Kinetic and Static Coefficients of Friction
revised Fall 2014

Introduction

You should recall from class the analysis of the inclined plane. This is important to be sure that you understand since you will see related problems again. I have reproduced this analysis on the class home page for your benefit. You should also watch the short movie that I made about the inclined plane. This is intended to help you with today's lab.

Materials & Equipment

You will need a weight hanger, two blocks (one with cork on it and one without) and also one block with sandpaper, glass, high friction boards, etc.

Read these two important details carefully!

(1) A very important detail:
Weigh and record the mass of the blocks you are using in this lab (for the portions using method one).

(2) A second important detail:
In order to measure the angle of inclination, you will look directly at the inverted protractor attached to the plane. Read the smaller of the numbers. Note: if you obtain a negative coefficient of friction, then you might be reading the wrong angle.

Setup

You should construct your equipment as was indicated in the movie. I will have an example set up for you in lab. You will want to choose an angle of about 35^0 for the inclination of the plane for use in method one. Record the angle in your lab writeup.
You will want to weigh (on the electronic scales) the mass of the wooden you are using today in the first part of the lab. You will want to weigh the hanging weights in part (1) also, with the electronic scales.

Brief summary of experiments to do:

(a) **Method (1)** pine on polyboard static
(b) **Method (2)** pine on polyboard static (to compare to experiment (a)
(c) **Method (2)** cork on polyboard static on **wide area** and **narrow area** for area comparison
(d) **Method (2)** Glass on polyboard, static and kinetic
(e) **Method (2)** Sandpaper on polyboard, static and kinetic
(f) **Method (2)** High friction on high friction static and kinetic
(g) **Method (2)** Several other materials (glass on wood, sandpaper on wood, etc.) static and kinetic.

You should perform the following experiments:

method one:

I want you to measure the coefficient of static friction for your wooden (only wood) block using two methods. First **(a)** add enough weight to your weight hanger until the system starts to slide (on its own, without a push). This provides a measurement of the static coefficient of friction. T**his is a little bit like a game: gently place as much weight as possible on the hanger, one gram at a time if necessary.** Then measure the same thing using method two. Be sure to do the tilting of the plane only after you have finished (a). You will be able to obtain the relative error between the two methods of measurement by measurement using the two different methods.

The percent deviation between the two methods of measurement is given by:

$$\%\,\text{deviation} = \frac{|\text{measurement}_1 - \text{measurement}_2|}{\frac{1}{2}(\text{measurement}_1 + \text{measurement}_2)} \text{x}\,100$$

Do not be distressed if this deviation is large: method one is more susceptible to experimental error which is why the rest of the lab is done with method two.

For the rest of the lab, I want you to measure the coefficients only by tilting the plane which is **method two**.

Method (2)

(2) Measure wide cork block side and narrow cork block side for area (use the metal rulers here). Then find the static and kinetic coefficients by tilting the plane. You will be able to have an indication as to how strongly area influences the frictional force from these experiments.

(3) Measure the static and kinetic coefficients of glass on wood by tilting the plane.

(4) Measure the static and kinetic coefficients of sandpaper on wood by tilting the plane. Use the block with sandpaper on it for this purpose or the sandpaper on the back of the glass.

(5) Measure the static and kinetic coefficients of the high friction boards.

(6) You should now measure other materials (static and kinetic) of your choice to include in your writeup as you desire. You can find the analysis for the mass connected to the inclined plane on the electronic handout entitled “Analysis of the inclined plane” on our website and also in the class worksheets. You should work through this analysis for your benefit and understanding. There is also a spreadsheet for this lab to help with the calculations. Be sure to save each under a different name in your root directory.

Note: only for the wooden block will the entire spreadsheet apply (rows 1-9). In the other cases, you will only calculate the coefficients of friction using the bottom portions of the spreadsheet. Be sure in your spreadsheet to denote if the experiment is kinetic or static and describe the experiment with a short (real short) description. Only submit in your work the portions of the spreadsheet that contain your actual data. The spreadsheet also contains some simple checks for data in the top portion of the lab. If the checks are violated, look to see if something is wrong. Also note on your spreadsheet, the experiment areas are text only do describe the experiment there.

In your lab writeup, I would like for you to answer the following questions based upon your measurements. For each material, (cork on wood, wood on wood, etc), what is the value of the static and kinetic coefficients of friction? **Also, from a comparison of your measurements with different areas, does this coefficient depend upon area?** You will need to include your observations in your lab write up in addition to the normally required portions of the lab writeup. You should attempt to answer these questions based upon the % deviation.