The Mu of the Shoe

(Consumer Product Testing)

Purpose: Investigate friction and measure friction coefficients of various shoes. In this experiment we will determine the static and sliding coefficients of friction for various shoes and surfaces, and compare them to each other.

Theory: One measure of the quality of the shoes you wear is their ability to grip slippery surfaces. The coefficient of friction is a way of showing how much friction is available per unit of force compressing the surfaces together. In this way coefficient of friction is a measure of gripping the quality of the surface involved.

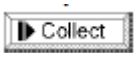
Strategy: In this activity you will measure the force of kinetic (sliding) and static friction for each of the shoes of the people in the group. You also need to measure the normal force pressing the shoe to the surface it rests upon. Substitution in this equation yields the coefficient of friction:

$$\mu = \frac{F_f}{F_n} \qquad \mu_s = \frac{F_s, \max}{F_n} \qquad \mu_k = \frac{F_k}{F_n}$$

Procedure:

1. We need to find the normal force in order to later determine the coefficient of friction. If we look at the situation, the vertical forces are balanced, the object is not moving up or down. So we can say that $F_{norm} = F_{grav}$. F_{grav} is the objects weight, so F_{norm} equals the weight of the shoe.

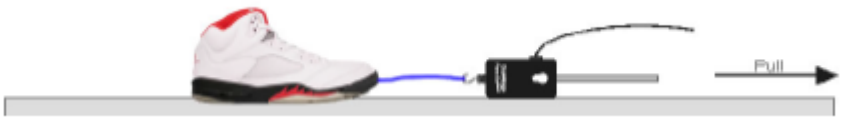
2. Open experiment 12a from your Vernier Software. Choose the force sensor that matches yours when given the option. Set the range switch on the Force Sensor to 50 N.

3. Measure the weight of each shoe. Hold the Force Sensor upright with nothing on it and Click at the top of the page to zero (Ø) the sensor. Connect a shoe to the Force Sensor, and hold it upright. Click 

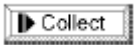
and collect about 5 second of data. Highlight the data and select 

to view the statistics for the data. The mean value is the weight of the shoe.

4. Tie one end of a string to the hook on the Force Sensor and the other end to the shoe. Place a total of 0.5 kg mass in the shoe. Practice pulling the shoe with the Force Sensor using this straight-line motion: Slowly and gently pull horizontally with a small force. Very gradually, taking one full second, increase the force until the shoe starts to slide, and then keep the shoe moving at a constant speed for another second.



5. Hold the Force Sensor in position, ready to pull the shoe, but with no tension in the string. Click (Ø) at the top of the graph to set the Force Sensor to zero.

6. Click 

to begin collecting data. Pull the shoe as before, taking care to increase the force gradually. Repeat the process as needed until you have a graph that reflects the desired motion.

7. Examine the data by clicking the Statistics button, 

. The maximum value of the force occurs when the block started to slide. Read this value of the maximum force of static friction from the floating box and record the number in your data table.

8. Drag across the region of the graph corresponding to the block moving at constant velocity. Click 

on the Statistics button again and read the average (or mean) force during the time interval. This force is the magnitude of the kinetic (sliding) frictional force. Record this value in your data table.

9. Repeat the procedures for the other two types of shoes on a dry surface. Record data in tables for Dry Surfaces.

10. When you are ready, notify me so that you may conduct the data for Wet Surfaces trial. I will spray a mist of water on your lab table for you. Do not use water from the sink!! Repeat the procedures for the wet surface and collect data in the appropriate box.

11. Clean your lab station and answer the conclusions portion of your lab.