Name _____ Date _____

Palm
29

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 interface
Palm handheld
Data Pro program
Vernier Force Sensor
wooden block (with a hook)
paper clip
wood with smooth surface
wood with rough surface
sandpaper

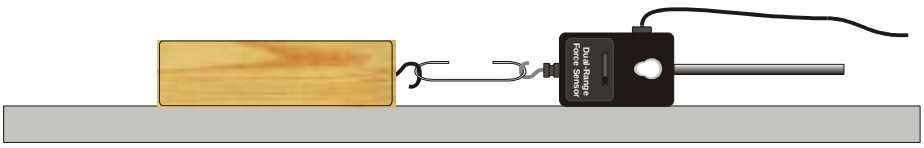

Figure 1

PROCEDURE

Part I Smooth and Rough Surfaces

1. Connect a Force Sensor to Channel 1 of the LabPro interface. If you are using a Dual-Range Force Sensor, set the range switch to 10N. Connect the handheld to the LabPro using the interface cable. Firmly press in the cable ends.

2. Press the power button on the handheld to turn it on. To start Data Pro, tap the Data Pro icon on the Applications screen. Choose New from the Data Pro menu or tap New to reset the program.

3. Set up the handheld and interface for the correct Force Sensor.
   a. On the Main screen, tap Setup.
   b. If the handheld displays FORCE(N) in CH 1, proceed directly to Step 4. If it does not, continue with this step to set up your sensor manually.
   c. On the Setup screen, tap CH1:.
   d. Depending on the type of sensor you are using, choose FORCE-DFS (10N) or FORCE-SFS (N) from the list of sensors.

4. Set up the handheld and interface for data collection.
   a. While still on the Setup screen, tap Settings:.
   b. Enter "0.05" as the time between samples in seconds, using the onscreen keyboard (tap "123") or using the Graffiti writing area.
   c. Enter "60" as the number of samples. (Data collection will last 3 seconds.)
   d. Tap OK to return to the Setup screen.

5. Zero the Force Sensor.
   a. Tap Zero.
   b. Ensure that the box in front of CH1: FORCE(N) is checked. If it is not, tap CH1: FORCE(N) to check it.
   c. Lay the Force Sensor on the tabletop in the position shown in Figure 1. When the force readings on the screen stabilize, tap Zero. When the Wait button changes back to Zero, the process is complete, and readings for the sensor should be close to zero.
   d. Tap OK twice to return to the Main screen.

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, tap Start to begin data collection.

8. Determine and record the force used to pull the block.
   a. After data collection stops, tap Analyze.
   b. Tap Stats.
   c. Record the Mean (average) force (in N).
   d. Tap OK twice to return to the Graph screen.

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.

Name _____ Date _____

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.

TEACHER INFORMATION

Friction

1. The student pages with complete instructions for data collection using LabQuest App, Logger *Pro* (computers), EasyData or DataMate (calculators), and DataPro (Palm handhelds) can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. A 15 cm (6 in) long wooden block cut from a 5 cm × 10 cm (2 in by 4 in) piece of wood works well. Insert a hook in the center of one end. Use a paper clip or a piece of string to attach it to the Force Sensor. Other flat-surface objects can be substituted.

3. Scrap pieces of wood obtained at a wood shop, building materials store, or a lumberyard can be used as surfaces for Part I.

4. Illustrate proper technique for pulling a wooden block across a surface with the Force Sensor before the experiment.

5. Remind your students not to pull the block too fast.

6. Your students should get better results using the Force Sensor and average force values than they would with spring scales.

SAMPLE RESULTS

Surface	Smooth wood	Rough wood	Desktop	Floor	Sandpaper
Force (N)	xxxx	xxxx	xxxx	xxxx	xxxx

ANSWERS TO QUESTIONS

Answers have been removed from the online versions of Vernier curriculum material in order to prevent inappropriate student use. Graphs and data tables have also been obscured. Full answers and sample data are available in the print versions of these labs.