Question: How does the angle between a sloped plane and the ground effect the rate of acceleration of a frictionless object travelling down the plane?

Hypothesis: As the angle increases, the rate of acceleration will increase. The relationship between the angle and acceleration will be trigonometric, by the equation 4.9sinθ = a.

Strategy:

- This experiment required two tracks, two carts (of the same mass), two pulleys and a way to put the second track on an incline. One track was directly above the other and the lower track was at an angle with the ground. The carts were connected via a string and two pulleys. Throughout the course of the experiment, the angle between the lower track and the ground, θ, was adjusted and the acceleration of the system was found using a Bluetooth system which measured displacement over time.

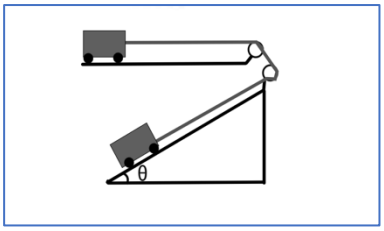

Fig 1. Alignment of Two masses during experiment.

Data:

Θ (degrees)	Acceleration (m/s)
15	4.057
30	3.742
45	3.184
60	2.158
75	0.968

Analysis:

The free body diagrams in Figure 2 show the forces on the masses.

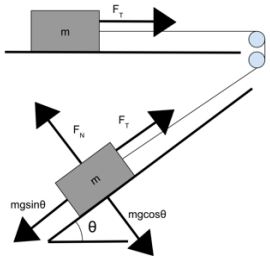

Figure 2: Free Body Diagram of system

Friction between the cart and the track is negligible because the carts wheels spin freely. The force of tension acting on the two objects is negligible because acts to the same degree on both carts in opposite directions, thus cancelling out. The following equation is based on the free body diagrams. Positive motion is defined as to the left for the cart.

$$F = 2ma = mgcos\theta$$

This equation can be manipulated to form the following equation.

$$a = \frac{1}{2}gsin\theta$$

$$a = 4.9sin\theta$$

This equation indicates that there is a trigonometric relationship between the angle between the track and the ground (θ) and the acceleration (a). The slope of this line should be equal to the sine of θ times half the force of gravity. Because the total force on the two masses is equal to the force of weight of one of the masses in the x-axis

A graph of the angle between the bottom track and the ground in relation to the acceleration of the two masses as well as in relation to the hypothesized value of acceleration. Theoretically, the two graphs should be the same.

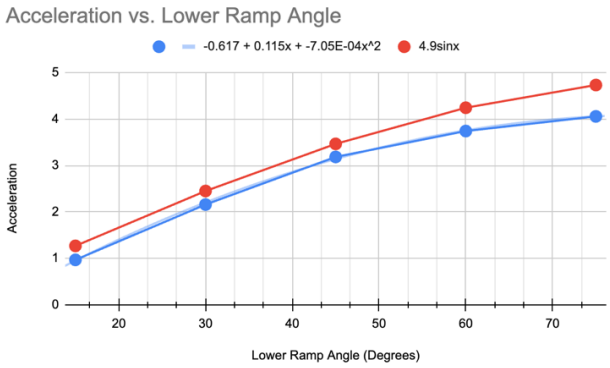

Figure 3: Force vs. Acceleration Graph

The graphs of two equations turned out to be noticeably correlated to a strong degree based off the results, and they both presented a positive increase as the angle increased. Thus, the hypothesis was correct. However, the two graphs were not the exact same due to errors during the experiment. One potential source of error was found in getting the cart to stay on the lower track. In the experiments run with steeper angles, the front wheels of the cart tended to lift off the track but were pushed down prior to release.