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 obey Newton's Second Law?

Hypothesis: As the angle of the inclined plane of the modified Atwood's machine increases, the acceleration decreases, meaning the relationship between acceleration and the sin of θ would be linear. The slope of the relationship should also be -4.9.

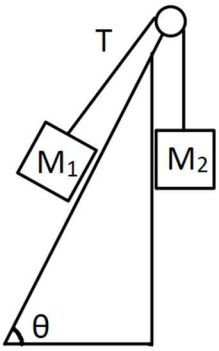

Fig 1: Modified Atwoods Machine on Inclined Plane

Strategy:

- The angle of a modified Atwood's machine on an incline was varied by placing textbooks under the track.
- A cart of mass .3024 kg was placed on the track. A hanging mass of .3024 kg was hung from the track to pull the cart. The acceleration of the cart at each angle was measured and recorded.
- The total mass was kept constant by using the same cart and hanging mass for each trial.
- A graph of acceleration vs sinθ was graphed.

- Data

sin(angle)	accel.(m/s^2)	m1 (kg)	m2 (kg)
0.11	4.046	.3024	.3024
0.11	4.034	.3024	.3024
0.11	4.054	.3024	.3024
0.26	3.579	.3024	.3024
0.26	3.596	.3024	.3024
0.26	3.601	.3024	.3024
0.37	3.036	.3024	.3024
0.37	2.997	.3024	.3024
0.37	3.025	.3024	.3024
0	4.77	.3024	.3024
0	4.746	.3024	.3024
0	4.75	.3024	.3024

Figure #2: Table of sin of track angle vs. acceleration

- Analysis

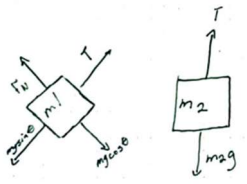

Figure #3: Free Body Diagrams

This is a free body diagram of the system on an incline. As shown, the force of gravity times the sin of theta times the mass of the cart on the track gives the force that is pulling the car down (T-m1gsinθ=m1a). The hanging mass times gravity gives the downward force on the hanging mass (T=m2g-m2a). This produces a linear equation of a= -m1gsinθ/(m1+m2) + m2g/(m1+m2)
Using the masses of the two weights, the expected slope of the graph would be -4.9, and the y-intercept would also be 4.9.

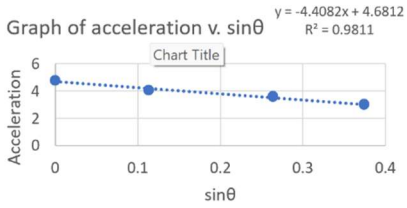

Figure #4: Graph of experimental data

As indicated by this graph, the relationship between the sin of theta and acceleration appears to be relatively linear, and acceleration appears to decrease as the track angle increases.

In this experiment, an actual slope of -4.408 was found. This gives a percentage error of 10%. This may have been caused by a few different factors, including negligence of friction (friction was negligible due to the cart freely moving along the track, however friction is always present). The coefficient of friction is less than 1, so this will cause the slope of the line to decrease, meaning acceleration is slightly less than what is currently predicted by the derivation. The y-intercept is unchanged, since this is based solely on the masses used and gravity. This may have also been caused by repeating the experiment over a two-day period, meaning that cart/weights used may have been slightly different. The angle was also measured using a protractor, meaning the measurement could have been slightly off. However, the relationship between these two variables was still found to be linear and decreasing, indicating that this machine indeed obeys Newton's second law of motion