EXPLORATIONS

Activity 8

Frictional Forces

Objectives

- To understand the role of frictional force on motion
- To understand how to measure difference in force

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- Dual Range Force sensor (with DIN adapter if necessary)
- Wooden block with screw attached
- String
- Different surfaces
- Meter stick/measuring tape
- Data Collection and Analysis pages (p. 69 – 72)

In this activity you 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.
- Examine your results to see when more force was needed to move the block.

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 the questions on the **Data Collection and Analysis** page to predict the force required to move the block on different surfaces.

Procedure: Collecting the Data

1. Collect the wooden block and the surfaces to be tested.
2. Plug the force 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. Select **1:SETUP**.
5. Select **CH 1**. Then select **5:FORCE**.
6. 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)** and select **1:OK** to return to the Main Screen.
7. Make sure that the wooden block is positioned on the surface to be tested.
8. 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.
9. 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 **Data Collection and Analysis** page.
10. Repeat the procedure three times with each surface.
11. To exit the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.
12. Find the average force needed to pull the block across this surface and record the result in the table on the **Data Collection and Analysis** page.

Data Analysis

Using the **Data Collection** tables, answer the questions on the **Data Collection and Analysis** page to analyze your results.

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.

Data Collection and Analysis

Name _____

Date _____

Activity 8: Frictional Forces

Problem

Which surfaces decrease and increase friction the most?

Hypothesis

1. Before testing, complete the table below to predict the amount of force needed to move the block on each surface (1 = least amount of force required).

Surface	**Predicted Rank** (Least Force to Greatest)

2. If a block is pulled across different surfaces, the force required will

   _____ with rougher surfaces and

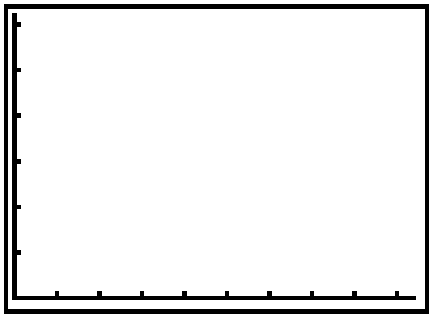
   _____ with smoother surfaces.

Data Collection

1. After you test each surface, record the data that you collected in the table below.

	Trial 1		Trial 2		Trial 3	
Surface	**Time in Seconds**	**Force**	**Time in Seconds**	**Force**	**Time in Seconds**	**Force**

2. Plot a line graph of force over time for one of the surfaces. Sketch the graph below or print it out on the computer and attach it to the **Data Collection and Analysis** page. Label and number the axes and identify any peaks and valleys.



3. After you test all of the surfaces, record the average force required by your group to pull the block across each surface in the table below. Next, use the results from all of the lab groups to find the average force required to pull the block. Finally, rank the results based on the amount of force required (1 = least amount of force).

Surface	Average Force	Class Average of Force	Actual Rank (Least to Greatest)

Data Analysis

1. Which surface required the highest average force? _____

   Least? _____

2. Compare the results to your hypothesis. Does the data seem reasonable? Is it what you expected?

   _____

   _____

3. Look at the table for each surface.

   a. Was the force constant throughout the collection interval?

   _____

   _____

   _____

   b. If not, when was the force greatest? Why do you think this is so?

   _____

   _____

   _____

   c. Explain any peaks or valleys.

   _____

   _____

   _____

Conclusion

1. _____ is a force measured in _____ that resists _____ of one surface that is in contact with another surface.
2. Friction is caused by _____ in the surfaces in contact.
3. The rougher the surface, the _____ the frictional forces.
4. The smoother the surface, the _____ the frictional forces.
5. Explain what would happen if there were no frictional forces between objects.

_____

_____

_____

Teacher Notes

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NSES Standards

- Physical Science: Motions and forces
- Science as Inquiry: Abilities necessary to do scientific inquiry

Preparation

- 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.

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 CBL 2 at each collection interval)
  - Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)

- Students can record force readings in their lab journals as they are displayed on the TI-73. 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

Data Analysis

3a. *Force will not be constant*.

3b., **3c.** *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*.

Conclusion

1. *Friction* is a force measured in *Newtons* that resists *movement* of one surface that is in contact with another surface.

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

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

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

5. Explain what would happen if there were no frictional forces between objects.

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).