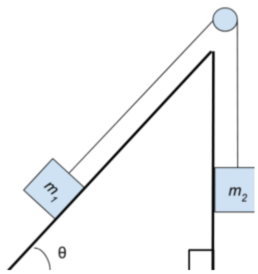
Question: How does the angle of incline between constant masses affect the cart's acceleration in a modified Atwood's machine.

Hypothesis: The relationship between the sin of the angle of incline and the acceleration would be linear with acceleration decreasing as the sin of the angle increases. The slope of the graph of the acceleration vs the sin of the angle will be close to –m1g/(m1+m2).

Strategy:

Figure 1: Modified Atwood's Machine



- The hanging mass in a modified Atwood's machine was varied by changing the ramp to various inclines.
- The inclines that were measured were 0, 15, 30, and 45 degrees. The resulting acceleration was measured using a Vernier motion detector.
- The total mass remained unchanged throughout the trials; the cart(m1) had a mass of 286.8 grams while the weights(m2) that brought it down had a mass of 210 grams. After conducting 3 trials with each incline, we used the mean of acceleration to graph it in relation to the sin of the angle of incline.

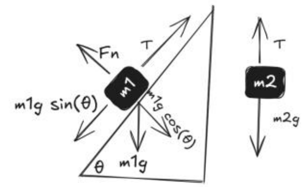
Data:

The mass of the cart: 0.2868 kg
The mass of the weights: 0.21 kg

	Acceleration (m/s^2)			
Angle (degrees)	Trial 1	Trial 2	Trial 3	Mean
0	3.951	3.578	3.983	3.837333333
15	2.579	2.637	2.595	2.603666667
30	1.135	1.185	1.177	1.165666667
45	0.06859	0.07254	0.0759	0.072343333

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

Figure 2: Free body diagram of Atwood's Machine



The cart's wheels move so freely that it makes friction negligible. The following equations are based on the free-body diagrams. Positive motion is defined as the cart going up the ramp, and down for the hanging mass.

$$T - m_1 g sin\theta = m_1 a$$

$$m_2 g - T = m_2 a$$

These equations can be used to substitute for T to form the equation

$$m_2 g - (m_1 g sin\theta + m_1 a) = m_2 a$$

$$a = \left(\frac{-m_1 g}{m_1 + m_2}\right) sin\theta + \frac{m_2 g}{m_1 + m_2}$$

This equation indicates that there is a linear relationship between the sin of the angle of incline(sin(θ)) and acceleration. The slope of this line should be (-m1g/ma+m2) which is the negative weight of the cart divided by the total mass of the system. A graph of the sin of the angle of incline vs. mean acceleration data for this experiment shows that it is linear and that the slope is equal to -5.385 which is close to the expected value of -5.657.

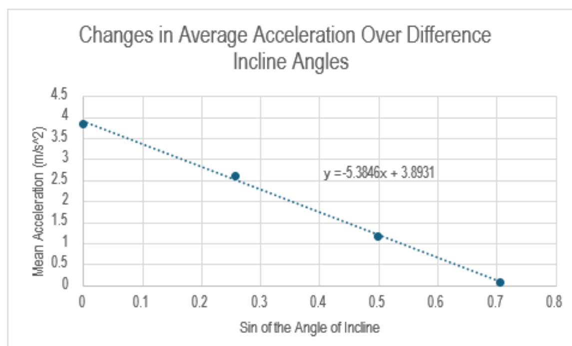


Figure 3: Mean Acceleration vs. Sin of the Angle of Incline

The expected value of the slope is - 5.657 and 4.143 for the y-intercept. The reason the slope is slightly higher is because of the small friction that slows down the acceleration of the system which we did not account for. This gives us a value that is 4.823% greater than expected. However, this shows that the correlation is correct as both the expected value and the actual value follow the same trend and are very close.