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Question: Does the relationship between the hanging mass and the acceleration maintain a linear relationship even when the surface of the hanging mass is slanted at a non-zero angle?

Hypothesis: We hypothesize that even with the incorporation of a slant on the hanging weight in a modified Atwood's machine, there is still a linear relationship between the hanging mass and acceleration.

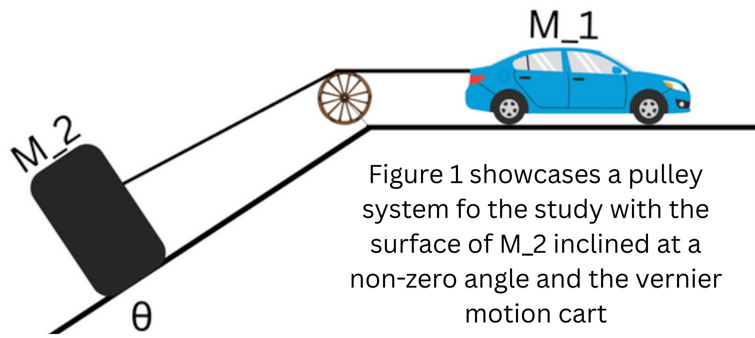


Figure 1 showcases a pulley system fo the study with the surface of M_2 inclined at a non-zero angle and the vernier motion cart

Strategy:

- The hanging mass in the modified Atwood's machine was varied by **hanging various numbers of washers** from a paper clip tied to the string. The resulting acceleration was measured using a Vernier motion detector.
- The total mass was kept **constant** in the total system when gathering data points in the figure to the right
- To understand how acceleration relates to the angle of a slope and the mass sliding down it, we must find the angle of the slope. To do this, we measured the table height and the length of the slope, which is a constant 121 cm. After, we took the inverse sine of the angle to get the angle measure.

Data:

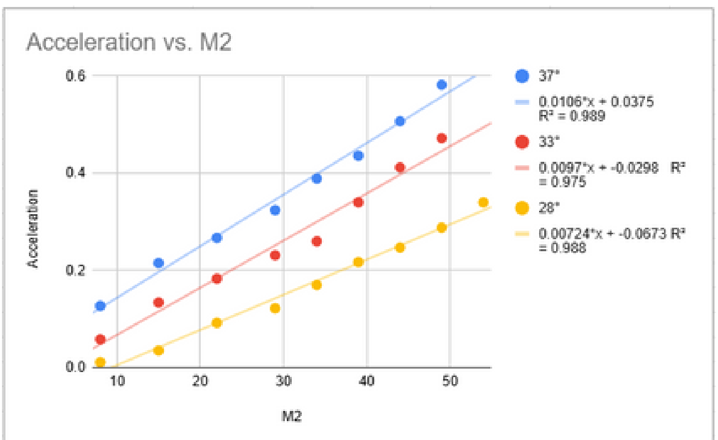


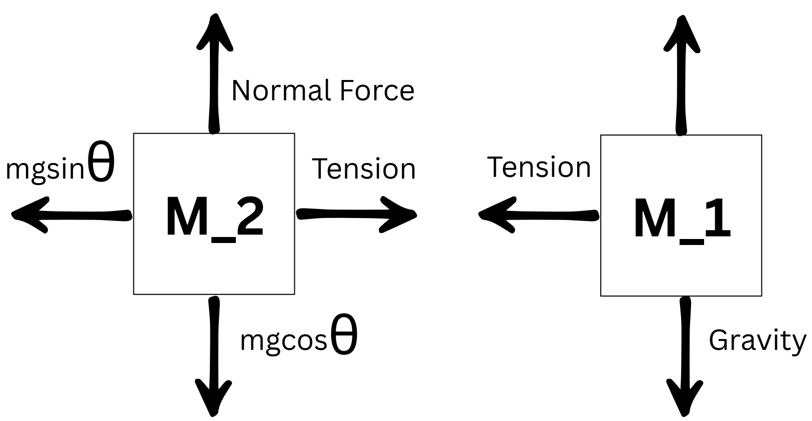
Figure 2 showcases the mass of the hanging block plotted against acceleration as the angle varies. The relationships are mostly linear, even with varying angles, supporting our hypothesis (percent error: 1.1%, 2.5%, and 1.2% for 37°, 33°, and 28° , respectively)

Raw Data:

Test Number	Angle	Mass on Cart	M2	Acceleration	m2g(N)
1	37	46	8	0.047	78.4
2	37	39	15	0.127	147
3	37	32	22	0.215	215.6
4	37	25	29	0.267	284.2
10	33	46	8	0.018	78.4
11	33	39	15	0.058	147
12	33	32	22	0.134	215.6
13	33	25	29	0.183	284.2
19	28	46	8	0.011	78.4
20	28	39	15	0.035	147
21	28	32	22	0.092	215.6
22	28	25	29	0.122	284.2

Figure 3 shows excerpts of the entire dataset used to interpolate the linear relationship between M_2 and the acceleration

Free Body Diagrams



Derivation of Formula for Acceleration

The following equations were derived based on the free body diagrams.

1). $T = m_1 a$ — Equation for mass 1, since tension is net force

2). $m_2 g \sin\theta - T = m_2 a$ — Equation for mass 2 (incline gravity + tension)

1). + 2). = — Add equations for mass 1 and mass 2

$$m_2 g \sin\theta = m_1 a + m_2 a$$

Simplify

$$m_2 g \sin\theta = (m_1 + m_2) a$$

Solve for acceleration

$$a = \frac{m_1 + m_2}{m_2 g \sin\theta}$$

Final Equation: $M\_2 * g\sin\theta = (M\_1 + M\_2) * a$

According to this equation, acceleration is directly proportional to M_2, with a linear relationship with the slope as the sum of the masses of both over the product of the gravitational constant and the sine of the slant angle.

Possible Sources of Error:

Friction between cart/hanging mass and ramp, selecting varying ranges on velocity-time graph to interpolate acceleration, human error in stopping timer, the mass of string affecting acceleartion, and air resistance