Question: Does the force of gravity on a cart traveling along a metal track maintain its direction and magnitude in a modified Atwood's machine?

Hypothesis: The force of gravity will remain constant at around 9.8 m/s despite the incline.

Strategy:

- The metal track was set at various angles (0-90 degrees, increasing by 15 degrees each time).
- The height of the stack of books remained constant at 15 books (.589 meters)
- The track was slid forwards or backwards to obtain each angle. The distance slid forward or backward was calculated using trigonometry and the track was slid to that point.
- The (frictionless) cart was then attached to a string and then hung from a force sensor.
- The force sensor tracks the force down the incline plane, which was recorded using the Logger Lite software.

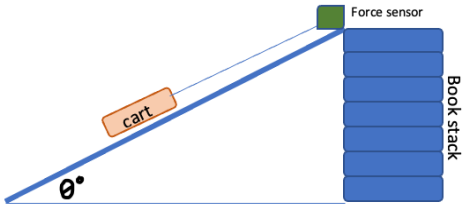

Fig 1: Cart-Force Sensor on an Incline

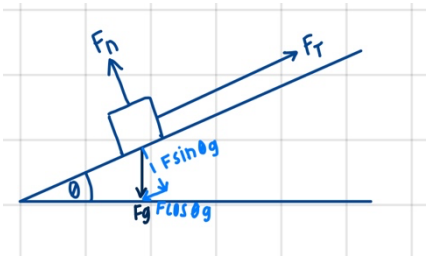

Fig 2: Theoretical Free-Body diagram

Data: Mass of the cart: 0.489 kg

Incline Angle (θ)	Tension Force (N)	Found Gravity (m/s)
0	0	9.930803676
15	1.28	10.08032129
30	2.51	9.797262631
45	3.45	9.947119096
60	4.29	9.916199559
75	4.77	10.05823293
90	5.01	9.930803676

Analysis:

Friction between the cart and the track is negligible because the carts wheels spin freely. The following equations are based on the free body diagrams. Positive motion is defined as to the right for the cart, and down for the hanging mass.

$$F_T - \sin(\theta)\, mg = ma$$

Since our acceleration is 0, this equation can be rewritten as

$$F_T = \sin(\theta)\, mg$$

This equation indicates that there is a linear relationship between the force of gravity on the hanging mass (m_2g) and the tension force. The mass (m) should remain constant with the mass of the cart (0.489). Ideally, the force of gravity should remain constant, meaning that our tension force should change as the angle does. If we extract our mass and angle data, our slope should be equivalent to the constant of gravity.

The graph of the tension force data for this experiment indicates a slope equal to 9.96(N).

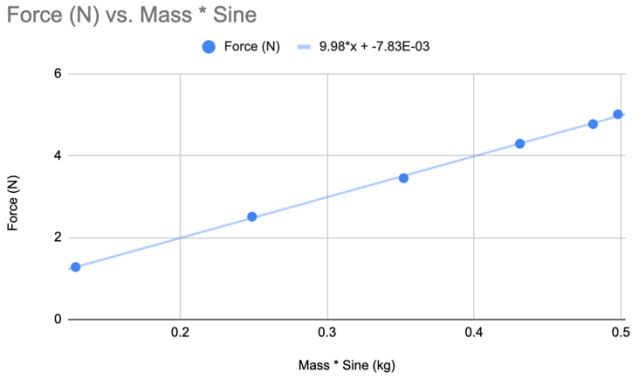

Figure 3: Force vs. Mass* Sine Graph

The hypothesized force of gravity 9.8 N which means that the force found in Figure 3 is 1.8% larger than expected. Although the difference between the expected and the actual force was insignificant, it can be attributed to errors in our method. The most likely source for this discrepancy is any friction between the ramp and the cart. There were also some moments where the cart didn't touch the ramp due to the steep incline angle which may have also contributed to the discrepancy. Despite this change, the graph maintains that there is a linear correlation between the sine of the incline angle and the tension force, by extension proving a constant acceleration for gravity.