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Lab #10: Period of the Pendulum

Principal Investigation by: Jesse Vaught

Our group was tasked with testing the limitations of the pendulum period formula given in the research section of this report. Pendulum motion can be described by using only the length of the swinging radius given that certain conditions are met. We devised an experiment to test and analyze this claim, and to also see if we could find outliers or any factors that make the claim false. To accomplish such a task, we ran over 9 trial runs. To create proper data we held some variables constant during each trial. After looking over the data, we arrived at the conclusion that for smaller arc lengths the period equation held true. Our manual measurements were in range with measurements taken from the LoggerPro system, which means that our data holds water. Below are a couple period measurements for our trial runs.

Changing mass and holding everything else constant

Trial run 1: Period was 1.819 seconds with an uncertainty of .0044 seconds

Trial run 2: Period was 1.813 seconds with an uncertainty of .0036 seconds

Trial run 3: Period was 1.821 seconds with an uncertainty of .0052 seconds

As you can see, these values overlap and are very similar. While changing mass and holding length and initial angle constant, the periods are the same for smaller swinging arcs. After doing 6 more trial runs with radius length and initial angle changing, we came to the conclusion that both of these variables did not have an effect on period as well (for smaller arcs).

In part two of our lab we set out to examine the limitations of this formula. After some careful planning our group decided to use two experiments with two different unique qualities to accomplish this task. Our first experiment would use the same measurements as a previous trial, but the mass would be a disc instead of the block and hook setup. Our idea was that the wind resistance from the hook and block took energy away from the system and that the disc shape would alleviate that.

Using the same measurements of length, mass, and initial angle, we ran a trial run with the disc shaped object.

Trial run with disc shaped and low mass: 1.667 seconds with .0032 uncertainty

This is compared to a 1.823 second period with the hook and block

Our next idea was to analyze the period when the initial angle was massive. The massive angle would cause a larger arc area to be swept out and hopefully show that another formula must be used to accurately calculate the period of pendulums with large arc lengths.

Using a massive angle and holding all other things constant we found that the period was slightly smaller, which was an odd finding.

Period using larger initial angle: 1.743 seconds with .0044 uncertainty

Period of same trial with small angle: 1.834 seconds with .0045 uncertainty

This means that the larger the arc length of the curve initially, the harder it is to calculate a correct period from the simple formula in part 1.

For the first modification it makes sense that the period would be smaller, since the hanging mass would be allowed to have more kinetic energy with less friction. The second modification is harder grasp intuitively; therefore we had to rely on the scientific method to explain such a phenomenon. The best answer that we could arrive at is that the large arc swing does accelerate the mass for a longer time, which would explain why the object was able to have a higher velocity and a shorter period.

Our group also found (based on our graphs) that there are ideal conditions for examining the functionality of the first formula. Obviously it is known that the angle should be no greater than 10 degrees initially, anything larger and the period starts to shrink. The best length that we found for the trial runs was between 70-75 cm. This range allowed the mass to accelerate and allowed us to break down the data in the logger pro easier. The mass we used seemed to be too heavy; therefore our calculations could have been better. We used a 500-gram mass, and we should have used a smaller mass (0-100 grams). The mass needs to weigh more than the string but not so much that it allows the string to stretch.