Question:

Does the relationship between force, mass, and acceleration of a cart traveling along a metal track in a modified Atwood's machine obey Newton's Second Law even when the hanging weight travels along a slant?

Hypothesis:

We hypothesize that the incorporation of a slant on the hanging weight in a modified Atwood's machine will retain the linear relationship between the hanging weight and acceleration.

Procedure:

- Vary the amount of weight of the mass hanging on the slanted slope. Then measure acceleration.
- If a change is made to one mass, the opposite must occur to the other side. This maintains a constant m term.
- Repeat with multiple slopes angles.
- Plot acceleration against hanging mass for each slant angle.

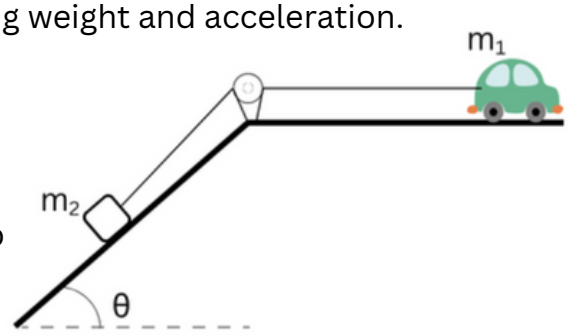

Figure 1: Slanted Modified Atwood

Data:

Angle	m1	m2	accel.
37	46	8	0.047
37	39	15	0.127
37	32	22	0.215
37	25	29	0.267

Angle	m1	m2	accel.
33	46	8	0.018
33	39	15	0.058
33	32	22	0.134
33	25	29	0.183

8 trials we ran; 4 trials per angle. (Not the complete data set.)

Analysis:

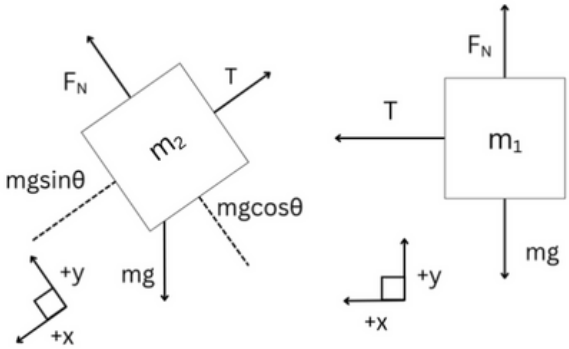

Figure 2: Mass Free Body Diagrams

As seen in Figure 2, friction has been omitted for both masses. In the case of m_1, the cart's wheels minimize this friction, and for m_2, it interacts very little with any surfaces.

Based on the free body diagrams, we can derive the following equations for m_1 and m_2 in that order:

$$T = m_1 a$$
$$m_2 g \sin\theta - T = m_2 a,$$

which sum to

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

This equation indicates there is a linear relationship between m_2 and acceleration when $m_2 + m_1$ and θ are kept constant. This is the same as the relationship between the hanging weight and acceleration of a regular Modified Atwood Machine, just multiplied by the angle of the slant.

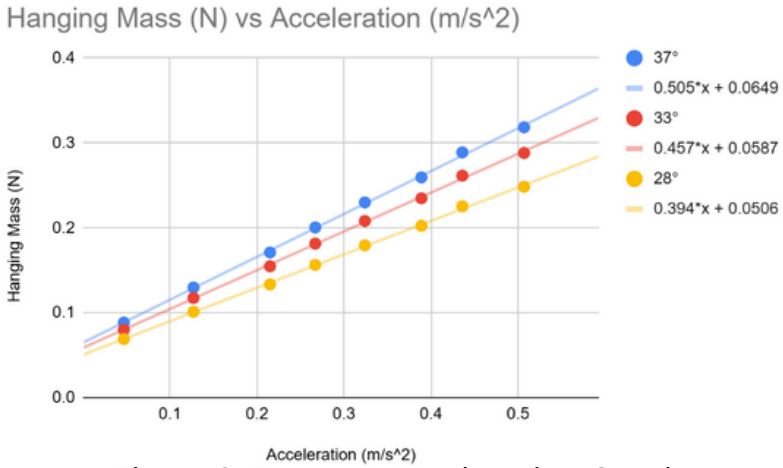

Figure 3: Force to Acceleration Graph

From Figure 3, which plots hanging weight vs acceleration, we observe that each angle is linear, just as expected. Unfortunately, some error seems to have been introduced into the system due to each slope varying from one another and the actual mass of the system, around 0.346 kg. The percent error for the angles are 31.49%, 24.29%, 12.18% respectively. With error increasing with slope angle, one cause of error is likely friction being significant.