Question: How does friction affect acceleration of a mass on a modified Atwood's machine?

Hypothesis: As the µ of a system increases, the magnitude of acceleration will decrease. The relationship between

Strategy:

- The friction of the Vernier cart was modified with a block pulling behind the cart to add friction. We used the block to test the friction of the felt side, the wooden side, and with no friction at all.
- The total mass was kept constant by leaving the block on the cart for the no friction trial. The hanging weight remained constant – 1.25 N.
- The track was placed horizontally with no incline. The varied variable will be friction, and the measured variable will be acceleration.
- µ was found in a separate experiment, which consisted of a force gauge pulling the block at a constant speed, allowing us to find the µ.

The formula used in this experiment was:

$$F\ = ma$$
$$F_{pull} - F_F = 0$$
$$F_{pull} = (\mu)mg$$

Data:

Total mass of the system: 0.41837 kg

Level of Friction	Force to pull friction block at Constant Speed	Acceleration (m/s²)	µ
None	0	2.2514	0
Wood	0.394	1.57	0.3152
Felt	0.468	1.4808	0.3744

The acceleration is an average of five trials per level of friction.

Analysis:

The free body diagrams in Figure 1 show the forces on the masses in the modified Atwood's machine. We found µ with the equation F=ma, since acceleration is 0 when moving at a constant speed.

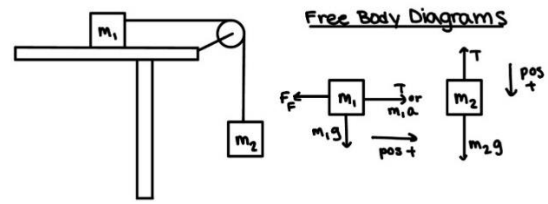


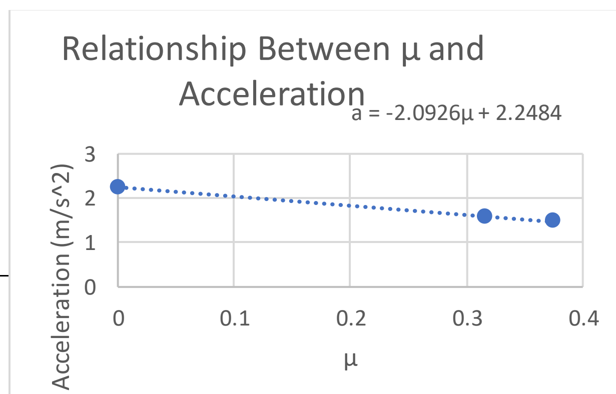
Fig 1: Modified Atwood's machine Free Body Diagrams

$$F_{NET} = (m_1+m_2)a$$
$$m_2g - F_F = (m_1+m_2)a$$
$$m_2g - \mu m_1g = (m_1+m_2)a$$
$$a = g * \frac{m_2 - \mu m_1}{m_1+m_2}$$

The final graph displays a linear relationship between Acceleration and µ. Since the slope has mu, or the independent variable, it corresponds to this term:

$$g * \frac{-\mu m_1}{m_1+m_2}$$

in our initial equation.



We can calculate the actual slope using the term above, and we get $9.8(\frac{-\mu(0.418367)}{0.418367+0.12755})$. This calculates to -7.51µ, making the percent error around 72%.

The most likely source for the percent error is friction in the wheels of the cart, as additional friction would impact the outcome of the data. In addition, one of our calculations could have been inaccurate, or the velocity could have been measured inaccurately when passing through the photogate.