Dynamics Lab Report

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Question: How does the weight of m1 required to barely overcome the static friction between m1 and the track change as the mass of m2 increases?

Hypothesis: As the weight of m2 increases, the weight required to keep m1 from moving will increase. This relationship will form a linear graph, with the slope indicating the coefficient of friction.

Strategy:

- The hanging mass in a modified Atwood's machine was varied by hanging a heavier m2 each time. This was accomplished by adding weights to the string
- The mass of m1 was adjusted in response to the change in m2, until the m1 moved forwards briefly and stopped again.
- The weights where the static friction was met were recorded in a table and graphed in a scatterplot of the mass of m1 vs. the mass of m2 with a line of best fit.

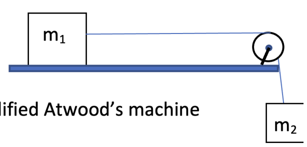

Fig 1: Modified Atwood's machine

Data:

Table 1 shows the masses of m1 and m2 required to barely overcome static friction in grams.

m1(grams)	m2(grams)
262.4	50
305.9	60
358.6	70
420.2	80
466.9	90
550.6	100
564.2	110
650.7	120
689	130

Table 1: the masses of m1 and m2 that meet static friction.

Analysis:

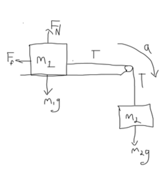

Figure 2: Free Body Diagrams

The free body diagram in Figure 2 shows the forces acting on the masses in the modified Atwood's machine. This free body diagram allowed us to derive the equations found below. We decided that positive motion is to the right for the cart, and down for the hanging mass.

$$T - F_f = m_1 a$$
$$F_n = m_1 g$$
$$m_1 g - T = m_2 a$$

These equations can be combined to form the equation

$$m_2 = \mu m_1 + (m_1 + m_2)a$$

This equation shows that there is a linear relationship between the mass of m_2 and the mass of m_1 required to match the static friction. As the objects are meeting static friction, there is no acceleration or movement of the object. The slope of this line should be the coefficient of friction between m1 and the track. A graph of the mass of m1 vs. mass of m2 data shows that their relationship is linear, and that the slope is equal to 0.1816, which is the value of mu between m1 and the track.

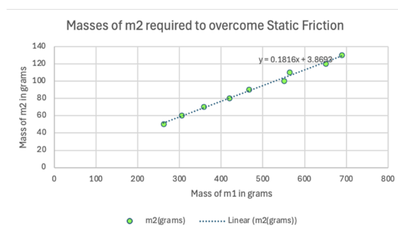

Figure 3: mass of m1 vs. mass of m2

The actual coefficient of friction between m1 and the track is 0.1887 (as seen in figure 3), while the expected mu is 0.1905. We calculated the expected mu by plugging the values in table 1 into the equation above. The coefficient of friction found from the mass data is 3.75% smaller than expected. The fact that it is too small indicates that the value of mu was less than expected. The most likely source for this discrepancy is slight variations in judging whether the cart overcame the static friction or not. It was hard to tell just how much the cart moved and if that movement showed that it overcame the static friction. The y intercept of figure 3 should be the origin, which shows that if the mass of the first block is zero, then the mass needed to meet the static fraction would also be zero. The difference between the expected y intercept shows a potential source of error.