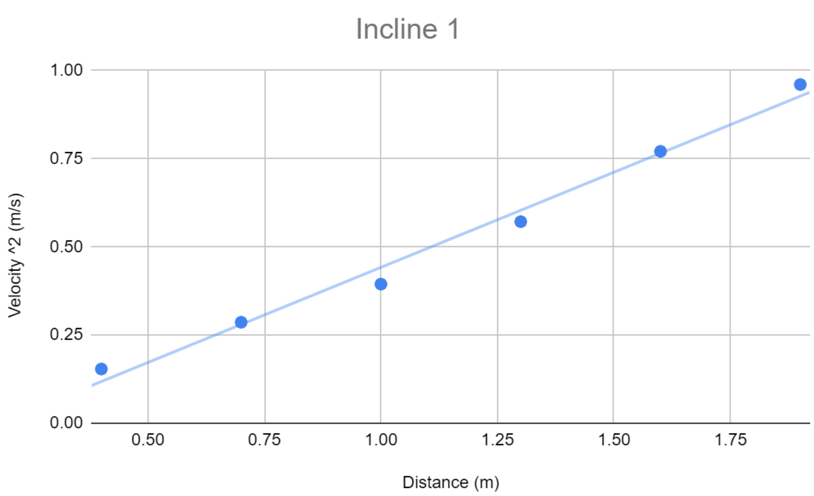
Acceleration on an Inclined Plane Lab

Analysis

In order to accurately find the acceleration, it is important to linearize the data. The equation used for finding the acceleration is $V^2 = V_o^2 + 2a\Delta x$, because it does not include time, which is the variable that we did not measure for.

For a linear graph, the equation of the line must follow the form y = mx + c. To get the original equation, $V^2 = V_o^2 + 2a\Delta x$, into that form, no algebraic manipulation needs to be used. Knowing that the cart always starts from rest, the initial velocity, or V_o, would always be 0, cancelling it out of the equation, leaving us with the new equation $V^2 = 2a\Delta x$. Since the acceleration is always constant, then 2a can be represented by m, or the slope. This leaves Δx as the x variable (and thus drawn on the x-axis) and V^2 as the y variable (and similarly drawn on the y-axis). Since the y-value is V^2, the average final velocities, which are found by averaging the final velocity of each trial, must be squared before being plotted on the y-axis. Finally, we are able to disregard the y-intercept, or the c in the linear equation, because it is close to 0.

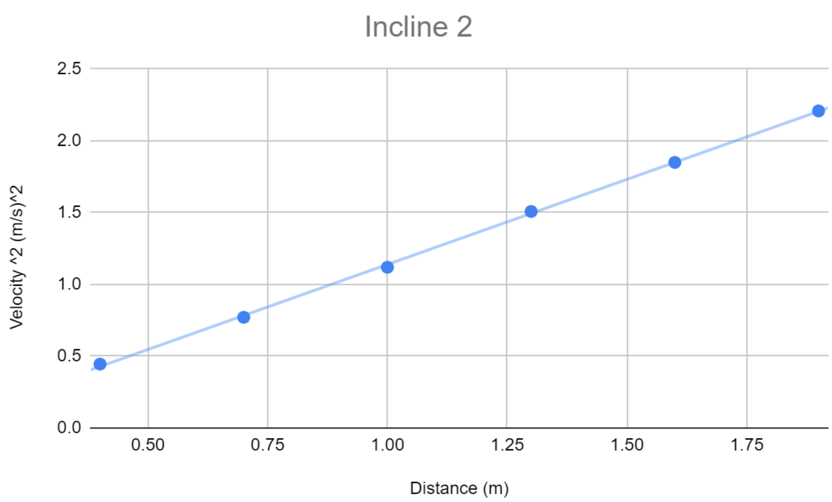
Incline 1



^ the above graph shows the distance (in metres) vs. the average final velocity squared for the first incline

The first incline my group and I measured had a height of 0.071m above the table, and the ramp was 2.0m long. To find the experimental acceleration, we used the equation of the above graph, which was y = 0.54x - 0.0951 (or $V^2 = 0.543\Delta x - 0.0976$) and divided the slope (0.5395) by 2, to get an answer of around 0.2698 m/s^2. To find the theoretical acceleration, we used the equation $a = g\sin(\theta)$, substituting the approximate gravity on earth (9.8 m/s^2) for g, and the ratio of the height of the incline to the length of the ramp, which was found to be 0.0355. The resultant theoretical acceleration was 0.3479 m/s^2. Then, to find the error percentage, the difference between the theoretical and experimental accelerations was divided by the theoretical acceleration, and the error percentage was found to be around -22.48%.

Incline 2



^ the above graph shows the distance (in metres) vs. the average final velocity squared for the second incline

A similar process was repeated for finding the theoretical and experimental acceleration, as well as the error percentage, for the second incline. The second incline my group and I measured had a height of 0.14m above the table, and the ramp was still 2.0m long. To find the experimental acceleration, we used the equation of the line above, which was found to be y = 1.18x - 0.0458 (or $V^2 = 1.18\Delta x - 0.0458$) and divided the slope (1.18) by 2, to get an answer of around 0.592 m/s^2. For theoretical acceleration, we again used the equation a = gsin(θ), substituting the approximate gravity on earth (9.8 m/s^2) for g, and the ratio of the height of the incline to the length of the ramp, which was found to be 0.07. The resultant theoretical acceleration was 0.686 m/s^2. Then, to find the error percentage, the difference between the theoretical and experimental accelerations was divided by the theoretical acceleration, and the error percentage was found to be around -13.64%.

Conclusion

Because the experimental acceleration turned out to be smaller than the theoretical acceleration for both inclines, there are a few sources of error that one can consider. In the beginning of the lab, we were told to ignore friction, but there is always some form of friction present. If the wheels on the cart had any friction with the ramp, then the acceleration would be smaller than expected, which holds true. There could also have been inaccurate measures of velocity due to our inability to see exactly where the centre of the screw would reach the centre of the velocity sensor. Similarly, the tools we used to measure the distance between the ramp and the sensor could have led to some inaccuracies, as we used a metre stick with less significant figures than professional equipment would have provided us with. This aligns with the values we got because if we measured a length or height that was slightly too small, we would have gotten a smaller slope and thus a smaller experimental acceleration, which is true. There was also some trouble with the release of the cart on the ramp in which we accidentally gave the cart a slight push in the beginning, which made the initial velocity greater than 0, and while we tried to redo the trials in which a push occurred, we might not have been completely aware of it every time.