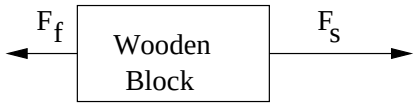
Forces in One Dimension

In this laboratory, we will explore Newton's second law in one dimension. We are concerned with the motion of a wooden block. The wooden block feels two forces, one from a string (F_s) and one from friction (F_f), as shown in the figure below.



Step 1

Arrange your equipment so that the string connected to the wooden block goes over a pulley at the edge of the table. Connect the other end of the string to a weight hanger. We will hang different amounts of mass on the hanger. The total mass on the hanger, including the hanger itself, is called m.

Place the wooden block far from the pulley so that the weight hanger is hanging close to the pulley. Mark this as the "starting place" for the wooden block. (Use a pencil or tape or something to do this.) Release the wooden block. If there is enough mass m hanging from the string, the wooden block should move across the table. Next mark an "ending place" for the motion of the wooden block. It should be close to the pulley, but the wooden block must reach the ending place before the weight hanger hits the ground and before the wooden block hits the pulley. Try to obtain a distance of something around 1 m between the starting place and the ending place. Measure the distance between the starting place and the ending place and call it L. Record that distance below. (Be sure to include units.) Also measure the mass of the wooden block (let's call that M) and record that.

Distance wooden block will travel, L	
Mass of wooden block, M	

Step 2

What we are going to do is to put different amounts of mass on the weight hanger and measure the time it takes for the wooden block to travel from the starting place to the ending place. We will need to pick weights that are not so large that the wooden block travels too quickly (and we can't time it accurately) and not so small that the block sits still or comes to a stop before reaching the ending place.

Repeatability is an important idea in experimental science. We believe that our measurements mean something only when they are repeatable. If you perform an experiment several times and get different results each time, then it is hard to believe that you are learning anything about the thing you think you're measuring. On the other hand, similar results in a number of trials give you confidence that your measurement may really mean something.

Choose five different values for the hanging mass, m. For each mass, do three trials and record the times below.

Hanging mass m	Travel time			
	Trial 1	Trial 2	Trial 3	Average

Finding the force of friction

Record your hanging masses and average travel times in the main data table.

Question 1 *Explain below how you will calculate the acceleration of the block. You may assume that this acceleration is constant.*

Calculate the acceleration, a, for each hanging mass and record it in the main data table.

Question 2 *Explain below how you will calculate the net force on the block.*

Calculate the net force on the block for each hanging mass and record it in the main data table.

The force of the string on the wooden block depends on the amount of the hanging mass and on the acceleration of the block. We will study string tension later in the course. For now, you may take the force of the string on the block to be given by the following expression.

$$F_s = mg - ma \tag{1}$$

In this equation, m is the hanging mass, $g = 9.8\ \mathrm{m/s^2}$, and a is the acceleration that you have calculated. Record the force of the string on the block (F_s) in the main data table for each hanging mass.

Question 3 *Explain how you will calculate the force of friction on the block (F_f).*

Record the force of friction on the block in the main data table for each hanging mass.

Main Data Table

Hanging Mass m (kg)	Travel Time t (s)	Acceleration a (m/s^2)	Net Force F_{net} (N)	F_s (N)	F_f (N)

Other Questions

1. Do you consider your time measurements to be *repeatable*? What numbers are you comparing in making this determination?

2. Do your results suggest that the frictional force depends on the amount of hanging mass (or, would you say that the frictional force is independent of the amount of hanging mass)? Which numbers are you comparing in making this determination?

3. Summarize your results in a few sentences.