Dynamics Lab

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Question: How is the acceleration affected if the placement of mass of the washers was changed from the cart side of the pulley system to opposite end of the string?

Hypothesis: The mass of the washers and acceleration would have a linear relationship with the mass of the four entities (cart, both friction blocks, and hanging washers) in the experiment being the slope that affects this linear relationship.

Figure 1 Free Body Diagram

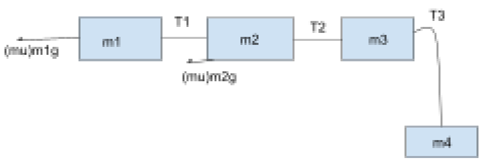
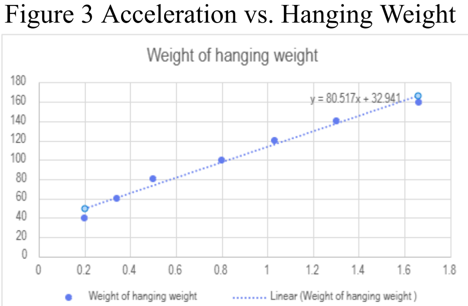


Figure 2 Dataset with displacement of the washer and the corresponding acceleration

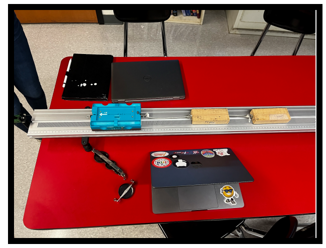
Weight of hanging weight	Weight iof dragging weight	Acceleration
40	120	0.2
60	100	0.34
80	80	0.5
100	60	0.8
120	40	1.03
140	20	1.3
160	0	1.66

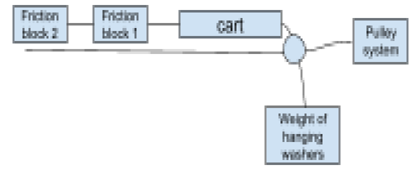
Figure 3 Acceleration vs. Hanging Weight



Materials: Track, Cart, 2 Friction Blocks, Washers, String, Pulley System

Strategy: We began by attaching two blocks with felt sides on the ramp to our cart. These blocks created friction for the cart on the ramp. Then a light string was attached to the cart to which weights of different masses were hung along a pulley, thus creating an Atwood machine.This string along with weights creates the tension for the cart. As weights were added to the string the same amount of weight was taken off from the cart (which were initially placed on the cart to prevent fluctuations in friction). This happened in increments of 20 g for each iteration. This change was documented to measure how the change in acceleration would be affected by the weight of the washers.





Data: Equation we derived for our system as follows:

$$m4g = (m1 + m2 + m3 + m4)a + \mu m1g + \mu m2g$$

The equation indicated that we were studying the linear relationship between acceleration (x) and the mass of the weight of the washers hanging on the string (y). The total addition of the masses (the cart, washers, and the friction blocks) would be our slope and the y-intercept would be the friction force before it began moving. These equations were derived from the free body diagrams that we created as shown in figure 1.

The dataset on the graph shows the linear relation between the acceleration as well as the equation of the trendline that represent this relationship. As suggested by the graph the slope is 80.517 g (addition of all masses) while the friction force before it started moving was 32.941 N.

Analysis: Comparing acceleration to the mass of the hanging washers did create a linear relationship between both of these. The expected slope from our equation was around 75.55 g (addition of all masses) and the expected friction force was around 38.31 N (we used one of the data points to determine the friction coefficient which was 0.15). This means that the percent error from the experimented slope in comparison to the expected one was around 6.57% larger and for the experimented vs. expected friction force is 16.3% lesser. The source of this error could be due to the movement of the mass of the washers from cart side to the hanging weight which affected the weight of the masses as well as the friction that played on the cart. Although the overall mass stayed consistent where it was played a contributing factor to the slope as well as the friction force on the carts.