Question: How does adding an incline affect the relationship between force, mass, and acceleration of m_1 and m_2 in a modified Atwood's machine?

Hypothesis: The relationship between the sine of the incline and the acceleration is linear. The slope of the incline vs. acceleration graph will be equal to the hanging weight divided by the mass of the whole system.

Strategy:

Our strategy was to choose different inclined angles (shown in the diagram as angle theta), measure acceleration and find the best fit line of acceleration vs sin(theta) and verify that that the slope equals the expected value. The mass of the cart (m1) and the hanging weight (m2) were kept constant, so they wouldn't impact the results of the experiment.

Data:

Mass of the cart (m1) : 0.2834 kg

Mass of the hanging weight (m2): 0.05 kg

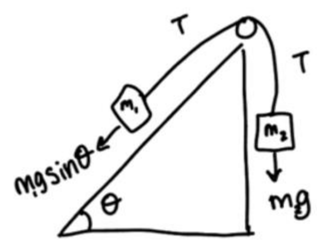
Angle (θ)	**Sine of angle**	**Acceleration (m/s^2)**
0	0	1.47
20	0.342	-1.312
25	0.423	-1.917
30	0.5	-2.232

The acceleration was an average of 5 trials. The first data point (y-intercept) was found using the equation (m2g/(m1+m2).

Analysis:

The free body diagrams in Figure 2 show the forces on the masses in the modified Atwood's machine.

Figure 2: Free body diagram (FBD)



Positive motion was defined as moving clockwise, and friction between the cart and plane was not considered. Based on the FBD, two equations were created.

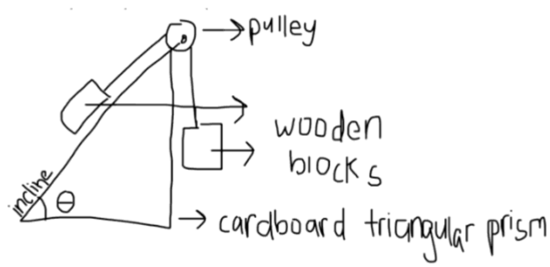
T-m1sinθ = m1a **and** m2g – T = m1a

Based on these equations:

$$a = \frac{m_2 g}{m_1 + m_2} - \frac{m_1 g}{m_1 + m_2} \sin\theta$$

y-intercept slope

Figure 1: Modified Atwood's Machine



This equation indicates that there is a linear relationship between the sine of the angle and the acceleration of the cart. Once the values of the variables are inputted, the slope of the line should be -8.3303 m/(s^2 degrees).

A graph of the sine of the angle vs acceleration of the cart for this experiment shows that the relationship is linear, consistent with the hypothesis, and the slope of the line of best fit was -7.6372, which is very close to the calculated value based on the equation.

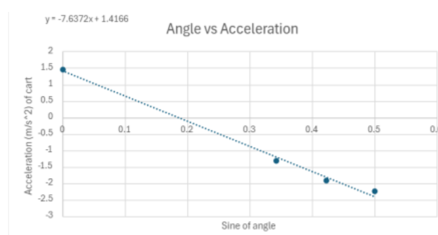


Figure 3: Angle vs acceleration

The percent error of this experiment (calculated slope vs experimental slope) was 8.32%. One reason the experimental slope could be lower than the actual slope is because of friction, which was not accounted for in this problem. Even though the incline was smooth, there is always friction in the wheels of the cart, and this will have an impact on results. Friction will result in the slope being lower than the expected value because it is doing negative work on the cart (reduces net force acting on the cart), making it go slower than what is expected. Also, it was difficult to let go of the hanging weight and make sure it didn't hit the side of the table, so this could have impacted the acceleration values collected.