Question: Does the relationship between force, mass, and acceleration of a cart traveling along an inclined metal track still follow Newton's Second Law?

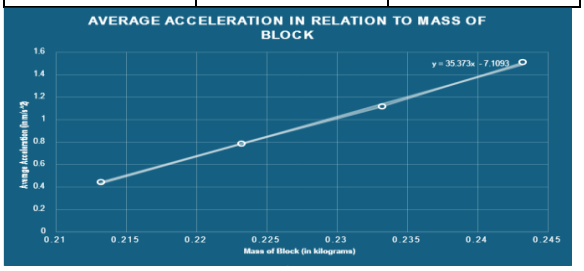
Hypothesis: The relationship between the hanging mass and acceleration will be linear. The slope of that line will be the gravitational constant divided by the total mass

Description of Lab Set-up:

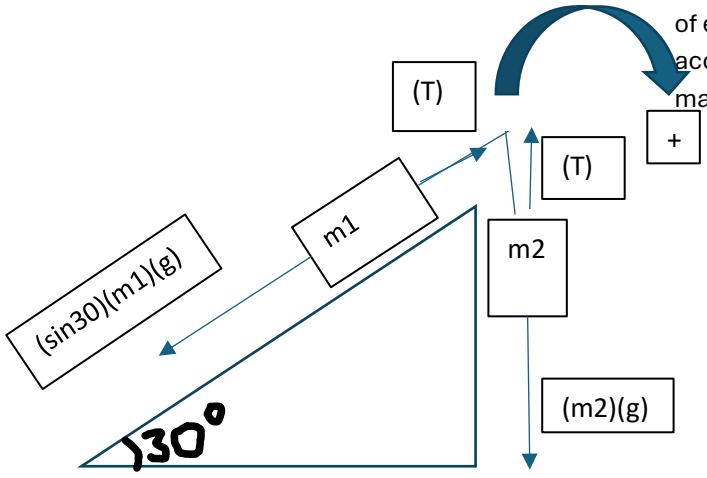
We will use a modified Atwood's machine with an angle. m_2 will be hanging down and m_1 will be on a 30° incline.

Data:

m_1	m_2	a
0.3817	0.2132	0.442
0.3617	0.2232	0.783
0.3417	0.2332	1.116
0.3217	0.2432	1.510



Use a Vernier motion detector to measure the acceleration of various weights. To graph m_2 vs. a, the sum of m_1 and m_2 should stay constant.



$$T - m_1 g \sin 30° = m_1 a$$

$$m_2 g - T = m_2 a$$

Manipulating these equations gets a in terms of m_2.

$$\frac{m_2 g}{m_1 + m_2} - \frac{m_1 g}{2(m_1 + m_2)} = a$$

The slope is $\frac{g}{m_1+m_2}$ because it is a constant being multiplied by m_2, which means m_2 would go on the x-axis and acceleration would go on the y-axis.

Analysis & Conclusion:

We ended up with a linear graph, which is good because that is what Newton's Second Law would suggest. Our experimental slope was 35.373. Because we couldn't keep the sum of the masses constant, we could at least take an average for our expected slope.

The average expected slope was 16.9, and we ended up with a percent error of 109.23%. This means the acceleration was higher than expected. One potential source of error is the y-intercept of the graph. In the equation, the y-intercept is based on the angle. The y-intercept should be $g \sin(\theta)$ because m_1 would cancel out if there was no m_2. If there was a smaller angle, the y-intercept would be less negative, and therefore make acceleration higher. Setting this expected y-intercept equal to our measured y-intercept gives an angle of 46°, rather than the 30° we measured. Another source of error could be the mass of the string making the acceleration higher as it pulls down the hanging mass faster.