Lab Report Outline—Bungee Journal I

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TITLE: Determining the Effect of Static String Length on Acceleration

ABSTRACT:
This experiment looks at the effect of the length of static string on the acceleration of object attached to a bungee cord and dropped from a set height. The second law equation F=ma served as core equation of our experiment. We measured the force on a constant mass at varying static string lengths in order to analyze the trend in acceleration as those static string lengths increased. As static string length increases, the force of the mass also increases, and therefore acceleration increases. With this information on acceleration and static string length, we will be able to conduct a successful egg drop experiment.

INTRODUCTION:

In the context of our upcoming egg drop experiment, we performed an experiment to determine the variables that affect acceleration of a mass attached to an elastic cord. By determining acceleration trends, we can determine how far and fast the egg will travel at a given static string length, which will allow us to safely drop the egg.

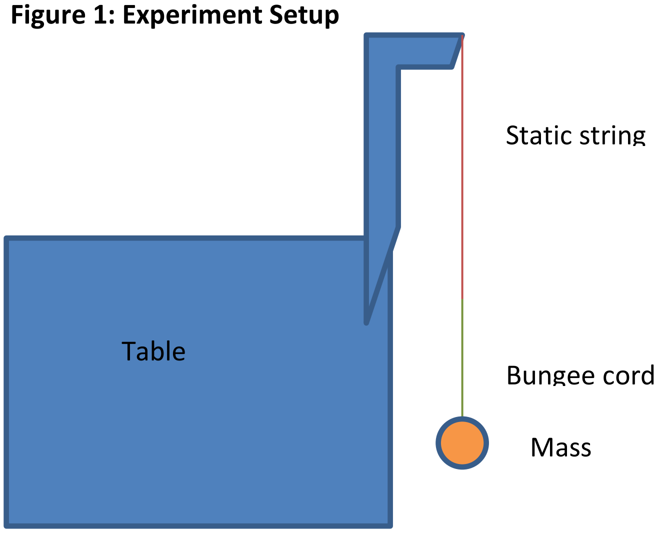
We derived an equation for acceleration, acceleration= force/ mass, based on the equation F=ma. This equation, F=ma, is Newton's second law equation. The independent variable is the length (m) of the static string and the dependent variable is force (N) (and therefore acceleration (m/s^2). Mass (kg) was kept constant in addition to the length of the bungee cord.

We hypothesize that as the length of the static string of the system increases, the force on the mass will increase and therefore the acceleration of the constant mass will increase.

METHODS:

Using force systems with the Capstone system, we will measure the force on the mass that is dropped from a constant height but attached to varying static string lengths. Elastic cord length remains constant.

Figure 1: Experiment Setup



Describe setup:
In order to test the force at various static string lengths, we kept mass and elastic cord length constant. We took data at various static string lengths while keeping elastic cord and mass constant (150 g). See Figure 1.

Procedure

- set up force sensor: attach to metal table arm, connect to Capstone software.
- Vary length of static cord, taking data points at each length of cord. Static cord should be attached to bungee cord using loop knots to prevent stretching that would alter our force measurement.
- Drop mass (150g) from height level to force sensor.
- Record maximum force, determined by Capstone software
- Using maximum force data, determine acceleration using equation a= F/m.
- Plot max acceleration v. cord length in excel
- Perform linear regression in excel to determine uncertainties

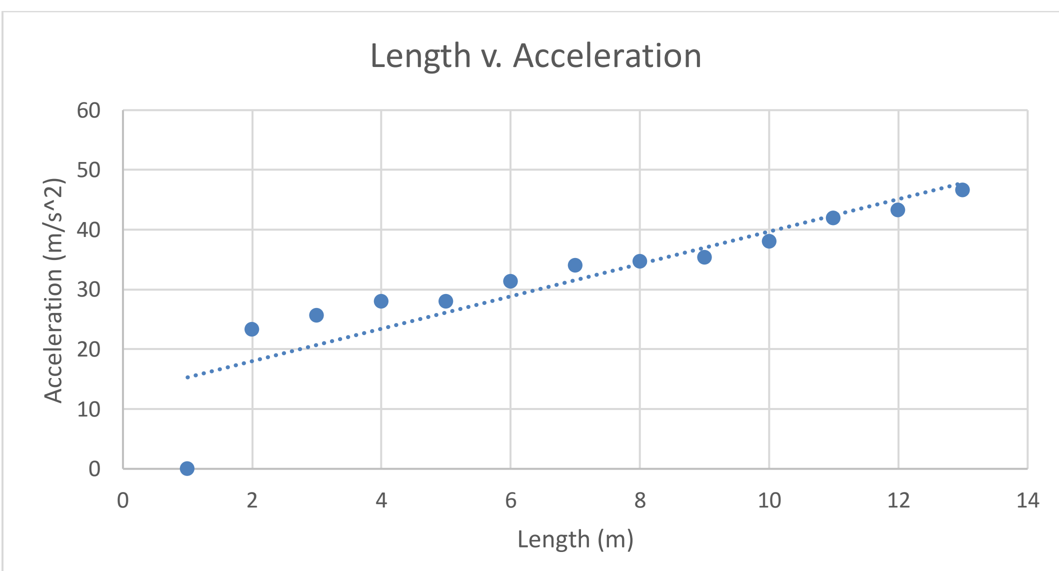
RESULTS:

Data was collected using the Capstone software, then acceleration was calculated using the force data that was obtained. The relationship between acceleration and static string length was then analyzed in Excel.

Table 1:

Static String Length (m)	Acceleration (m/s^2)	Elastic/ Static String Ratio
0.04	23.33	0.33
0.08	25.67	0.667
0.1	28	0.833
0.12	28	1
0.18	31.33	1.5
0.22	34	1.833
0.26	34.67	2.167
0.32	35.33	2.67
0.38	38	3.17
0.45	42	3.75
0.51	43.33	4.25
0.59	46.67	4.92

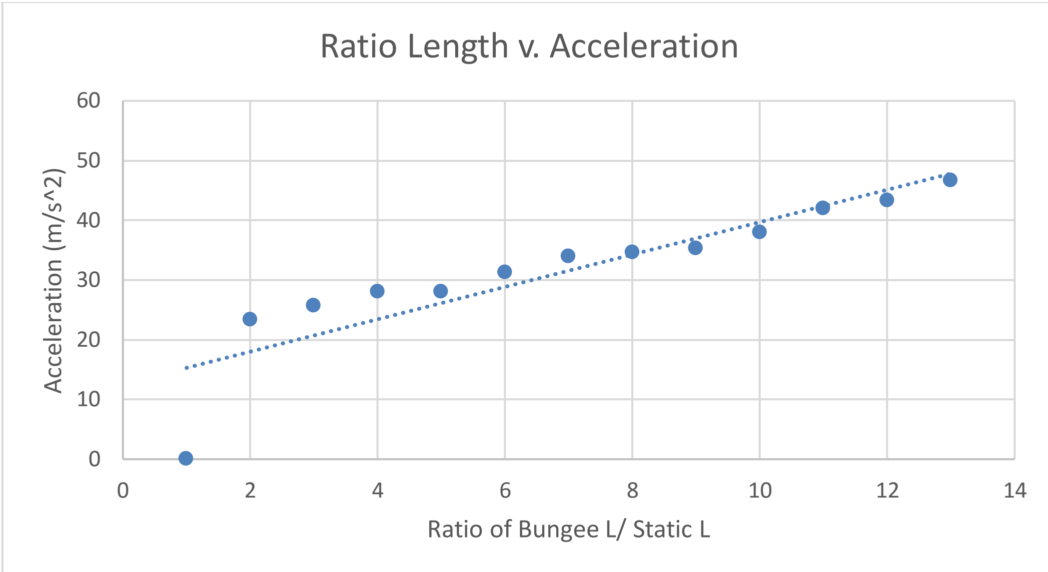
Figure 2: Graph of Length v. Acceleration



Equation 1: A = 40.293(L) + 23.282

After analyzing the first graph, we determined it would be beneficial to look at the relationship between the ratio of elastic cord length and static string length because that would be the most relevant for further experiments.

Figure 3: Graph of Ratio Length v. Acceleration



Equation 2: A = 2.7107(L) + 12.589

We then performed an excel regression analysis to determine uncertainty of our slope and y-intercept for Length v. acceleration.

uncertainty for slope= 1.7 % uncert= 4.2 %

uncertainty for y-intercept= 0.55 % uncert= 2.36 %

DISCUSSION:

Based on our results, we determined that the ideal ratio of static string to elastic cord is approximately 1:1 in order to achieve maximum acceleration without exceeding the established force limit. The limit of the force is determined by max force= 3mg, which is calculated to be 4.41 N (max force allowed by bungee cord is equal to 3mg). The maximum acceleration is approximately -28.00 m/s^2, calculated from F=4.1 N at L= 0.12 m. After determining the ideal ratio at 1:1, we tested our ratio using a longer static string of approximately 0.20 m. We achieved an acceleration of 27.3 m/s ^2, validating our 1:1 ratio theory.

Our uncertainty was fairly low. However, sources of uncertainty could include measurement flaws within the force sensor (perhaps not calibrated correctly), uncertainties within the Capstone program, inconsistency associated with the "style" of drop, and stretching of the elastic cord as more and more trials were performed. It was difficult to ensure that all of our knots connecting the bungee and elastic cord were the exact same. If force was not calculated accurately, the maximum force would not be accurate and we could not determine the ideal static string length.

Our main results do support our hypothesis. As length of the static string increases, forces increases and therefore acceleration of the mass increases.

CONCLUSION:

The outcomes of our experiment determined the relationship between static string length and acceleration of a mass being dropped. Moving forward, this information on acceleration will allow us to properly design a successful and thrilling egg drop where we can safely achieve maximum acceleration without breaking our egg.

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

Pledged: Frances Walker Abbott