Frictional Forces
ID: 13694

Time required: 1 class period
Suggested Grade Levels: 6–8

Activity Overview
In this activity, students will pull a block across different surfaces and use a CBL 2™ with a force sensor to see how much force is needed to move the block. Then they will examine their results to see when more force was needed to move the block.

Math Objectives
- *Interpret line plots*

Science Objectives
- *Understand the role of frictional force on motion*

- *Understand how to measure difference in force*

Teacher Preparation and Notes
- *Tie a string to the screw on the wooden block.*
- *Measure out and mark a given distance (select units) on a flat surface.*
- *Students should pull the block the same distance over the same time (five seconds) with the force sensor measuring the amount of force needed. Change the surface for each test. Suggested surfaces are sand paper, plastic wrap, sweatshirt material, metal, wax paper, and rubber mat.*
- ***To download the student worksheet and TI-Navigator files, go to education.ti.com/exchange and enter "13694" in the quick search box.***

Associated Materials
- *TI-73 Explorer™*
- *CBL 2™*
- *Dual Range Force Sensor*
- *Wooden block with screw attached*
- *String*
- *Different surfaces*
- *Meter stick/measuring tape*
- *SciAct08_FrictionalForces_worksheet_TI73.doc*

Classroom Management

♦ Ask students to sketch the lab setup before starting the lab and label the sketch with key terms. Students learn vocabulary in context and seem less confused by the procedure.

♦ Assign these student jobs for this lab:

- Materials/setup person (sets up samples, sensor)

- Tech person (operates CBL 2 and TI-73)

- Data recorder (reads force readings from the TI-73 at each collection)

- Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **worksheets** to the teacher)

♦ Students can record force readings as they are displayed on the TI-73 in their lab journals. This keeps them engaged throughout the data collection period and if they lose their data/graph later, they can still write up their lab report. Students can also access the data in the TI-73 lists after data collection. You can send the lists to all students' calculators using [APPS] **1:Link**.

a. Press [APPS].

b. Press [ENTER] to select **1:Link.**

c. Select **4:List** and press [ENTER].

d. Press [▼] to move the ▶ beside the list you wish to send. Press [ENTER].

e. Repeat step **d** for each list you wish to send.

f. Set the receiving unit by pressing [APPS] [ENTER] [▶] to select **RECEIVE**. Press [ENTER]. **Waiting…** displays on the TI-73 screen.

g. On the sending unit, press [▶] to select **TRANSMIT** and press [ENTER].

For more permanent storage of data, use TI-GRAPH LINK or TI Connect to save the lists in a computer folder.

Selected Answers

8. **a.** *Force will not be constant.*

   b/c. *The force initially will be greatest, because overcoming inertia to set the object in motion takes more force than the force required to overcome frictional forces. Once sliding, the frictional force remains about the same.*
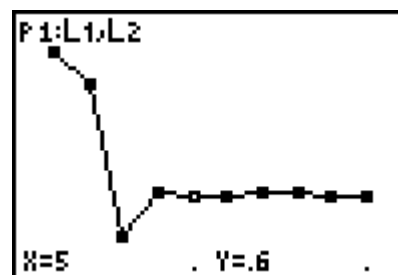
9. *Friction* is a force measured in *Newtons* that resists *movement* of one surface that is in contact with another surface.

10. Friction is caused by *irregularities* in the surface in contact.

11. The rougher the surface, the *stronger* the frictional forces.

12. The smoother the surface, the *weaker* the frictional forces.

13. *Objects in motion would continue to stay in motion at a constant velocity if there were no frictional forces (until acted upon by an outside force).*

Extensions

♦ Design a friction lab that tests how friction is affected by the mass of the block. Hold everything constant except the mass.

♦ Explain what gravity may have to do with your results.

♦ Design a lab that tests how use of a lubricant can vary frictional forces on the same surface. Explain how a lubricant works. Give an example from real life.

♦ Make a poster that shows at least 10 real life examples of when friction is helpful or when it is a hindrance. Use magazine photos, computer images, or drawings of each situation.

The Problem

Which surfaces decrease and increase friction the most?

Introduction

A friction car starts off fast in the beginning but then slows to a stop. If there were no frictional forces, the car in motion would not need any additional force to stay in motion. Friction is the force that opposes motion between two surfaces that are in contact. The amount of force is measured in Newtons by a force sensor (a computerized spring scale). The force of friction between solid surfaces does not depend on speed or area of contact. Friction does depend on the type of surface material and the force with which they are pressed together.

Hypothesis

Before testing, answer Questions 1 and 2 on the **worksheet** to predict the force required to move the block on different surfaces.

Collecting the Data

1. Collect the wooden block and the surfaces to be tested.

2. Plug the force sensor sensor into Channel 1 (**CH 1**) on the CBL 2 using the DIN adapter, if necessary.

3. Start the DATAMATE program.

4. The Main Screen is displayed. If **CH 1:FORCE (n)** is displayed at the top of the screen, go to step 9. If **CH 1:FORCE (n)** is not displayed, go to step 5.

5. Select **1:SETUP**.

6. Select **CH 1**. Select **5:FORCE**.

7. Select the type of force sensor you are using. If you are using the 10 or 50 range sensor, select **2:DUAL R FORCE 10(N)**.

8. Select **1:OK** to return to the Main Screen.

9. Make sure that the wooden block is positioned on the surface to be tested.

10. When you are ready to begin, select **2:START**. The CBL 2 beeps. Begin pulling the block across the surface. The CBL 2 beeps again when it has finished collecting data.

11. The graph is displayed showing the data that was collected. Use ◀ and ▶ to move to each data point and record the force for each one-second interval in the table on the **worksheet**.

12. Repeat the procedure three times with each surface.

13. To exit from the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.

14. Find the average force needed to pull the block across this surface and record the result in the table on the **worksheet**.

Data Analysis

Using the tables in Questions 3 and 5, answer the questions on the **worksheet** to analyze your results.