Question: How does the relationship between tension and hanging mass impact the acceleration of a block traveling along a ramp?

Hypothesis: The relationship between the tension and hanging mass is linear to that of the acceleration. As hanging mass increases there is more tension created, which is able to increase the acceleration acted upon by the block due to Newton's Second Law.

Strategies:

- The hanging mass in the experiment was varied and added upon by the use of washers from an overall hanging mass tied to a string. This string was then anointed onto the wheel and attached to the block on a ramp.
- The block was gently placed down on the ramp and dragged down due to the forces acting upon it.
- After each washer was added, the velocity of the block at the bottom of the ramp was measured using a Vernier motion detector.
- The weight of the block going down the ramp was kept constant. The Δx was also kept the same between each trial.
- For each trail of which a washer was added, the new mass of the hanging weight was recorded, and the velocity was tested twice to ensure less margin for error in our calculations.

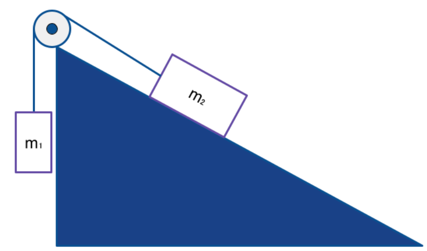


Figure 1: Free Body Diagram of Experiment Overall

Data:

Figure 2: Measured Velocity after each Washer was added

# of Washers	m_1	v1	v2	Acceleration
0	0	-1.452	-1.446	4.140
1	50.1	-0.416	-0.394	0.307
2	51.7	-0.368	-0.39	0.301
3	53.7	-0.355	-0.331	0.217
4	56.1	-0.224	-0.233	0.108
5	58.8	-0.125	-0.119	0.028
6	61.4	-0.037	-0.036	0.003

Analysis:
Using this big 4 equation, we are able to use the velocity found in our experiments and find the acceleration of each trial, which is shown in the table:

$v^2=v_o^2+2a\Delta x$

The following equations are based on the free body diagrams shown in Figure 3. Positive motion is defined as right for block on the ramp, and up for hanging mass:

$T-m_1g= m_1a$

$T= m_1(a+g)$

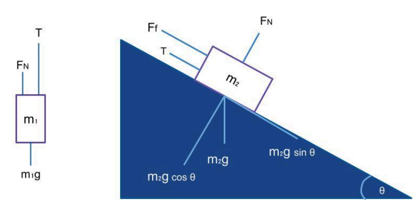


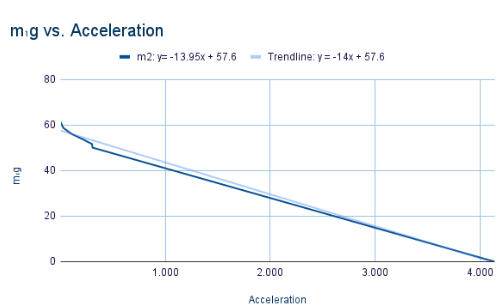
Figure 3: Detailed Body Diagrams of Each Block

The equations from the free body diagram can be used to form this equation:

$m_1g \sin\theta - Ff - T = m_2a$

$m_2g \sin\theta - \mu(m_2g \cos\theta) - m_1(a+g) = m_2a$

Figure 4: Graph with coefficients in relation to mass



This equation demonstrates that the relationship between the acceleration and the changing mass is linear. We can use the equation above and format it into the y=mx+b equation to demonstrate the relationship proposed above:

$m_2g \sin\theta - \mu(m_2g \cos\theta) + a(m_1 + m_2) = m_1g$

This relationship is demonstrated on the graph.

The percent error is 0.3% when comparing the expected linear relationship to the experimental one. The acceleration was less than expected, which may be due to the friction between the block and the ramp, as friction decreases acceleration.

Newton's Second Law states: Acceleration of an object is proportional to the net force acting upon it and inversely proportional to its mass stays. Therefore as the force acted upon it (T) increases due to an increased hanging mass, the object has more acceleration going up the ramp, demonstrating a linear relationship.