Question: How does adding an incline to the ramp affect the acceleration of m_1 and m_2 in a modified Atwood's machine? The setup is described in the diagram below.

Hypothesis: The relationship between the sine of the angle of the incline and the acceleration will be linear. The slope of the sine of the incline vs. Acceleration graph will be equal to the hanging weight divided by the mass of the whole system.

Strategy:

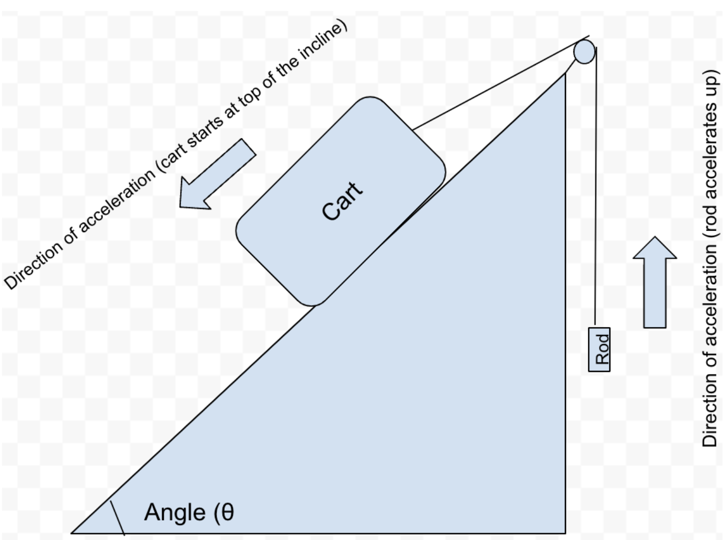
1. The inclined angle was varied by having the Atwood's machine rest on different amounts of books, which thus changes the elevation and angle of the machine

2. The masses used were kept constant, one being a brass rod (hanging weight) and the other as a rolling cart (on the incline)

3. The cart starts at the top of the incline, and then when let go, it will accelerate down the incline, thus bringing the golden rod up from the ground. The acceleration of the total system was calculated using a Vernier motion detector

4. For each angle, the acceleration was measured 3 times, then the average of those three were calculated

5. The sine of the angle was graphed vs. the acceleration to confirm that the slope will equal to the hanging weight divided by the mass of the whole system (the cart and golden rod)



Data:

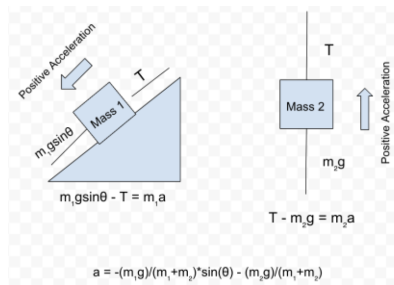
Mass of the cart: 0.2834 kg

Mass of the rod: 0.05 kg

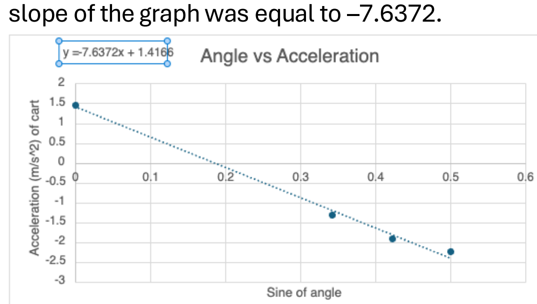
Angle	Sine(Angle)	Acceleration (m/s^2)(Test 1)	Acceleration (m/s^2) (Test 2)	Acceleration (m/s^2) (Test 3)	Mean of Accelerations
0°	0	1.47	1.47	1.47	1.47
20°	0.342	-1.311	-1.313	-1.313	-1.312
25°	0.423	-1.897	-1.938	-1.916	-1.917
30°	0.500	-2.259	-2.224	-2.214	-2.232

Analysis:

The free body diagrams for the diagram are:



Friction in this system was negligible. The equation for tension of both the slope and gravity diagram is $T = m_1g \sin(\theta) - m_1 a$, and $T = m_2a + m_2g$, respectively. Then, the equations can be made equal, because of the common Tension. After simplifying, you will get $a = -(m_1g) / (m_1+ m_2) * \sin(\theta) - (m_2g) / (m_1+ m_2)$. This equation indicates that there is a linear relationship between the sine of the angle and the acceleration of the system. The slope of this line would be the coefficient of the $\sin(\theta)$, which is the force of gravity on m_1 divided by the total mass of the system $(m_1+ m_2)$. The y-intercept would be the weight of m_2 (m_2g) divided by the sum of both masses $(m_1 +m_2)$.
After putting the data on the graph, it was indeed linear. The slope of the graph was equal to –7.6372.



The actual slope of the graph would be $(- m_1g) / (m_1+ m_2)$, which is around –8.33, meaning that the actual value is 8.32% smaller than the expected. The fact that it is too steep means that acceleration was greater than expected. This discrepancy could be due to the negligence of friction and the inaccuracy of Vernier Analyzer, which would misanalyse the acceleration.