Forces Laboratory

In this lab, we will learn how to construct and analyze force (or “free body”) diagrams. We will make use a camera and Logger Pro software.

I. Force table analysis

A. Attach 3 spring scales to a ring and to the different points on the perimeter of the force table. Place a ruler on the force table for scale calibration.

B. Photograph the force table and *insert* the picture into an open Logger Pro session. Be sure to save your original photograph; Logger pro references your original image, it may not actually import the image.

C. Make the image as large as possible in logger pro without it being too blurry.

D. *Set the scale* of the image using the ruler in the image.

E. *Set the origin* at an appropriate place in the image (probably the center point of the ring to which the three scales are attached.

F. Find the x and y components of each force. In order to do this, you will need to determine the magnitude and direction of each force. To get the magnitude of a particular force, you can just read the spring scale. To find the angle, you will need to find two (x,y) coordinates for each force. The origin can be one and the back of the scale could be another.

G. If the ring is in equilibrium, the sum of the x and x components of the forces should be zero. Is it? If not, then why not? Are the spring scales calibrated correctly? To check this, you might hang known weights from each scale.

II. Friction ramp

A. Determine the mass of a felt-padded wooden block. Then place the block on a slightly inclined ramp so that it does not slide down.

B. Hold a ruler aligned perpendicular to the surface of the ramp. Also, suspend a string with a plumb line beneath the block. Then photograph the ramp, plumb line, ruler, and block from the side. Insert this photograph into an open Logger Pro session.

C. Construct a free body diagram in your lab book. Using logger pro, identify the *magnitude* and *direction* of the three forces acting on the block. In particular, you should identify the forces due to (i) the weight of the block, (ii) the normal force exerted by the ramp on the block, and (iii) the friction force exerted by the ramp on the block.

D. Now incline the ramp a bit further and repeat the process. The block should not slide yet.

E. Once again, incline the ramp and repeat the process. Iterate this process until you find the maximum angle that the ramp can be lifted before the block slips.

F. Analysis: For each of your angles, calculate the ratio of the friction force to the normal force. Then. Make a plot of this ratio as a function of angle for at least four different angles. You should notice that this ratio has a maximum value before the block begins to slide down the ramp. This maximum value is called the coefficient of static friction. Its value is particular to the surfaces with which you are dealing (a wooden block on a wooden ramp, in our case.)