

# Lab 04: Friction

## OBJECTIVE

In this experiment you will be verifying the relationship between the force of friction acting on a sliding object and its weight. You will also be measuring the coefficients of static and kinetic friction.

This experiment is adapted from Vernier *Physics with Computers* experiments using *Logger Pro*.

## EQUIPMENT

computer	string
Vernier computer interface	block of wood with hook
<i>Logger Pro</i>	electronic balance
Vernier Motion Detector	set of standard masses
Vernier Force Sensor	

## PROCEDURE

### PART I – STARTING FRICTION

1. Measure the mass of the block and record it in the data table.
2. Connect the Dual-Range Force Sensor to Channel 1 of the interface. Set the range switch on the Force Sensor to 50 N.
3. Open the file “12a Static Kinetic Frict” from the *Physics with Computers* folder.
4. Tie one end of a string to the hook on the Force Sensor and the other end to the hook on the wooden block. Place a total of 1 kg mass on top of the block, fastened so the masses cannot shift. Practice pulling the block and masses with the Force Sensor using this straight-line motion: Slowly and gently pull horizontally with a small force. Very gradually, taking one full second, increase the force until the block starts to slide, and then keep the block moving at a constant speed for another second.
5. Sketch a graph of force vs. time for the force you felt on your hand. Label the portion of the graph corresponding to the block at rest, the time when the block just started to move, and the time when the block was moving at constant speed. (Graph paper is printed on your worksheet.)
6. Hold the Force Sensor in position, ready to pull the block, but with no tension in the string. Click  to set the Force Sensor to zero.
7. Click  to begin collecting data. Pull the block as before, taking care to increase the force gradually. Repeat the process as needed until you have a graph that reflects the desired motion, including pulling the block at constant speed once it begins moving. Print or copy the graph for use in the Analysis portion of this activity.

## PART II – PEAK STATIC AND KINETIC FRICTION

In this section, you will measure the peak static friction force and the kinetic friction force as a function of the normal force on the block. In each run, you will pull the block as before, but by changing the masses on the block, you will vary the normal force on the block.

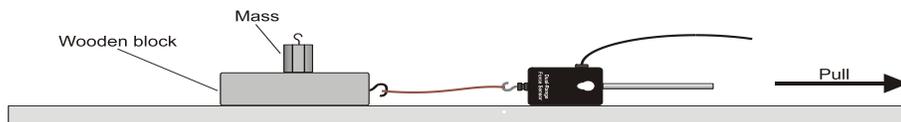


Figure 1

8. Remove all masses from the block.
9. Click  to begin collecting data and pull as before to gather force vs. time data.
10. Examine the data by clicking the Statistics button, . The maximum value of the force occurs when the block started to slide. Read this value of the *maximum* force of static friction from the floating box and record the number in your data table.
11. Drag across the region of the graph corresponding to the block moving at constant velocity. Click on the Statistics button again and read the average (or mean) force during the time interval. This force is the magnitude of the kinetic frictional force.
12. Repeat Steps 9-11 for two more measurements and average the results to determine the reliability of your measurements. Record the values in the data table.
13. Add masses totaling 250 g to the block. Repeat Steps 9 – 12, recording values in the data table.
14. Repeat for additional masses of 500, 750, and 1000 g. Record values in your data table.

## PART III – KINETIC FRICTION AGAIN

In this section, you will measure the coefficient of kinetic friction a second way and compare it to the measurement in Part II. Using the Motion Detector, you can measure the acceleration of the block as it slides to a stop. This acceleration can be determined from the velocity vs. time graph. While sliding, the only force acting on the block in the horizontal direction is that of friction. From the mass of the block and its acceleration, you can find the frictional force and finally, the coefficient of kinetic friction.



Figure 2

15. Connect the Motion Detector to DIG/SONIC 1 of the Vernier computer interface. Open the “12b Static Kinetic Frict” in the *Physics with Computers* folder.
16. Place the Motion Detector on the lab table 2 – 3 m from a block of wood, as shown in Figure 2. Position the Motion Detector so that it will detect the motion of the block as it slides toward the detector.
17. Practice sliding the block toward the Motion Detector so that the block leaves your hand and slides to a stop. Minimize the rotation of the block. After it leaves your hand, the block should slide about 1 m before it stops and it must not come any closer to the Motion Detector than 0.4 m.
18. Click  to start collecting data and give the block a push so that it slides toward the Motion Detector. The velocity graph should have a portion with a linearly decreasing section corresponding to the freely sliding motion of the block. Repeat if needed.
19. Select a region of the velocity vs. time graph that shows the decreasing speed of the block. Choose the linear section. The slope of this section of the velocity graph is the acceleration. Drag the mouse over this section and determine the slope by clicking the Linear Fit button, . Record this value of acceleration in your data table.
20. Repeat Steps 18-19 four more times.
21. Place masses totaling 500 g on the block. Fasten the masses so they will not move. Repeat Steps 18-19 five times for the block with masses. Record acceleration values in your data table.

**Each student is required to turn in a completed worksheet by the end of the lab session unless otherwise indicated by the lab instructor.**