Lab Report Outline—the Bones of the Story

Your name and your lab partner(s): Jamie Guider and Mike Barry and Scott Philips (this week) **Section:** Monday

Date: 11/13/16

TITLE:

Determining Relationship of Maximum Acceleration of a constant Mass with Varying Lengths of Bungee Cord

ABSTRACT:

This experiment was designed to determine the maximum acceleration of an object during a bungee jump and how different lengths of bungee cords would change the maximum acceleration. Our hypothesis for this experiment was that max acceleration would increase as the length of the bungee cord increased. A bungee cord was attached to a force sensor connected to a computer. A constant mass, attached to 5 varying lengths of bungee cord, was dropped twice, per each length of cord, to determine the maximum force of the mass on the bungee cord. This maximum force was measured with a force meter connected to a computer assisted data acquisition program "Capstone". The force meter data was utilized to deduce the maximum acceleration of the mass during the bungee jump. Analysis of the data yielded the experimental equation: A_{max} = -0.2845m - 22.9**. The slope of the maximum acceleration equation is important because it is indicative of a horizontal line graphically, which implies the maximum acceleration will not change based on varying lengths of bungee cord. Although our hypothesis was not accurate, this result is essential for future bungee cord experiments because it will allow experimenters to not worry about the mass attached to the bungee cord exceeding an acceleration of 3g's.**

INTRODUCTION:

The purpose of this experiment was to determine the maximum acceleration of an object with constant mass. The acceleration was deduced from the maximum force the object exerted on varying lengths of bungee cords. This question is relevant because in future bungee cord experiments the mass will not be able to exceed an acceleration of 3g's. Therefore it is imperative to understand the how maximum acceleration changes between varying bungee cord lengths.

The following equation was utilized in our experiment to determine max acceleration from values of maximum force:

$F_{max} = ma_{max}$ **Where "F" is the maximum force exerted, "m" is the mass of the object, and "a" is the maximum acceleration of the object.**

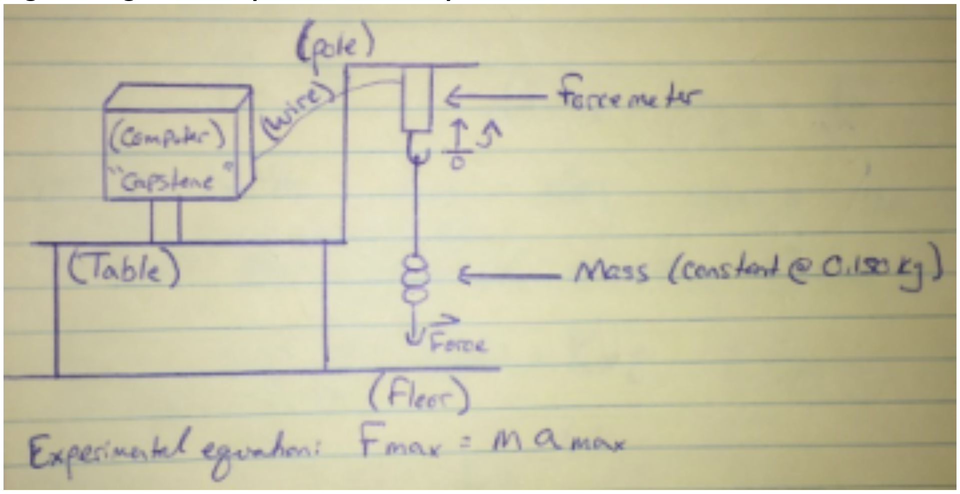
This equation is Newton's 2nd Law and our focus is on the "maximums" of the Force and Acceleration.

Our hypothesis for this experiment was that max acceleration would increase as the length of the bungee cord increased.

METHODS:

A bungee cord was attached to a force sensor connected to a computer. A constant mass, attached to 5 varying lengths of bungee cord, was dropped twice per length of cord to determine the maximum force of the mass on the bungee cord.

Fig. 1: Diagram of Experimental setup.



Setup:

A tall pole was attached to a table and a force sensor was attached to the top of the pole. The force sensor was connected to a computer, on the table, running the program Capstone. One end of the bungee cord was attached to the bottom of the force meter, utilizing appropriate knots, and the other end of the bungee cord was tied to the mass.

Procedure:

- Adjust the pole attached to the table to provide enough height for the mass on the bungee cord to be dropped without hitting the floor.
- Attach the force meter to the top of the pole.
- Sync the force meter with the Capstone program on the computer.
- Tie one end of the bungee cord to the hook on the bottom of the force sensor.
- When tying the bungee cord, make sure to use appropriate knots to avoid damage to the bungee cord and to avoid unnecessary stretch in the bungee cord.
- Tie the other end of the bungee cord to the hanging mass.
- Keep the mass constant at 0.150 kg.
- Lift the mass to the height of the first knot in the bungee cord, connected to the force meter hook.
- Drop the mass and catch it on its way up from the bungee jump.
- Record the maximum Force indicated in Capstone.
- Complete 2 trials for each length of bungee cord.
- Repeat the prior steps for a total of 5 lengths of bungee cord, totaling 10 trials.

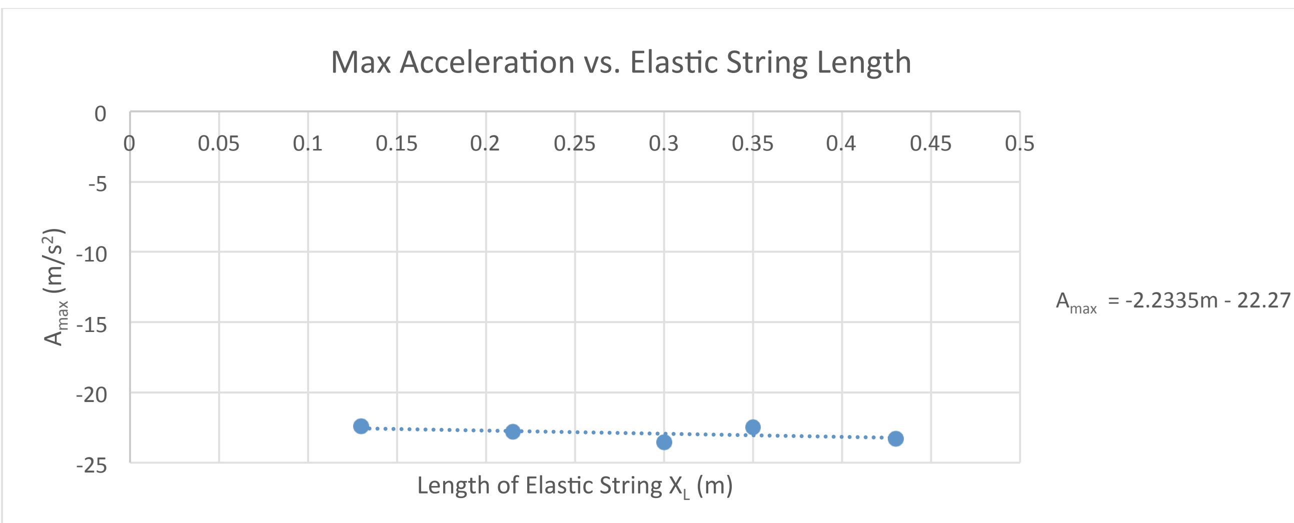
RESULTS:

Raw data was collected utilizing a computer assisted data acquisition program "Capstone", which was connected to the force meter. Capstone measured the maximum force of the mass reached during the bungee jump and this maximum force was used to determine the maximum acceleration of the mass during the bungee jump.

Fig. 2: Acceleration of mass. 5 different bungee cord lengths were utilized with 2 trials per length to determine the maximum force. The two forces from each trial were averaged and then utilized to deduce the maximum acceleration of the mass.

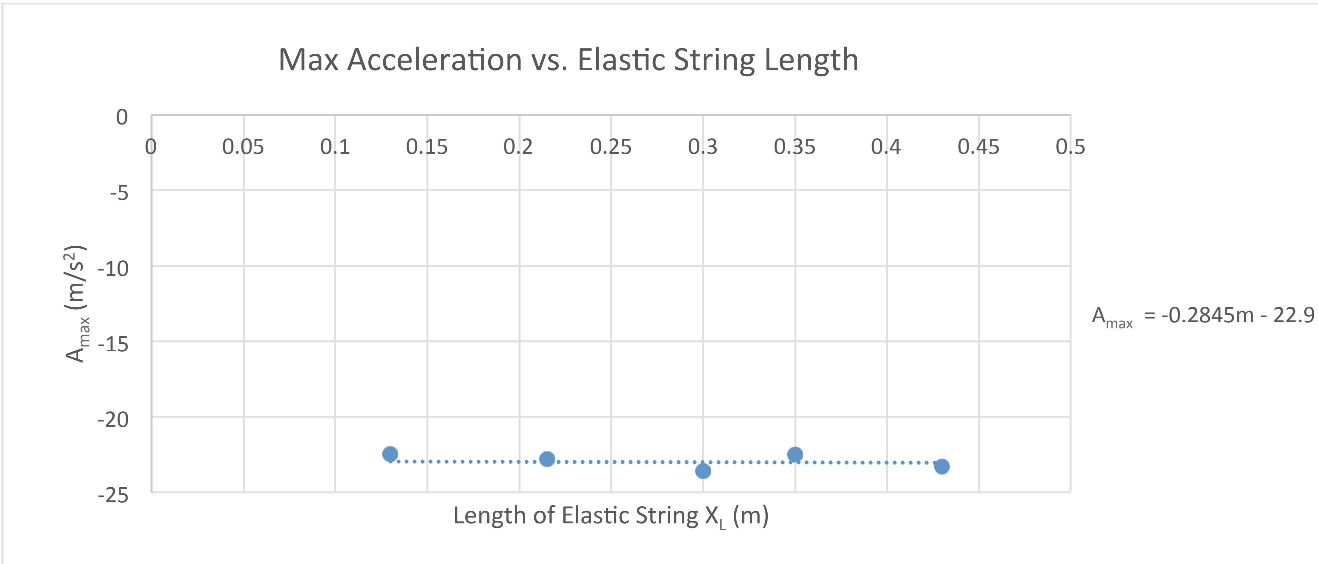
Length of Elastic String X_L (m) (± 0.01 m)	**$F_{max}1$ (N) (± 0.02 N)**	**$F_{max}2$ (N) (± 0.02 N)**	**A_{max} (m/s^2) ($\pm 0.02\ m/s^2$)**
0.21	-3.41	-3.42	-22.76
0.3	-3.53	-3.54	-23.56
0.43	-3.46	-3.53	-23.3
0.13	-3.35	-3.38	-22.43
0.35	-3.39	-3.35	-22.46

Fig. 3: Max Acceleration vs. Elastic String Length. The slope, -2.2335 ($\pm$ 0.02) m/s^2 does not seem appropriate for this graph, but it is due to the small amount of data points collected.



Equation: $A_{max} = -2.2335m - 22.27$

Fig. 4: Max Acceleration vs. Elastic String Length. The slope, -0.2845 ($\pm$ 0.02) m/s^2 is different from the slope in Fig. 3 due to a change in the location of the y-intercept. The y-intercept was changed to the average of all the data points for max acceleration. This decision was made to gain a more appropriate slope that is a closer representation of a horizontal line.



Equation: A_{max} = -0.2845m - 22.9

uncertainty in coefficient(s)= $\pm$ 0.02 m/s^2 % uncert= 0.09%

State where/how you got this uncertainty: **weakest link technique**

The slope of Max Acceleration graph is the value of interest because in future bungee jump experiments the mass will not be able to exceed 3g's and the slope of Max Acceleration indicates that the slope is essentially a horizontal line. This horizontal line indicates an unchanging acceleration of mass despite changes in the length of bungee cord. The slope of Max Acceleration was obtained from the coefficient of bungee cord length (m) in the experimental equation.

value obtained = -0.2845

uncertainty of experimental value(s) = $\pm$ 0.02 m^2/s^2 % uncert= 10%

Obtained via: weakest link technique

Analysis of the data yielded the experimental equation: A_{max} = -0.2845m - 22.9. **This is relevant because this small slope indicates a nearly horizontal line for the max acceleration points, which is indicative of an unchanging max acceleration during changes in bungee cord length.**

DISCUSSION:

Although there is no accepted value to compare these results to, we determined results to be acceptable due to the nearly horizontal line the slope of max acceleration indicated and the small percent uncertainty.

One source of uncertainty could stem from how the mass was dropped at the beginning of the bungee jump. If the mass was not dropped exactly the same way the force meter reading could not have been completely accurate. Furthermore, another source of uncertainty could come from the restrictions of being in the lab. The data points collected were based on a bungee cord length that ranged from 0.1 meters to 0.5 meters, as a larger range could not be achieved in the lab. Although our maximum acceleration seems to be unchanged regardless of bungee cord length, the lengths did not vary by a very large amount.

Although we hypothesized that max acceleration would increase as bungee cord length increased, our results indicated that the max acceleration was unchanged by the bungee cord length. Therefore our hypothesis was not supported. The unchanged max acceleration was determined based on graphing our results, which indicated a seemingly horizontal line and a slope value that supported this assumption.

CONCLUSION:

Max acceleration of the mass attached to a bungee cord did not change when the length of the bungee cord was changed.

Although the hypothesis was not consistent with the conclusions, there is still significant information that can be understood from this experiment. The results of this experiment propose a relationship between acceleration of a mass and the length of a bungee cord. The relationship indicates that the acceleration of a constant mass of 0.150kg will not change with differing lengths of bungee cord. This understanding is essential for future bungee cord experiments because it will allow experimenters to not worry about the mass attached to the bungee cord exceeding an acceleration of 3g's.

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

Pledged: Jamie Guider