Title: Sliding Friction and the Factors that Affect It

Problem: How does the friction between various materials compare? Does weight affect friction? Does surface area affect friction?

Hypothesis: Examine the surfaces of the materials listed in the data table and predict the rank of each in terms of their amount of friction on a piece of wood. A rank of 8 would indicate the greatest friction, while a rank of 1 would indicate the least amount of friction. Record your hypothesis ranking on the data table. Also hypothesize how weight and surface area affect friction as well.

Discussion: In this lab, you will be moving friction blocks horizontally across different surfaces at a constant velocity. If the block does not move vertically up or down, what must be true of the weight and the normal force?

If the block is moving at a constant velocity, what is true of the applied force and the frictional force?

Draw a free body diagram of a block of wood moving at a constant velocity and label all the forces acting upon it.

In the lab, you will be asked to calculate the coefficient of friction. Write out the formula we learned that involves the coefficient of friction.

In order to calculate the coefficient of friction, you need to know the frictional force and the normal force. We will not be directly measuring these two forces. You will be measuring the weight of the block and the force applied to pull the block at a constant velocity. Rewrite this formula substituting in the measurements you will be taking.

Materials: 4 friction blocks, large piece of wood, fine and rough sandpaper, plastic bag, cotton cloth, aluminum foil, felt, batting, spring scale, tape, string, ruler, and computer.

Procedure:

Part A – Comparing friction of various materials

1. Determine the weight of a friction block using a spring scale. Try to take all readings to 2 sig figs. Record.

2. Attach a spring scale to the block of wood. Lay the block near the edge of a large piece of wood. Pull horizontally and measure the force required to smoothly pull the block across the wood at a constant velocity. Record this value in your table.

3. Tape a piece of fine sandpaper to the bottom of the block so that no tape affects the bottom of the block. Lay the block down on the wood so that the sandpaper side touches the wood surface. Pull horizontally and measure the force required to smoothly pull the block across the wood at a constant velocity. Record this value in the data table. Remove the sandpaper from the block.

4. Repeat procedure 3 using the following materials: rough sandpaper, plastic, cotton cloth, aluminum foil, felt and batting.

5. Determine the coefficient of friction of each of these materials.

6. Analyze your data and re-rank the materials based on their coefficient of friction.

Part B – How weight affects friction

1. Determine the weight of one friction block. Record. Now lay the block and spring scale horizontally at one end of the long piece of wood. Pull horizontally at a constant velocity and measure the magnitude of sliding friction. Record.

2. Obtain a second block and determine the weight of the two blocks together. Record. Lay one block on top of the other and attach the spring scale to the bottom block. Pull horizontally at a constant velocity and measure the magnitude of sliding friction. Record.

3. Repeat this procedure for 3 blocks, and 4 blocks.

Part C – How does surface area affect friction?

1. Determine the weight of 1 friction block. Record. Determine the surface area of the block bottom by measuring length and width and multiplying these values together.

2. Attach a spring scale and pull horizontally at a constant velocity. Measure and record its sliding friction.

3. Determine the surface area of the long side of the block.

4. Attach a spring scale and pull the block on its side horizontally at a constant velocity. Measure and record its sliding friction.

5. Determine the surface area of the edge of the block.

6. Using a loop of string around the block, attach a spring scale to the string and pull the edge of the block horizontally at a constant velocity. Measure and record its sliding friction.

Data and Observations: Weight of friction block _____

Materials	Hypothesis	Sliding Friction	Coefficient of Friction	Re-ranking
wood on wood				
fine sandpaper on wood				
coarse sandpaper on wood				
plastic on wood				
cotton on wood				
aluminum on wood				
felt on wood				
batting on wood				

Part B

Number of blocks	Weight of blocks	Sliding Friction
1		
2		
3		
4		

Part C Weight of block _____

Surface	Area of face	Sliding Friction
Bottom		
Side		
Edge		

Analysis and Questions:

1. Which material had the greatest coefficient of friction? Did this surprise you? Give reasons why this substance has such a high coefficient of friction.

2. Which material had the least coefficient of friction? Did this surprise you? Give reasons why this substance has such a low coefficient of friction.

3. Nubby leather, rather than rubber, is generally recommended for the soles of toddler's shoes. Why?

4. Sand is often scattered on roads during snowstorms and icing. Why?

5. If there were no friction, would it be possible to tie a knot in a piece of string or rope? Explain.

6. What is the name of the relationship between weight and sliding friction based on the shape of your graph?

7. In the discussion section of this lab it talked about forces that have to be equal and opposite if the block is not moving vertically or is moving at a constant velocity. In the data table for part B you recorded the weight of the blocks. What force is this equal and opposite to?

8. Will the soles of your boots wear out faster when hiking (just walking yourself) or backpacking (walking with a heavy pack)? Why?

9. Does surface area of contact affect friction? Explain.

10. If friction (or traction) between a tire and the road is the same whether the tire is wide or narrow, what is the advantage of having wide tires on your vehicle? Why do racing cars have even wider tires?