is .08 and the % uncertainty is 3.27%. These are acceptable values of uncertainty for the data provided so we can hypothesize the equation is an accurate representation of the relationship between length and maximum distance. If we were to find error, our accepted value would be found from knowing the length of the cord and distance the bungee should drop before the experiment. If we know these factors, we can determine an equation and compare this to Distance=2.47(Length)+.2. When we find the difference of values chosen by picking random lengths, then we will find the error of the data.

The sources of uncertainty are the uncertainties associated with using a tape measure and an application to find values in the experiment. Also, the precision needed to drop the mass from the same position for each length leads to uncertainty and error in the experiment. There is error in the exact distance of the bungee itself because the cord was not as stable as possible.

The results strongly supported our hypothesis because the uncertainty we found was relatively low. This means that our equation is an accurate representation of the relationship between length and total maximum distance. Thus, by finding the distance of the bungee cord from different lengths of the bungee, we found an accurate equation to predict distance of the bungee.

CONCLUSION:

We calculated an equation that gave us a relationship between distance and length of a bungee cord. This means we can predict the maximum distance that the bungee will travel if we know the length of the bungee cord. For our Bungee Jump experiment this is vital to determine how for the egg can go before it breaks. If we adjust the length of the cord we can calculate the distance of the egg to be right before impact with the ground, we can have a successful experiment and an exciting ride for the bungee. Our results are also vital in understanding how the bungee cord works and can help determine displacement of the cord with our equation to find constant k from Bungee I.

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

Pledged: Kacie Carter