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BUNGEE 2

B. Diagram

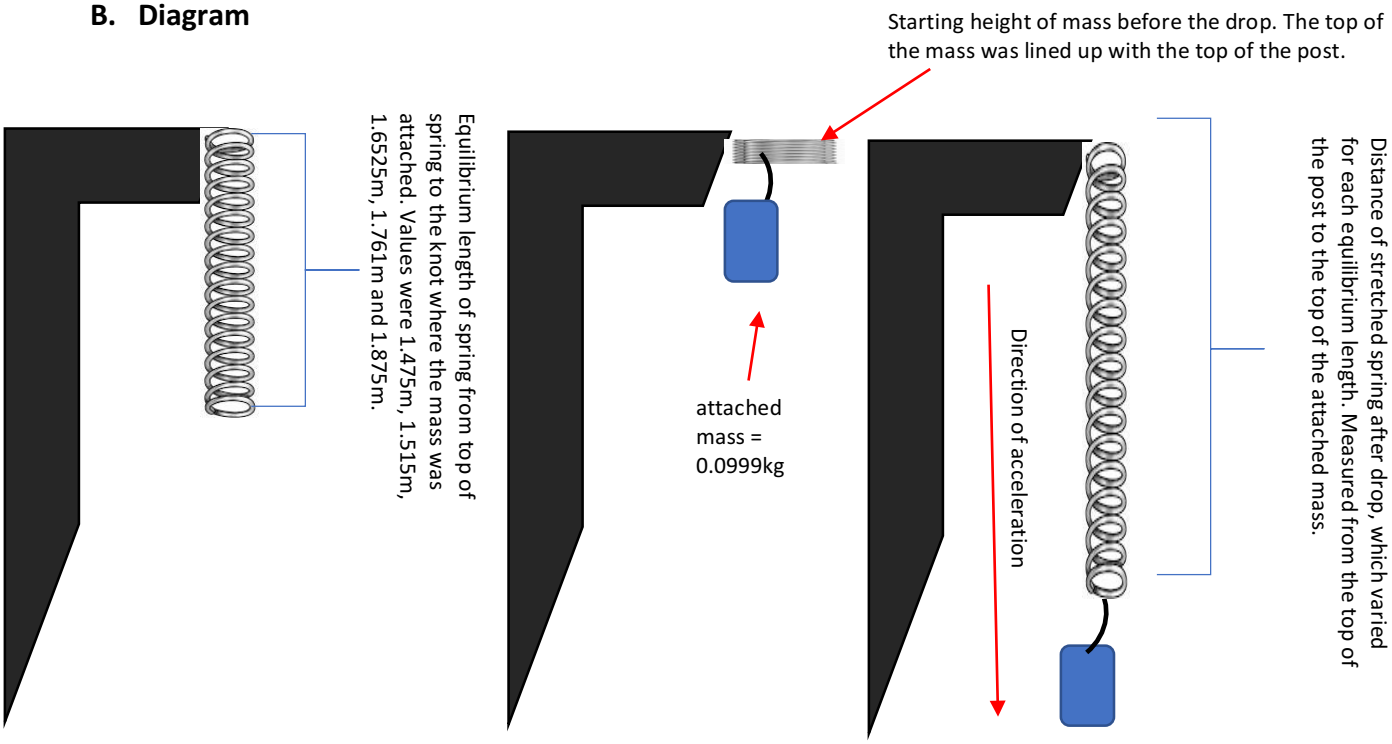

Figure 1: Diagram of the experiment. All bungee cords were doubled up for half of their equilibrium lengths. The mass was dropped with the top lined up with the top of the post and the video app, Coach My Video, was used to record the fall. The maximum displacement from equilibrium was calculated from the final height of the mass at the bottom of the fall. The mass was 0.0999kg and we tested the equilibrium lengths of 1.475m, 1.515m, 1.625m, 1.761m and 1.875m. 1.475m, 1.515m, 1.625m, 1.761m and 1.875m. The height was measured from the bottom of the floor.

D. Experiment Summary

The purpose of this experiment was to analyze the effect of equilibrium length of the bungee cord on the total distance that the cord will stretch when a mass is dropped from rest, which is exactly how the egg will be dropped on the day we do the bungee experiment. We performed this experiment with ½ of the bungee cord doubled up because our previous experiment found that the spring constant, k, of the cord increases with more of it doubled up. We didn't want to send our mass into the floor since we can only drop from the short height available to us in the physics lab room, so we doubled up the cord to allow us to measure more and longer equilibrium lengths. The mass was dropped and recorded using the Coach My Video app and then the video was analyzed to find the maximum distance stretched that the cord reached. We

performed three trials at five different equilibrium lengths and threw out one trial at each length that was an outlier. The video footage was blurry so there was one measurement for each equilibrium length that we felt was not representative of the true value of the maximum stretched distance. We dropped from equilibrium lengths of 1.475m, 1.515m, 1.625m, 1.761m and 1.875m.

We found that our analysis yielded an outlier at our second height measurement of 1.515m. We deleted this point in our data analysis because no type of relationship fit the data with this point inserted. Thus, our final equation of interest is Distance stretched = -1.86*equilibrium length + 3.8391 (all in meters). The standard error of the slope is 0.1169 and the standard error of the y intercept is 0.1984. The percent standard error of the slope is 10.67% and the percent standard error of the y intercept is 3.04%. Since the percent standard errors are relatively small, we can conclude that we made accurate measurements. One source of error is that the video app was somewhat blurry. This made it hard to read the exact distance that the spring stretched upon release of the mass. Another source of error is that when the mass was dropped it might not have been from the exact same height each time because we dropped it without using a device to make sure the mass was completely level with the top of the post. Another source of error is that the equilibrium height was hard to measure because the bungee cord oscillated when the ruler was placed next to it, making it hard to get an accurate reading.

This experiment will help us on the day that we drop the egg because we will be able to determine what equilibrium length we should use if we want the cord to stretch as close to the floor without touching it. We will look at The Bungee Journal to see how varying mass affects the stretch of the bungee cord and take it together with our data on how varying equilibrium length affects the stretch of the bungee cord to determine the final equilibrium length we should use.

C. Data

	Equilibrium Length (+- .001m)	Final Height (+- .001m)	Distance Stretched (m)	k (N/m)
	1.475	0.382	1.093	5.518118
	1.475	0.414	1.061	5.547688
Average		0.398	1.077	5.532903
Standard Deviation		0.022627417	0.022627417	0.020909
	1.515	0.654	0.861	5.69758
	1.515	0.665	0.85	5.712168
Average		0.6595	0.8555	5.704874
Standard Deviation		0.007778175	0.007778175	0.010316
	1.6525	0.826	0.8265	5.453302
	1.6525	0.865	0.7875	5.499144
Average		0.8455	0.807	5.476223
Standard Deviation		0.027577164	0.027577164	0.032415
	1.761	1.215	0.546	5.572422
	1.761	1.2115	0.5495	5.565873
Average		1.21325	0.54775	5.569147
Standard Deviation		0.002474874	0.002474874	0.004631
	1.875	1.525	0.35	5.574998
	1.875	1.536	0.339	5.608308
Average		1.5305	0.3445	5.591653
Standard Deviation		0.007778175	0.007778175	0.023554

Table 1: Raw Data. For each equilibrium length, two final height measurements were used for analysis. The height was measured from the bottom of the floor. The distance stretched is equal to the final displacement of the bungee cord, which occurs when the object has fallen to its maximum distance before rebounding in the upward direction. Averages and standard deviations were also calculated for further analysis and as a measurement of error.

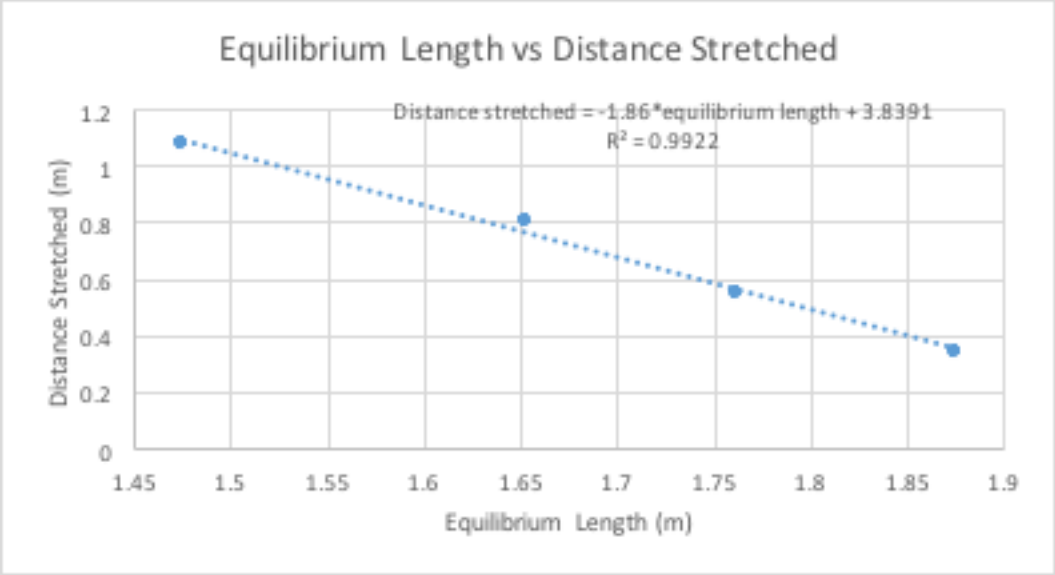

Figure 2: We plotted equilibrium length vs distance stretched. This graph yields our equation of interest, Distance stretched = -1.86*equilibrium length + 3.8391. Standard error of the slope is 0.1169 and of the y-intercept is 0.1984. The height measurement of 1.515m was not included in this analysis.

Equilibrium Length (+- .001m)	Distance Stretched (+- .001m)	Distance Stretched^2 (m^2)	Distance Stretched^3 (m^3)
1.475	1.077	1.159929	1.249243533
1.6525	0.807	0.651249	0.525557943
1.761	0.54775	0.300030063	0.164341467
1.875	0.3445	0.11868025	0.040885346
Standard Error of Slope	0.116908368	0.220787265	0.48846269

Table 2: This is the data we used for our final graph in Figure 2. We only used the average values of distance stretched from our raw data in Table 1. We also tried to see if displacement had a better relationship with equilibrium length^2 or equilibrium length^3, but these yielded graphs with slopes with much higher standard errors. Thus, we determined distance stretched vs equilibrium length was the best fit for our data and did not include the actual graphs of distance stretched^2 and distance stretched^3 vs equilibrium length.

Experimental Value of Interest

Our experimental equation of interest is Distance stretched = -1.86*equilibrium length + 3.8391 (all in meters) (Figure 1). The standard error of the slope is 0.1169 and the standard error of the y intercept is 0.1984 (Table 2). These values were calculated from the Excel regression tool. This equation tells us how far the mass will fall upon release from rest with different lengths of bungee cords. This is important because we need to choose the appropriate length of bungee cord to make sure our egg will not extend it too far so that it crashes into the floor. There are no accepted values for this equation because the composition of our bungee cord is entirely unique to our experiment, but we have low standard deviations (Table 1) of our raw data measurements, and the percent errors of the slope and y-intercept are 10.67% and 3.04%, respectively, which are low so we can assume our raw data measurements were accurate.

We did try to see if displacement had a better relationship with distance stretched^2 or distance stretched^3, but these yielded graphs with slopes with much higher standard errors (Table 2). Thus, we determined distance stretched vs equilibrium length was the best fit for our data.

The next step for this experiment is the final egg drop. We need to factor in various factors, such as how changing mass affects the final displacement, that were explored by other groups for our final determination of the equilibrium length and fraction of it we want to double of the final cord. Another experiment we could have done would have been to measure how far the bungee displaces from dropping masses of different sizes. We will be able to look at other groups' data that performed this experiment to see how varying mass affects the bungee's displacement since our egg wont weight 99.9g on the day we drop it.