

**Question:** Does the coefficient of friction depend on the mass of the object being dragged?

**Hypothesis:** The mass of an object will not significantly change its coefficient of friction, but the force of friction will change. This is because the force of friction is dependent on normal force ( $m \cdot g$ ) not the coefficient of friction.

**Strategy:**

- A wood block with a string was attached to a Vernier force sensor and dragged across the floor at a constant speed and angle (see Fig. 1) The pulling force was measured and friction force was calculated
- Metal weights were gradually added and the object was dragged across the ground again
- The normal force, force of gravity, pulling force, and friction force were calculated using google sheets

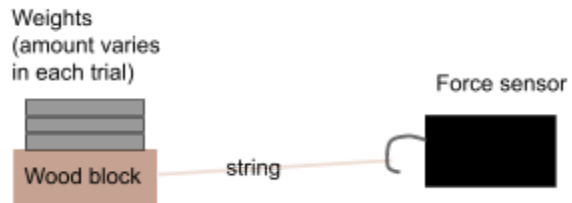


Fig. 1: "Pull Machine" with three weights

**Data:**

Initial mass of the "pull machine" with no weights attached: 0.1336 kg

Final mass of "pull machine" with 6 weights attached: 3.121 kg

Fig. 3: A graphical version of the dataset from Fig. 2

**Masses of Objects v. Their Coefficients of Friction**

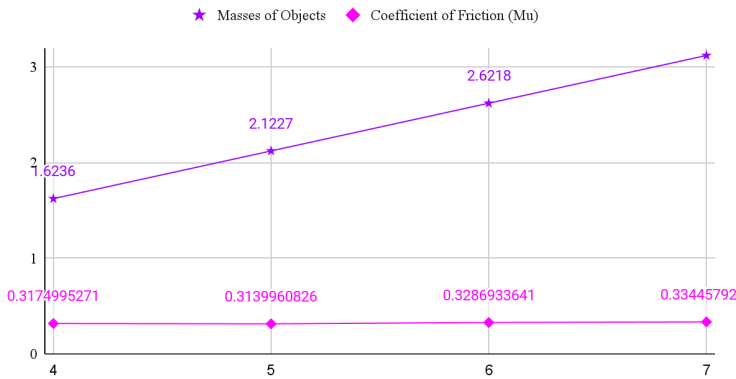


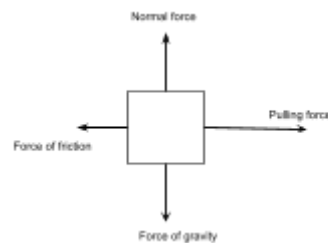
Fig. 2: Cases 4-7 of the experiment comparing mass to coefficient of friction

4	1.6236 kg	0.3174995271
5	2.1227 kg	0.3139960826
6	2.6218 kg	0.3286933641
7	3.121 kg	0.3344579273

**Analysis:**

As you can see from both Fig. 2 & 3, the coefficient of friction remains relatively consistent even when the mass of the dragged object increases. This is consistent with the original hypothesis.

Fig. 4: Free body diagram of "pulling machine"



The force of friction of the object will change with its mass, but this is because  $F_f$  is equal to the Normal Force  $\times$  Coefficient of Friction. When more weight is added, the normal force changes, which causes the pull force to change as well. However, the coefficient of friction remains the same assuming the two surfaces remain the same as well. This makes sense, because tribologists identify the coefficients of friction between objects, allowing people to create safety measures on areas like roads (the coefficient of friction between the average rubber tires and asphalt is 0.7 when the road is dry and 0.4 when wet!). Any significant change in coefficients of friction during this experiment can be explained by human error (dragging at inconsistent speeds or not angling the string properly).

