

## Friction Lab

### Teacher's Guide

**Topic:**

Newton's Laws of Motion

**The following information is provided to the student:**

**Question:**

What is the value of the coefficients of static and sliding friction between two surfaces?

**Purpose:**

To use methods of graphical analysis to determine the coefficients of static and kinetic friction between two surfaces.

A complete lab write-up includes a Title, a Purpose, a Data section, a Conclusion, and a Discussion of Results. The Data section should include a table of collected data organized in labeled columns. Sketches of the plots of  $F_{\text{frict}}$  versus  $F_{\text{norm}}$  should be included for both the static and the sliding situation and the results of a linear regression analysis should be reported. The Conclusion should respond to the question raised in the Purpose of the lab. The Discussion of Results should explain the logical connection between the graphical information and the coefficient of friction values.

**Materials Required:**

Small wood block with hook inserted in the side; computer interfaced force probe and motion detector; mass sets; mass balance.

**Description of Procedure:**

Students place the block of wood on the lab table and load it up with a 1-kg mass. A force probe is connected to the hook on the block and a force of gradually increasing magnitude is exerted until the stationary wood block budes from its resting position. The force which just barely budes the wood block from rest is the maximum value of the force of static friction which this block can experience. Students can then pull the wood block at a constant speed. The pulling force which causes the constant speed motion is equal to the force of sliding friction on the wood block. These values of static friction force and sliding friction force can be obtained from the software program which accompanies the lab interface. Additional trials are performed for varying mass. Adding various combinations of 50-g, 100-g, 200-g, and 500-g masses to the wood block allows for the collection of an extensive set of friction-normal force data. Plotting the force of friction (vertical axis) as a function of normal force (horizontal axis) and performing a linear regression analysis allows students to determine the relationship between the two variables and the coefficients of friction for the two surfaces.

**Alternative Materials and Procedure:**

A force scale can be used in place of the computer interfaced force probe. Measurements can easily be taken directly from the force scale. Trials can be quickly repeated to insure accurate results.

**Safety Concern:**

## The Laboratory

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

### Suggestions, Precautions, Notes:

1. The wood blocks can be constructed from scrap wood (3/4 to an inch thick). They should be approximately 6 inches by 6 inches; bigger is better. A coffee hook can be screwed into the edge.
2. If mass balances are not widely available, the mass of the wood boards can be determined and provided to student lab groups. Writing the mass directly on the board is an efficient method of conveying the mass to students.
3. Remind students to pull horizontally. A horizontal pull will balance the friction force for a constant speed motion or a static situation. An angled pull will introduce error.
4. Depending on the quality of the class and the amount of exposure to the topic, this lab often requires extensive preparation. It is important that students understand the theory behind the procedure.

### Auxiliary Materials:

None

### Scoring Rubric:

NL8. Sliding Friction Lab	Score
<ul style="list-style-type: none"><li>___ Included, labeled and organized all parts of the lab report.</li><li>___ Data section includes tabulated data in a row-column format with units about the <math>F_{\text{frict-static}}</math>, <math>F_{\text{frict-sliding}}</math>, and <math>F_{\text{norm}}</math> values; appropriate plots are constructed and the results of linear regression analysis are correctly and clearly reported. Data appear reasonable as reflected by the regression constant and slope value.</li><li>___ Conclusion states the experimentally-determined values of the coefficients.</li><li>___ Discussion of Results explains the rationale behind the connection between the graphs and the reported coefficients.</li></ul>	___/___

### Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/newtlaws/u2l1d.cfm>

<http://www.physicsclassroom.com/Class/newtlaws/u2l2b.cfm>

<http://www.physicsclassroom.com/Class/newtlaws/u2l2c.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevels 4 and 5 of the Newton's Law module is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/mop/module.cfm>