

## Science Friction Adventure Lab

### Teacher's Guide

**Topic:**

Vectors and Forces

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

**Question:**

What is the coefficient of friction for a wood block on a metal track and what is the maximum angle at which the track can be inclined before the block accelerates from rest? How are these two values related?

**Purpose:**

To determine the coefficient of static friction for a wooden block on a metal track and to relate this coefficient to the maximum angle at which the track can be inclined before the block accelerates from rest.

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 data capable of determining the coefficient of friction and an analysis of the data in order to determine the coefficient of static friction. The Data section should also include the result of several trials in which the threshold angle at which acceleration from rest occurs for the wood block on the incline. Outliers should be identified and an average value reported. The Conclusion should answer the two questions posed in the Purpose. The Discussion of Results should include a discussion of the expected threshold angle based on the coefficient of friction; the reasoning for the expectation should be clearly explained. An error analysis with a percent difference should also be included.

**Materials Required:**

Wood or metal track, wood block (or other object)

**Description of Procedure:**

A wood block (or other available object) is placed upon a track. A force is exerted upon the block until it budes from rest. Measurements are made to determine the coefficient of static friction between the block and track. Then the track is gradually elevated at one of its ends until the parallel component of gravity exceeds the maximum limit on the static friction force. At the moment that the wood block budes from rest, the incline angle is measured. The coefficient of static friction is determined from the angle measurement for which the object begins to budge from its rest position. Students make an effort to relate the coefficient of friction to the threshold angle.

**Alternative Materials and Procedure:**

Consider allowing students to experiment with a variety of different surface combinations. Make a habit of pooling data, determining average values of  $\mu$  and comparing the results to posted values of  $\mu$  as found in textbooks and manuals.

**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. This lab serves as a great preface to inclined planes. Students do not need to know much about inclined planes in order to perform the lab. On the other hand, a successful assimilation of the data may require an understanding of some inclined plane physics.
2. The development of the mathematics associated with this lab ( $\mu = \tan \Theta$ ) is complicated. Save the theoretical development of the equation for your most able classes. For your other students, simply give them the equation.
3. Home stores typically sell anti-skid rubber mats for placement between wood floors and area rugs. The mat prevents the rug from sliding all over the wood floor. As an interesting extension, acquire some anti-skid matting and use it to determine the coefficient of friction between the wood block and the anti-skid surface.

### Auxiliary Materials:

None

### Scoring Rubric:

VF5. Science Friction Adventure Lab	Score
<ul style="list-style-type: none"><li>— Included, labeled and organized all parts of the lab report.</li><li>— Data section includes an organized table (with column headings and stated units) and analysis which leads to the calculation of the coefficient of friction. All work is shown and documented. Data is reasonable and analysis is error-free. Measurements of the threshold angle are provided; results for several trials are provided; outliers are indicated and an average value is reported.</li><li>— Conclusion answers the two <i>questions</i> posed in the Purpose. Results seem reasonable and reflect accuracy of measurement.</li><li>— Discussion of Results includes a discussion of the expected relationship between <math>\mu</math> and the threshold angle and an evaluation of the reliability of the results. An error analysis and percent difference calculation is included. Work is shown.</li></ul>	—/—

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/vectors/u3l3e.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevels 5 and 6 of the Forces in Two Dimensions module are a suitable accompaniment to this lab:

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