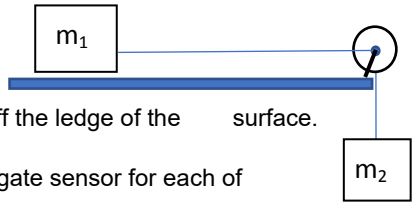
Question: Does the friction generated from a surface and block depend on the surface area of the block touching the surface?

Hypothesis: The coefficient of friction between the surface and block is independent of the surface area of the block.

Strategy:



1. A wooden block is attached to a weight of 90.1 grams by string and placed on top of a surface, with the cloth side touching the surface. The wooden block should be held 39.65 centimeters away from a photogate sensor, and the weight should hang off the ledge of the surface.
2. Let go of the block and record the velocity measured by the photogate sensor.
3. Repeat steps 1 and 2 another 9 times, and record the velocity outputted by the photogate sensor for each of these trials.
4. Repeat steps 1 to 3, but place the wooden block on its side, so the wood is directly touching the surface.
5. Come up with a formula to calculate the coefficient of friction for each of the trials and observe and plot the data. Observe any patterns that prove or disprove the hypothesis.

Data:

Total mass of the system: 215.5 grams

Trial	Long side v	Short side v
1	1.072	1.16
2	1.063	1.129
3	1.091	1.13
4	1.079	1.131
5	1.081	1.129
6	1.074	1.128
7	1.109	1.135
8	1.112	1.12
9	1.108	1.129
10	1.143	1.118

The coefficient of friction for ten trials on different surface areas.

Analysis:

The free body diagrams in Figure 2 show the forces on the masses in the modified Atwood's machine.

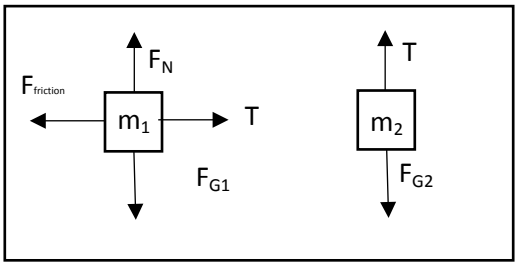


Figure 2: Free-Body Diagrams

As seen in this free-body diagram, there are two parts to this system: the block and the weight. The tensions caused by both bodies are equal and opposite and therefore can be cancelled out. The main parts that are a focus of this experiment is force of friction.

Based on this free-body diagram, a formula was derived to calculate the co-efficient of friction:

$$Fnet = mT * a$$
$$v^2 = v0^2 + 2 * a * \Delta x$$
$$a = \frac{v^2}{2 * \Delta x}$$
$$Ff = m2 * g - mT * a$$

$$Ff = m2 * g - \frac{mTv^2}{2 * g * \Delta x * m1} = \mu * m1 * g$$

Final equation:

$$\mu = \frac{\boldsymbol{m2}}{\boldsymbol{m1}} - \boldsymbol{mT} * \frac{\boldsymbol{v^2}}{\boldsymbol{2 * g * \Delta x * m1}}$$

The values of this specific experiment can be applied to this equation to come up with the following:

$$\mu = \frac{90.1}{125.4} - \frac{215.5v^2}{97519.48506}$$

The equation to calculate friction in each trial.

To break down these numbers, 90.1 grams is the weight of the weight, 125.4 grams is the weight of the block, and 215.5 is the total mass of the system. The large decimal value underneath 215.5 represents the product of 2 times the gravity, the distance between the photogate and block, and the mass of the block.

A graph of the coefficients of friction calculated for the long side versus the short side of the block can be seen below:

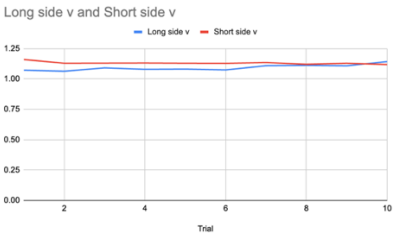


Figure 3: Velocity vs Trial Graph

This graph continues to support the hypothesis that the surface area of the block did not influence the coefficient of friction between the block and the surface. Both the red and blue line are extremely close to one another. In fact, both values directly overlap in trial 8. As a result, the surface area of the block touching the surface did not influence the coefficient of friction between the surface and block. One interesting observation is that the lines seem to get closer as the trials progress. This may be due to a human source of error: as more trials were conducted the human performing the experiment became more comfortable with the procedure and performed the steps more accurately. Therefore, the coefficients of friction became more like one another, and the general results became closer to the theoretical results of this experiment. Percent error is not calculated for this

experiment because there is no theoretical friction of coefficient that should be achieved. The coefficient of friction is dependent on the velocity of the block, which is not a constant value.