Experiment

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Friction

Friction is a force that resists motion. It involves objects in contact with each other, and it can be either useful or harmful. Friction helps when you want to slow or stop a bicycle, but it is harmful when it causes wear on the parts of a machine. In this activity, you will study the effects of surface smoothness and the nature of materials in contact on sliding friction. You will use a Force Sensor to measure frictional force, in Newtons (N), as you pull a block across different surfaces.

OBJECTIVES

In this experiment, you will

- measure sliding friction
- measure friction between a wooden block and smooth-surface wood
- measure friction between a wooden block and rough-surface wood
- make predictions about other surfaces
- test your predictions

MATERIALS

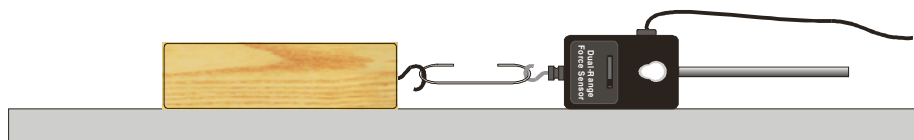|	
LabPro or CBL 2 interface	paper clip
TI Graphing Calculator	wood with smooth surface
DataMate program	wood with rough surface
Vernier Force Sensor	sandpaper
wooden block (with a hook)	

Figure 1

PROCEDURE

Part I Smooth and Rough Surfaces

1. Plug the Force Sensor into Channel 1 of the LabPro or CBL 2 interface. Use the link cable to connect the TI Graphing Calculator to the interface. Firmly press in the cable ends. If you are using a Dual-Range Force Sensor, set the range switch to 10N.

2. Turn on the calculator and start the DATAMATE program. Press $\boxed{\text{CLEAR}}$ to reset the program.

3. Set up the calculator and interface for the Force Sensor.

   a. Select SETUP from the main screen.
   b. If the calculator displays a Force Probe in CH 1, proceed directly to Step 4. If it does not, continue with this step to set up your sensor manually.
   c. Press ⏄ENTER⏄ to select CH 1.
   d. Select FORCE from the SELECT SENSOR menu.
   e. Select the correct Force Sensor and setting from the FORCE menu.

4. Set up the calculator and interface for data collection.

   a. Use ⏄▲⏄ and ⏄▼⏄ to select MODE and press ⏄ENTER⏄.
   b. Select TIME GRAPH from the SELECT MODE menu.
   c. Select CHANGE TIME SETTINGS from the TIME GRAPH SETTINGS menu.
   d. Enter "0.05" as the time between samples in seconds.
   e. Enter "60" as the number of samples. Data collection will last 3 seconds.
   f. Select OK to return to the setup screen.

5. Zero the Force Sensor.

   a. Lay the Force Sensor on the tabletop in the position shown in Figure 1.
   b. Select ZERO from the SETUP menu.
   c. Select CH1-FORCE (N) from the SELECT CHANNEL menu.
   d. Press ⏄ENTER⏄ to zero the Force Sensor.

6. Get a wooden block (with a hook on one end). Partly straighten a paper clip—leaving a hook at each end. Use the paper clip to attach the wooden block to the Force Sensor.

7. Slowly pull the wooden block across a piece of wood with a smooth surface. Hold the Force Sensor by its handle and pull it to you, as demonstrated by your teacher. The Force Sensor should be held parallel to and about 1 cm above the surface. Once the wooden block is moving at a steady rate, select START to begin data collection.

8. Determine and record the force used to pull the block.

   a. After data collection stops, press ⏄ENTER⏄ to return to the main screen.
   b. Select ANALYZE from the main screen.
   c. Select STATISTICS from the ANALYZE OPTIONS menu.
   d. Press ⏄ENTER⏄ before moving the cursor.
   e. Use ⏄▶⏄ to move the cursor to the right side of the screen and press ⏄ENTER⏄.
   f. Record the MEAN (average) force (in N).

9. Repeat Steps 7-8 as you pull the block over a piece of wood with a rough surface.

Part II Predicting Friction

10. You will measure friction as the block is pulled across your desktop, the floor, and sandpaper. In the space provided in the Data table below, predict the order of friction for these surfaces—from lowest to highest.

11. Repeat Steps 7-8 for each of the surfaces.

DATA

Part I Smooth and rough surfaces		
Surface	Smooth wood	Rough wood
Force (N)		

Part II Predicting friction		
Predicted order of values for desktop, floor, and sandpaper		
(Lowest)		(Highest)
Surface	Desktop	Floor	Sandpaper
Force (N)			

PROCESSING THE DATA

1. What is the effect of surface roughness on friction?

2. How did you decide the order of your predictions in Part II?

3. How good were your predictions? Explain.

4. Give two examples of situations where friction is helpful.

5. Give two examples of situations where it is best to reduce friction.

6. Summarize the results of this experiment.

EXTENSIONS

1. Test the friction of other surfaces, such as glass, metals, rubber, and different fabrics.

2. Investigate how frictional force varies with contact area and mass.

3. Design an experiment to test methods of reducing friction.