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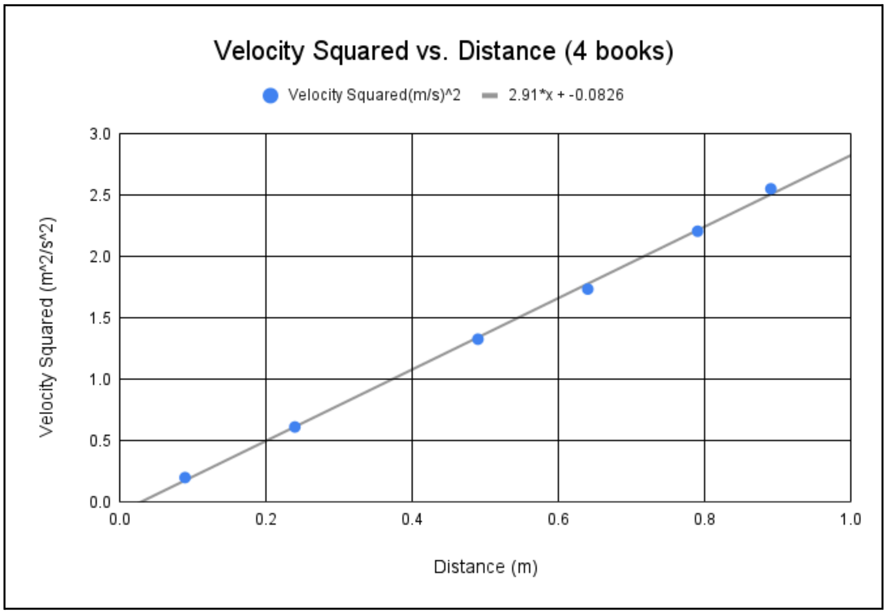
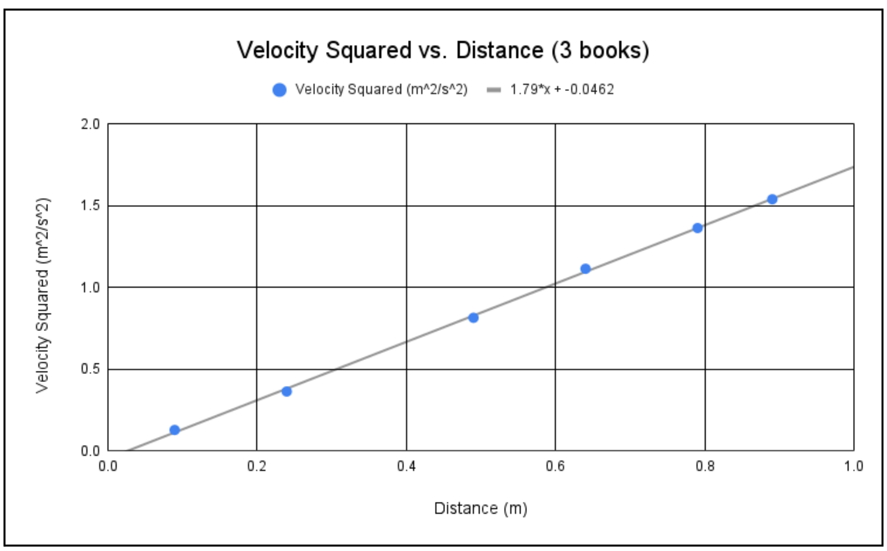
Lab Report 1: Acceleration on an Inclined Plane





Analysis:

In this experiment, my group measured the velocity of a cart moving down a ramp at two different incline heights and needed to find the acceleration with the given information. Since the objective was to determine the acceleration of the cart, I had to use one of the kinematic equations to help linearize the data. The equation I chose was $v^2 = v_0^2 + 2a\Delta x$. Since the cart started from rest, the initial velocity(v_0) was zero, simplifying the equation to $v^2 = 2a\Delta x$. This has the same form as the equation of a line, y = mx, where the y-value corresponds to v^2, the x-value corresponds to Δx, and the slope, m, corresponds to 2a. The y-intercepts of these equations can be ignored since they are very close to 0 and only an approximation of gravity is being sought after. By graphing v^2 on the y-axis against Δx on the x-axis, I determined the slope and therefore solved for acceleration.

The equations of the best-fit lines for our two trials were:

- **Four-book incline:** v2 = 2.91Δx
  - Slope = 2.91
- **Three-book incline:** v2 = 1.79Δx
  - Slope = 1.79

From these slopes, I calculated the acceleration by dividing by 2:

- **Four-book incline:** $2a=2.91 \Rightarrow a = 2.91/2 = 1.455$ m/s^2
- **Three-book incline:** $2a=1.79 \Rightarrow a = 1.79/2 = 0.895$ m/s^2

Next, I compared these results to the expected theoretical values. The expected acceleration down an incline is given by $a = g \cdot \sin(\theta)$ where g = 9.8 m/s2 and θ is the angle of the ramp. θ can be solved using the common ramp length of 1.22 meters and the distinct incline heights for the four-book and three-book incline.

Four books: The height of the incline was 0.195 m, so θ = $\sin^{-1}$(0.195/1.22) = 9.197°. This means the theoretical acceleration is 9.8 * sin(9.197°) = 1.566 m/s^2.

- **Percent Error:** Now, to find the percent error, you take the ((theoretical - exact)/exact). In this case, that would be ((1.566 m/s^2 - 1.455 m/s^2)/1.455 m/s^2). This comes out to 0.0729, or **7.29%**.

Three books: The process for three books is exactly the same, only this time, with a different height. The height of the three-book incline was 0.155 m, so θ = sin-1(0.155/1.22) = 7.299°. This means the theoretical acceleration is 9.8 * sin(7.299°) = 1.245 m/s^2.

- **Percent Error:** The percent error was found using the following formula again: ((theoretical - exact)/exact). In this case, that would be ((1.245 m/s^2 - 0.895m/s^2)/0.895 m/s^2). This comes out to 0.3911, or **39.11%**.

Conclusion:

My experimentally measured accelerations were 1.455 m/s2 for a four-book incline and 0.895 m/s^2 for a three-book incline. Our corresponding theoretical accelerations were 1.566 m/s^2 and 1.245 m/s^2 respectively. This means our percent errors were around 7.29% and 39.11%, showing that our results were consistently higher than the expected values, yet they were within the same magnitude.

There are several possible reasons why the experimental values came out too large. One possibility is measurement error in the distances, such as misplacing the cart's starting position or incorrectly measuring where the photogates were set up. If the cart traveled a shorter distance than recorded, the velocity-squared values would appear too high, inflating the slope. Another potential source of error is sensor calibration: if the photogate sensors triggered slightly too early or too late, the velocity readings could have been too high. Additionally, the black straw attached to the cart that was used to measure it's furthest point was titled, which could have also affected proper distance measurements.

Overall, although our experimental values were higher than expected, the results were reasonable: increasing the ramp incline led to larger accelerations that stayed relatively consistent with the rate of gravity.