Lab #1: Acceleration on an Inclined Plane

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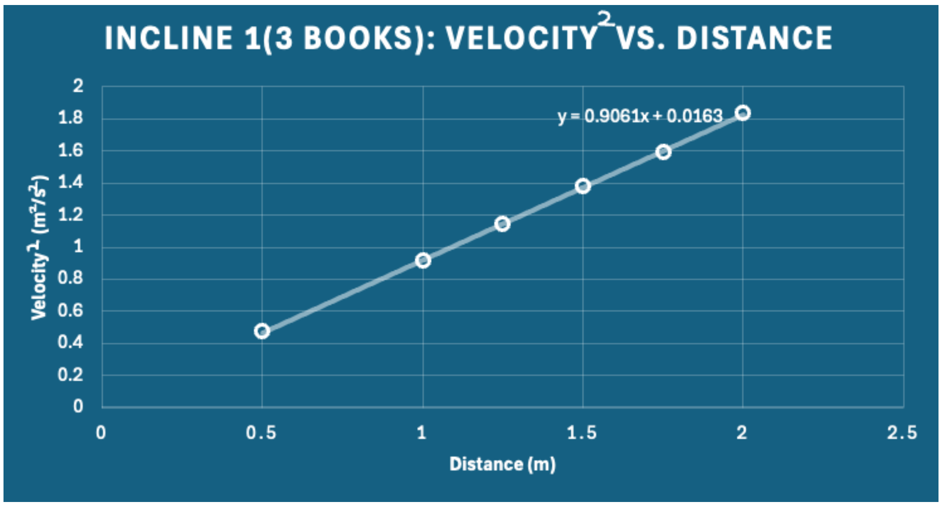
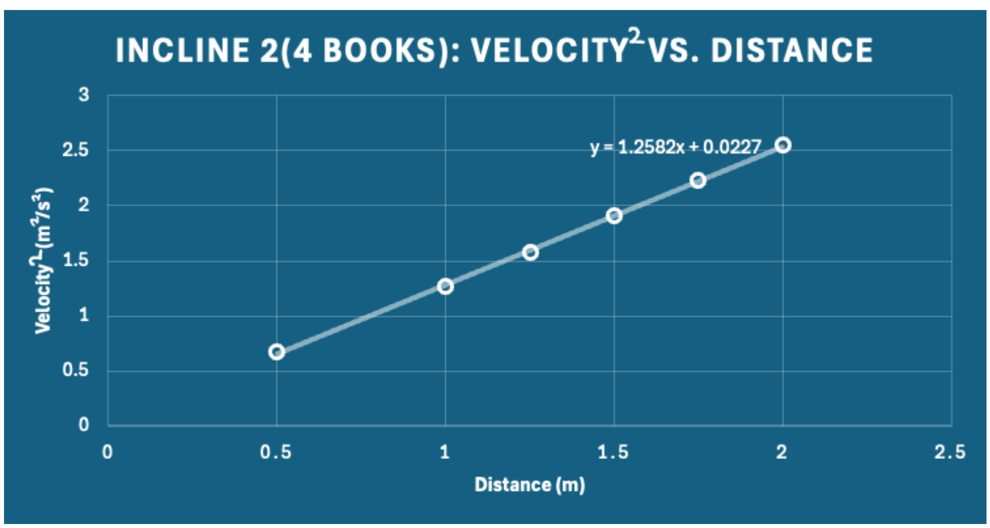
Analysis

Graph 1 shows the data for Incline #1, which had the incline height of 3 books.



Graph 2 shows the data for Incline #2, which had the incline height of 4 books.



The equation of the graphed line in both graphs represents the square of the velocity as a function of twice the acceleration times the distance traveled by the cart.

Calculations

Incline	Line of Best Fit	Solving for	Calculation
1	y=0.9016x+0.0163	a	a=0.9016/2=0.4508 $\frac{m}{s^2}$
2	y=1.2582x+0.0227	a	a=1.2582/2=0.6291 $\frac{m}{s^2}$

Table 1 shows the calculations that were done to find the value of acceleration

Explanation

The purpose of this lab was to find the acceleration of a cart traveling on an inclined plane based on the velocity and distance traveled by a cart. We had 2 scenarios with 2 trails each, and the incline height was different for each scenario. After following a certain procedure for this and recording all the data, we derived a method to calculate the acceleration of the cart by using the appropriate kinematics equation: $v^2 = {v_0}^2 + 2a\Delta x$.

We used the above equation because we had the values for distance traveled, initial velocity, and final velocity and we needed to find the value of acceleration. Since the cart was released from an initial velocity of 0 m/s, the equation could be simplified to $v^2 = 2a\Delta x$.

Now, this equation needs to be linearized so that when it is plotted, it is a straight line. Currently, the above line is a quadratic, so if plotted it would not be a straight line. In order to linearize this equation, we can use the linear slope formula y=mx+b. By putting the slope formula and the above equation above each other, we can equate y to v^2 , m to 2a, and x to Δx. This way, when plotted, the line will be linear, and the slope of the line will be 2a.

After this, the velocity values that were recorded were squared and then plotted, as shown in Graph 1 and Graph 2.

Measurements	Equation	X-axis	Y-axis	Slope
$\Delta x\ ,v$	$v^2 = {v_0}^2 + 2a\Delta x$	Δx	v^2	2a

Table 2 shows the reason behind choosing the x-axis to represent the change in distance choosing the y-axis to represent the square of the velocity.

Conclusion

Evaluation of results

As shown in Table 2, the experimental acceleration for each incline was found by dividing the slope of each line by 2. The experimental acceleration for incline #1 was 0.4508 $\frac{m}{s^2}$ and the experimental incline for incline #2 was 0.6291 $\frac{m}{s^2}$. However, we also must find the theoretical acceleration and compare both accelerations to find the percent error of the experiment. The calculations for the same are shown in the table below

Incline	Experimental acceleration	Height	Hypotenuse	Equation	Incline Angle	Theoretical acceleration
1	0.4508 $\frac{m}{s^2}$	0.115m	2m	$g\ sin(\theta)$	$\sin^{-1}\frac{0.115}{2} = 3.296$	$9.8 \times \sin 3.296$ $= 0.5634\ \frac{m}{s^2}$
2	0.6291 $\frac{m}{s^2}$	0.155m	2m	$g\ sin(\theta)$	$\sin^{-1}\frac{0.155}{2} = 4.445$	$9.8 \times \sin 4.445$ $= 0.7595\ \frac{m}{s^2}$

Table 3 shows the calculations that were done to find the theoretical acceleration.

Using the values in the table above, the percent error for the first incline was 19.60%, while the percent error for the second incline was 17.17%.

Sources of Error

As shown in the table above, the expected values were faster than the experimental values, and this happened for various reasons. The first reason is that there is friction between the cart and the ramp. This friction could've caused the cart to go slower, causing it to have a slower velocity and so a lower experimental acceleration. This friction, although it may be very less, was not considered during the calculations. The second reason that the experimental values turned out to be slower could be because each time during the experiment, the apparatus would shift slightly. This would happen because each time a team member caught the cart at the end of the ramp, the force would slightly move the ruler and the photogate. Although we tried to move them back to the original place, inconsistencies in the repositioning are possible. The last reason that the experimental value turned out to be slower is that sometimes the cart wasn't aligned perfectly with the grooves on the ramp, which could've caused even more friction, causing the cart to slow down even more.