Question: Does the relationship between force, mass, and acceleration of a cart traveling along a metal track in a modified Atwood's machine on an inclined plane, refer to figure 1, obey Newton's Second Law when the angle between the ground and the inclined plane is changed?

Hypothesis: As the angle of the up the ramp of the modified Atwood's machine increases, the acceleration decreases. The relationship between the acceleration of the cart and the sin of θ would be linear, as derived in appendix A. The slope of this line should be equal to $\frac{-m_1 g}{m_1+m_2}$ and the y-intercept should equal $\frac{m_2 g}{m_1+m_2}$.

Strategy:

- We tied one vernier cart to weights of the same mass as the cart using string.
- The cart will be placed on a metal rail with a pulley, the weight perpendicular to the ground with the string on the pulley
- The cart will be pulled back until the weight touches the pulley upon when the cart will be let go.
- The cart on the track will move up the track and the hanging mass will fall downwards.
- Vernier graphical analysis will be used to measure the acceleration of the cart.
- The angle between the track and the table will be increased using textbooks and measured using a level and a protractor.

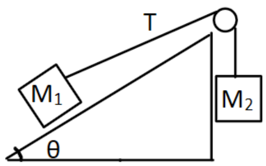

Figure 1: Diagram of experimental apparatus

Data:

Angle (Degree)	Average Acceleration (m/s^2)
0	4.76
6.5	4.04
15.3	3.59
22	3.02

Shows the average acceleration over three trials at 4 different angles between the ramp and the table.

Analysis:

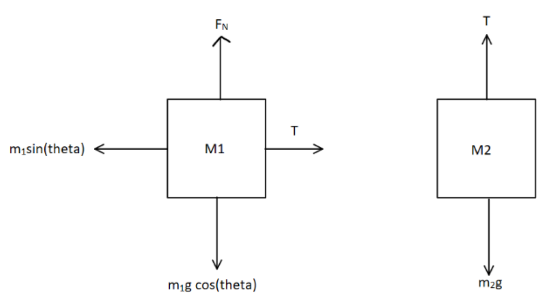

Figure 2: Free body diagrams

Friction between the cart and the track is negligible as the track is a smooth surface and the cart-wheels spin freely. Positive acceleration is defined as clockwise around the pulley. When graphing sin(theta) to acceleration it is found that the slope should be equal to $\frac{-m_2 g}{m_1+m_2}$, as shown in the derivation in Appendix A, and because $m_1 = m_2$ the slope can be simplified to $\frac{-g}{2}$ or -4.9.

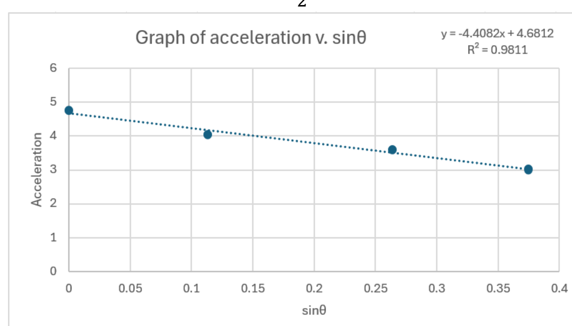

Figure 2: Graph of the sin of the angle to the acceleration of the cart

After performing a linear regression on the data, a slope of -4.4082 was found. This leads to a 10% error from the expected value calculated by $\frac{|-4.4082+4.9|}{-4.9}$. This could be due to issues with the measuring tools used or slight changes in acceleration due to friction.

Appendix A:

Solving the F=ma equation for the first mass in the x direction according to Figure 2 yields: $T = m_1 g \sin\theta + m_1 a$

Solving the F=ma equation for the second mass in the y direction according to Figure 2 and isolating T yields: $T = -m_2 a + F_{G_1}$

Because tension is the same across the string, the Ts in the two equations are the same. Thus, T can be substituted in each equation to combine them into: $m_1 g \sin\theta + m_1 a = -m_2 a + F_{G_1}$. Because the goal of this lab is to predict acceleration, we will now isolate it, resulting in: $a = \frac{-m_1 g}{m_1+m_2}\sin\theta + \frac{m_2 g}{m_1+m_2}$.

This is in the slope intercept form of a line where $y = a, x = \sin\theta, m = \frac{-m_1 g}{m_1+m_2}, and\ b = \frac{m_2 g}{m_1+m_2}$