Lab Activity

Measuring the coefficient of kinetic friction

Purpose: In this lab, we measure coefficients of friction and verify that they depend on the surfaces that are in contact, but not on the masses or the areas of the objects in contact.

Equipment: 1 computer, 1 motion sensor + base and support rod, 1 friction block, 1 mass hanger, 1 set of masses, and pieces of strings. A scale is also available for mass measurements. I will show you how to set up the equipment at the beginning of the lab.

To Do: Follow the worksheet

**This is a group write-up: turn in the worksheet**

**Report: download the lab from the class web site, and type your answers to the questions in Word (start from 2)).**

**Your write-up is due on the due date indicated on the calendar on the class web site (no late write-up will be accepted).**

Kinetic Friction

1. **Experiment**

For each of the cases a-d listed below, do the following:

1. Put enough mass on the mass hanger so that the block will slide without needing an initial push. Record the velocity of the block versus time (Start the recording just after releasing the block. End the recording just before the mass hanger reaches the floor.)
2. Find the acceleration. Recall that it is given by the slope of the v(t) graph (use a linear fit).
3. **Redo i) and ii) and check that you find an acceleration consistent with your first result.**  If not, redo the experiment until you get consistent results.
4. Record in the data table (on the last page) the total mass of the block (=block mass + mass on top of the block(if any)), the total mass of the hangar (=empty hanger + masses on the hanger), and the acceleration of the block.
5. The block is on its large wooden side.
6. The block is on its small wooden side.
7. The block is on its large felt side.
8. The block is on its large felt side. A mass is placed on top of the block.

**Names:**

1. **Theory**
2. Draw a free body diagram of the block. Label all of the forces.

Block

1. Apply Newton's 2nd law to the block. Show your x and y axes on the FBD of the block in a). Use mB and aB for the mass and acceleration of the block.

|  |
| --- |
| $$Block:\sum\_{}^{}F\_{x}= $$$$Block:\sum\_{}^{}F\_{y}= $$ |

1. Draw a free body diagram for the mass hanger. Label all of the forces.

hanger

1. Apply Newton's 2nd law to the hanger. Show your x and y axes on the FBD of the hanger in c). Use mH and aH for the mass and acceleration of the hanger.

|  |
| --- |
| $$Hanger:\sum\_{}^{}F\_{x}= $$$$Hanger:\sum\_{}^{}F\_{y}= $$ |

1. How do the accelerations aB of the block and aH of the hanger compare? Make sure that your signs are consistent with your choices of axes in b) and d).
2. How does the tension acting on the mass hanger by the string compare to the tension acting on the block by the string?
3. Use your previous equations (b), d), e) and f)) to solve for the friction force (on the block by the table) in terms of g, the masses of the block and hanger, and the acceleration of the block?
4. Use the law of friction to find the coefficient of kinetic friction between the block and the table, k,  in terms of g, the masses of the block and hanger, and the acceleration of the block
5. from h) in the previous section, compute the kinetic coefficient of friction μk for the four cases. Write your results in the data table.
6. Precise measurements show that the coefficient of friction depends only on the types of the surfaces in contact. In this part, you will check if your experiment does confirm this result.
7. Compute as a percentage the relative difference between the values of μk in cases a and b.



1. Does the coefficient of friction depend on the area of the surfaces in contact? Explain. If not, state any experimental error that could induce a difference between cases a and b.
2. Compute as a percentage the relative difference between the values of μk in cases c and d.



1. Does the coefficient of friction depend on the mass of the block? Explain. If not, state any experimental error that could induce a difference between cases c and d.

**Data Table (Don't forget to write the units that you are using)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case  | Total mass of the block | Total mass of the hanger | Acceleration of the block | Kinetic friction μk  |
| a) Block on its large wooden side |  |  |  |  |
| b) Block on its small wooden side |  |  |  |  |
| c) Block on its large felt side |  |  |  |  |
| d) Block on its large felt side with a mass on top. |  |  |  |  |