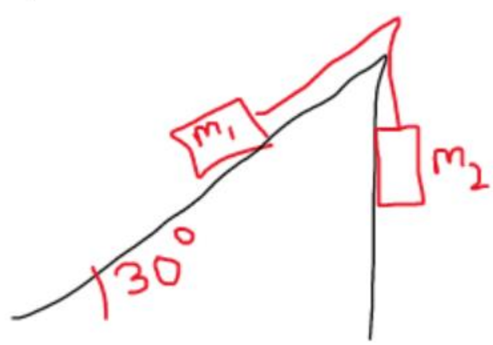
Question: Does the relationship between force, mass, and acceleration of a cart still follow Newton's Second Law despite being on an inclined plane?

Hypothesis: The relationship between the hanging mass (m_2) and acceleration of the whole system will be linear. The slope of the graph will be the gravitational constant (g) divided by the total mass (m1 + m2).

Description of Lab Set-up:

We modified an Atwood's machine by adding an angle of 30 degrees to test our research question.



Using the Vernier motion detector to measure the acceleration of various weights for m1 and m2, we graphed m_2 vs. A. To do this, the sum of m_1 and m_2 should stay constant. We chose m2 values that will make the cart slide up to the top of the ramp. Since the forces acting on m1 are the force of tension up the ramp and g going down the ramp, or $m1g\sin 30°$, you can derive the follow equation as the net force on m1 assuming clockwise about the pulley is positive:

$$T - m1g\sin 30° = m1a$$

The same follows for m2:

$$m2g - T = m2a$$

When we manipulate these equations, we can get a in terms of m2.

$$\frac{m2g}{m1 + m2} - \frac{m1g}{2(m1 + m2)} = a$$

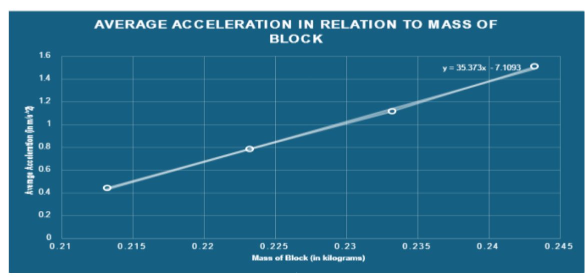
The slope is

$$\frac{g}{m1 + m2} = a$$

Data:

m1 m2

Mass of Cart (kg)	Mass of Block (kg	Average Acceleration (r
0.3817	0.2132	0.442
0.3617	0.2232	0.783
0.3417	0.2332	1.116333333
0.3217	0.2432	1.509666667



Analysis & Conclusion:

Our graph of Average acceleration of the system vs. The mass of the block is linear, which is accurate because that is supported by what Newton's Second Law would suggest. Our experimental slope was 35.373 (m/s^2/kg). Since we couldn't keep the sum of the masses constant, we took an average for our expected slope.

Using this, the expected slope was 16.9. This gives us a percent error of 109.23%. This means that our experimental acceleration was over twice as high as expected. It was expected that our y-intercept ($\frac{m1g}{2(m1+m2)}$) would be negative, which it did turn out to be. However, when simplified when m2 = 0, the y intercept should be $-\frac{g}{2}$, which ours (-7.1093) is lower than it should be. The fact it is less than it should be shows us that our angle could have been smaller than 30 degrees.

Sources of Error:

One potential source of error could be problems with finding the acceleration from Vernier. The parts highlighted to find the acceleration differed which could lead to a different and potentially higher acceleration than expected.

One source of error could be the measuring of the incline. Since we were not too exact with our measurements, we could have actually had a shallower incline than 30 degrees, leading to a faster acceleration.

One last source of error could have been a potential push down when dropping m2. Rather than dropping it, it may have been given an extra push downwards causing a higher acceleration