Question: Given that there are 3 unique masses set up such that 2 of the masses rest on an incline with a string attached to a third mass that is hanging in between, would all the masses have the same acceleration?

Hypothesis: All of the masses will have the same acceleration.

Strategy:

- 3 masses were set up according to Fig. 1
- The acceleration of the 3 masses were recorded

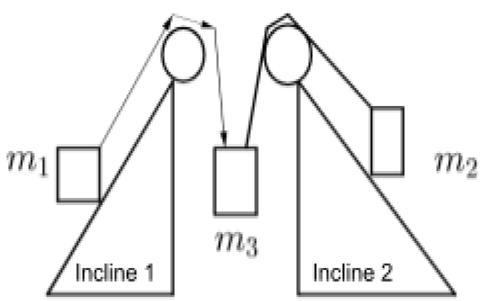

Fig 1. Diagram of the setup

Data:

For clarification, incline 1 and incline 2 have different angles. The angles were kept the same for all trials. The angle of incline of incline 1 will be referred to as θ and the angle of incline 2 will be referred to as ϕ. In this experiment θ was equal to 35.45 degrees and ϕ was equal to 26.74 degrees.

m_1 (kg)	m_2 (kg)	m_3 (kg)	Expe-rimen-tal a (m/s^2)	Theo-retical a (m/s^2)
0.3	0.5	0.42	0.19	0.17
0.3	0.4	0.42	0.55	0.58
0.4	0.5	0.42	0	-0.28

Analysis:

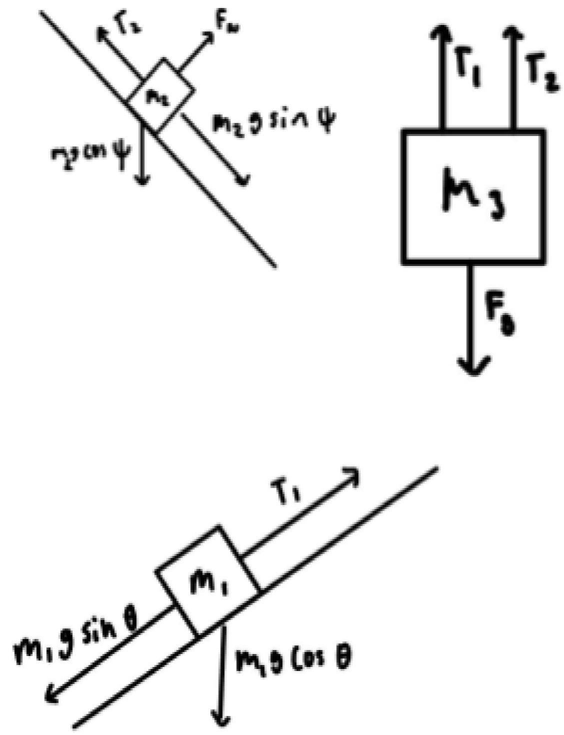

Fig 2. Free body diagram of each of the 3 masses

Using the free body diagram of m_3, we can derive $m_3g - T_1 - T_2 = m_3a$. We can do the same for m_1 and m_2 and get $T_2 - m_2gsin(\phi) = m_2a$ and $T_1 - m_1gsin(\theta) = m_1a$ respectively. Combining all these equations and solving for a, we get

$$a = \frac{m_3g - m_1gsin(\theta) - m_2gsin(\phi)}{m_1 + m_2 + m_3}.$$

This equation was then used to find the theoretical acceleration listed in Column 5 of the data table.

Some sources of error could be the immediate rounding that took place in the calculations as well as the friction between the wheels of the masses and the ramp which was considered negligible in our calculations. Both the strings were cut to be the exact length of 60 cm which held the system in place so that the masses don't go down the ramp(meaning no negative acceleration and staying at rest hence explaining the experimental a of 0 but theoretical of -0.28).