Lab 6-1: The Coefficient of Friction

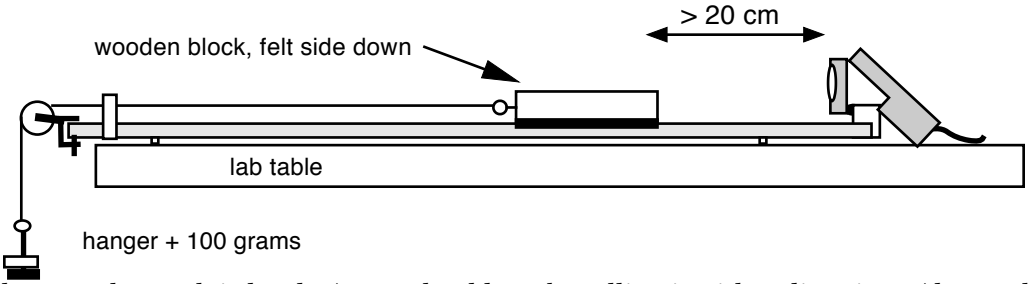
Purpose: To determine:

a. the relationship between the normal force between two objects and the force of friction that acts between them.
b. if the force of friction on a block sliding on the table or a track depends on the area of contact between the block and table.

Materials: 450 grams of slotted masses, 1 wooden block, 1 hanger, 1 string (~75 cm), 1 pulley

Procedure:

1. Record the mass of the wooden block. Then, set up the track, block, pulley, hanger and motion detector as shown in the diagram below.



2. Make sure the track is level. A cart should not be rolling in either direction. Also, make sure that the string is attached to the block horizontally and that it is not rubbing on anything.
3. Start LoggerPro and use the preset "02 Cart". Add a 100 gram mass to the hanger. For this first trial, do not have any extra mass on the wooden block.
4. Hold the block in the middle of the track, start collecting data, and then release the block.
5. To determine the acceleration of the block, measure the slope of the best fit line of the velocity graph. Paste the velocity graph (including best fit) for your first trial here:

Paste Graph Here

6. Repeat the above to find the acceleration of the block for a total of eight different masses. For each new trial, add 50 grams to the wooden block. Make sure the pulley stays straight – you may have to adjust it after each trial.
7. Flip the wooden block on its side and repeat.

Data:

Mass of hanger: _____ kg Mass of wooden block: _____ kg

		Bottom down	Side down
Trial #	extra mass on block (kg)	acceleration (m/s^2)	acceleration (m/s^2)
1	0		
2	.050		
3	.100		
4	.150		
5	.200		
6	.250		
7	.300		
8	.350		

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Derivations:
You will be making some calculated columns in Logger Pro in a few steps. First do the following derivations (and use a little English to explain what you are doing) using the following symbols:

m_1 = hanger mass m_2 = block mass m_3 = extra mass a = acceleration

1. Make an equation to calculate the normal force on the block.

2. Make an equation to calculate the force of friction on the block. (This is easier if you treat it as a system.)

Calculations:
The goal is to make graphs of Friction vs Normal Force, and we will use Logger Pro to do our calculations:

- Quit Logger Pro, unplug the LabPro, and start LoggerPro again. Now it should be ready for you to type in data.
- Enter the data from the other side. Name the columns "Extra Mass," "Acceleration 1" and "Acceleration 2." Don't forget the units. Notice you can automatically fill in values that follow a pattern if you like. To make the third column, under "**Data**" choose "**New Manual Column**".
- Make a calculated column called "Normal Force" and use your equation from above.
- Make a calculated column called "Friction Force 1," using your other equation and "Acceleration 1."
- Make a calculated column called "Friction Force 2," using your other equation and "Acceleration 2."
- Make sure you save this file as you will need it at the end of the lab.

Results:
Make the Data Window wide enough to see all the columns and then copy and paste it below:

Paste Data/Calculations Here

Graph:
Make the two Friction vs Normal force graphs and paste them below. Be sure to include best fit lines, appropriate titles, and make sure the origin is visible.

Paste Graph Here Paste Graph Here

Conclusion:
1. What are the equations that describe the relationship between friction and normal force for your data?

2. What is the slope of those graphs called? What symbol is used to denote it?

3. Does the force of friction depend on the surface area of contact? (It might help to see your classmates results as well.)

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4. In general, what does the force of friction depend on? (i.e. write the equation that is on the board.)

5. Ideally, there should not have been an intercept in the graphs in this lab. However, problems in the setup or problems with the analysis could make a graph that is still linear but has a sizable intercept. Please assume that accelerations were measured correctly for the following questions:
   a. What could have caused the graph to have a positive intercept? (i.e. what could have caused the data to have shifted up or to the left by a constant amount?) Support your answer by making a new calculated column and including the resulting graph in your answer.

   b. What could have caused the graph to have a negative intercept? (i.e. what could have caused the data to have shifted down or to the right by a constant amount?) Support your answer by making a new calculated column and including the resulting graph in your answer.