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BUNGEE JUMP ONE

ABSTRACT

We determined that the force remains constant for different lengths of string holding the same mass so that we would later be able to isolate other variables in Hooke's Law and form an optimal bungee. We attached a constant mass at varying lengths of string and dropped the mass while measuring the force of the drop. We used this information to calculate the spring constant k for the bungee cord and k's relation to the force and length of the cord. Though simple, this experiment allowed us to confirm that force and mass are directly proportional in Newton's second law equation. From our results, we were able to conclude that the force is constant when the mass does not change, thus allowing us to explore the variations and combinations of other variables.

INTRODUCTION

Question: How can we predict the value of k in Hooke's Law?

Relevant equation(s), identifying variables:

$F = -kx\ i$

$F_{spring} = -\frac{1}{2}kx^2$

$F = mg$

x_L = unstretched

x_0 = equilibrium

x_s = stretched

Brief theoretical background:

The force varies directly with mass according to the equation F = mg. Thus the equation for force can be written $-\frac{1}{2}kx^2 = mg$. From this relation, we can prove that the force will remain constant along with the mass.

Hypothesis:

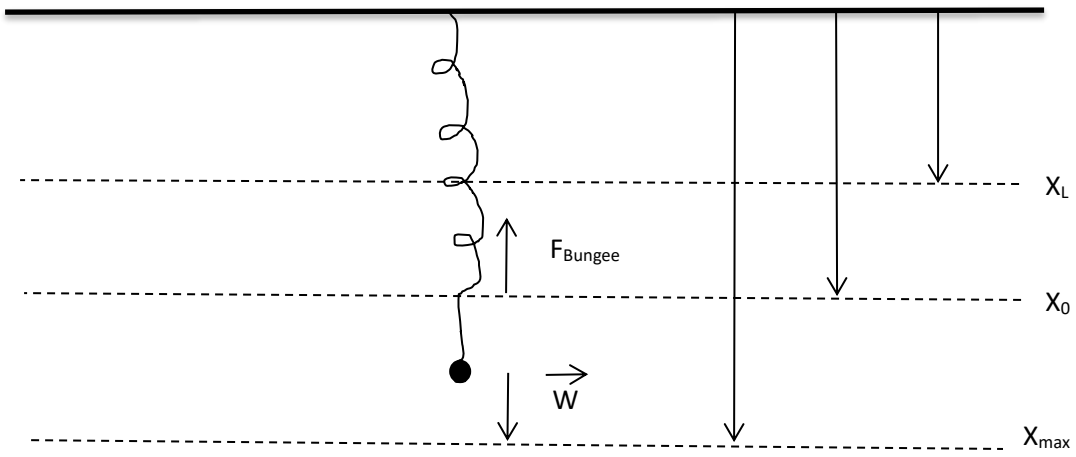
The graph of the unstretched vs stretched string will be linear because the force will remain constant.

METHODS

By measuring the length of the stretched string and force we are able to plug these values into the equation and determine the constant k.

Figure 1: Picture of Set Up

This illustration sets up the variables used throughout this experiment



Setup and Procedure:

- Hang string from secure location
- Tie a small loop and measure the distance from the top of the string to the loop
- Secure mass through loop
- Let mass hang in equilibrium position and measure distance
- Calculate the stretch of the string
- Use this value to calculate the constant k

RESULTS:

We collected data for the force of the string when dropped, length of the unstretched string, and length of the string at its equilibrium. We then were able to determine the stretch of the string and plug it into the Hooke's Law equation to determine the constant k.

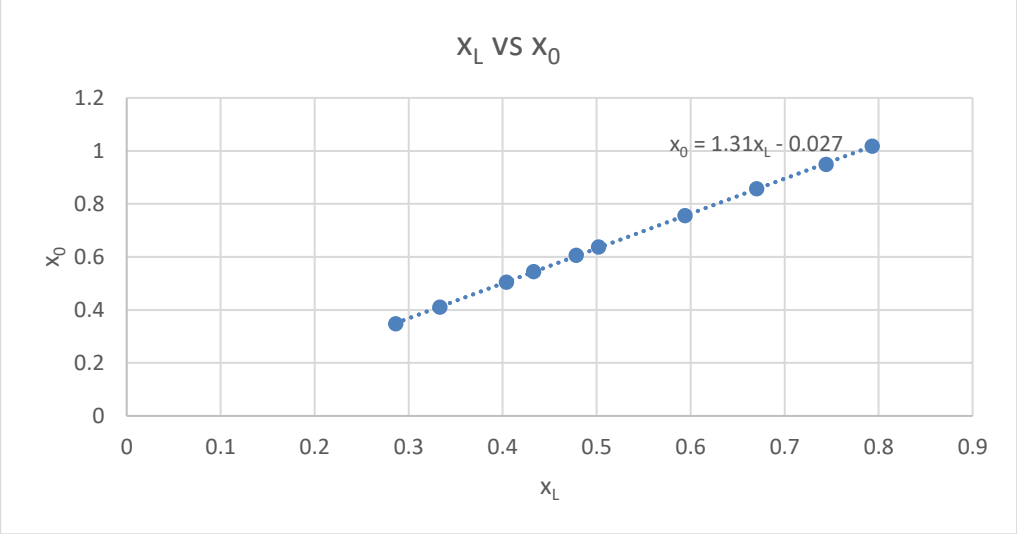
Figure 2: Table of Values

This table contains the values for the length of the unstretched string, string at equilibrium position, string when stretched, and stretch constant.

x_L (m)	x_0 (m)	x_S (m)	k
0.286	0.348	0.062	7.91
0.333	0.410	0.077	6.37
0.404	0.504	0.100	4.91
0.433	0.545	0.112	4.38
0.478	0.606	0.128	3.83
0.502	0.637	0.135	3.63
0.594	0.756	0.162	3.03
0.670	0.857	0.187	2.62
0.744	0.949	0.205	2.39
0.793	1.018	0.225	2.18

Figure 3: Graph of Unstretched String vs Equilibrium Position

This graph depicts the proportional relationship between the length of the unstrectched string and the length of the string at its equilibrium position.



$x_0 = 1.13x_L - 0.027$

uncertainty for slope= 4 % uncert= 10%

uncertainty for y-intercept= 0.7 % uncert= 8%

Our graph represents the relationship between the unstretched and equilibrium lengths of the string. Since our graph is linear, we were able to conclude that the force remains constant at a constant mass.

DISCUSSION

We were able to compare our values to the Newton's second law equation and the Hooke's law equation. The results that we received from this experiment were consistent with accepted ideas about force and spring constants.

Sources of uncertainty:

- Measurement of lengths – both unstretched and at equilibrium
- Measurement of force due to loop size in cord

From Hooke's law and Newton's second law, we know that force is dependent on and varies directly with mass. Therefore, our results directly support this with negligible uncertainty since the percent uncertainty for our slope and y-intercept values are small.

CONCLUSION

To determine and isolate k, we had to experiment with keeping mass constant, and therefore the total force was constant. By confirming that mass and force are constant, we were able to determine a way to calculate the value of k in future experiments with different variables. Now that we are aware of this connection, we can experiment with other variables in order to determine the most functional bungee jump construction.