Charles Tang Summary Sheet

Question: Is there a correlation between the mass and the coefficient of friction of a wooden block on an aluminum track when its mass is varied?

Hypothesis: There will be no correlation between the mass and the coefficient of both static and kinetic friction between the two surfaces because the coefficients will be constant when the block's mass is varied.

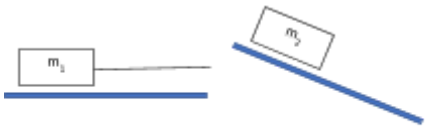


Fig 1. Kinetic Friction Fig 2. Static Friction

Strategy:

- The mass of the block was varied by placing metal weights on the top.
- The block was pulled horizontally at a constant velocity (a=0) along the track, and the applied force (F_{pull}) was measured using a force gauge (Figure 1).
- The block was placed at the edge of the track, and the track end was raised slowly. The height and length of the ramp were measured when the block began to slide down. (Figure 2).
- The coefficients of friction were calculated and graphed with a line of regression.

Kinetic Friction Data:

Metal Weights	Total Mass (kg)	Pulling Force (N)
0	0.1337	0.2387
1	0.6293	1.080
2	1.1271	1.832
3	1.6264	2.774
4	2.1228	3.592

Static Friction Data:

Metal Weights	Total Mass (kg)	Height of Ramp (cm)	Length of Ramp (cm)
0	0.1337	78	227.5
1	0.6330	82	227.5
2	1.1311	80	227.5
3	1.630	78	227.5
4	2.1157	80	227.5

Analysis:

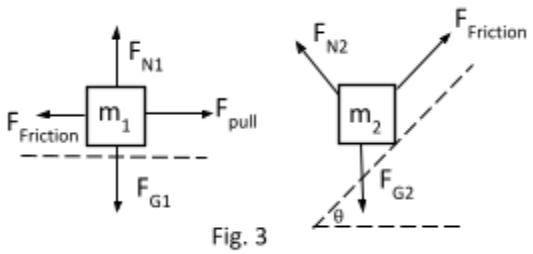


Fig. 3

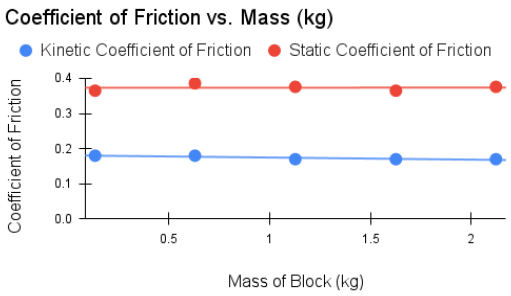
The free-body diagrams in Figure 3 show the forces on the blocks in the designed models. The following equations are based on the free-body diagrams to solve for the kinetic (μ_k) and static (μ_s) coefficients of friction.

$$F_{pull} - \mu_k F_N = m_1 * 0$$
$$F_{G2} sin(\theta) - \mu_s F_{G2} cos(\theta) = m_2 * 0$$

These equations simplify to the below.

$$\mu_k = F_{pull} / (mg) = a_{pull} / g$$
$$\mu_s = mgsin(\theta) / mgcos(\theta) = tan(\theta)$$

These equations indicate that there is no relationship between the mass on the frictional coefficients because the mass cancels out in both equations. The experimental kinetic coefficients of friction for each mass were calculated with the equations above to be 0.18, 0.18, 0.17, 0.17, and 0.17 for the five trials. The angle of the inclined ramp was calculated by using the inverse sine of the height and the length of the ramp. The static coefficients for each mass were then calculated to be 0.37, 0.39, 0.38, 0.37, and 0.38.



The graph above of the coefficient of friction v.s. mass for this experiment supports the equations that the coefficients remain constant since the slope of the line of regression is near 0.

The average kinetic coefficient of friction is 0.174, which differs by at most 3.4% with experimental values and could be caused when attempting to maintain a constant velocity. The average static coefficient of friction is 0.373, which differs by at most 3.3% with experimental values and could be caused by varied surfaces such as grooves or smoothened sections on the metal track.