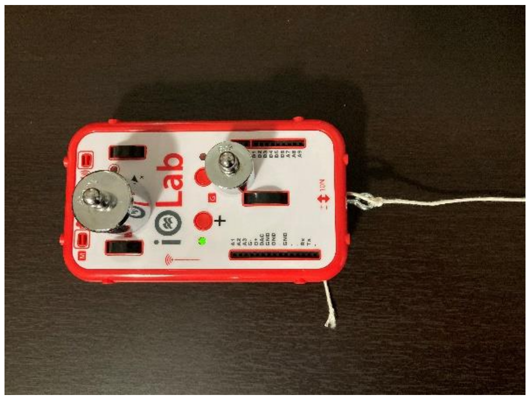
iOLab Friction

Purpose: To analyze the force of friction.

First, make sure you have felt pads attached to the back of your iOLab device (the side opposite the one with the wheels) as shown in the YouTube video on getting started.

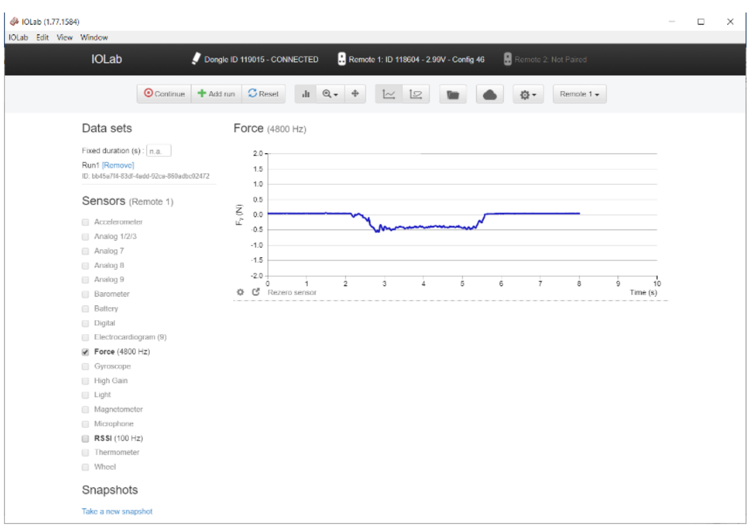
Screw the screw eye in your iOLab kit into the force sensor. Make sure that you screw it all the way in – it takes many turns. Then put a piece of string or thread through the screw eye. When you are done with this, your iOLab device should look like this:



In this picture, I've included a few of the jewelers' weights that you purchased in preparation for this course. We will be using them for this exercise.

Place your iOLab wheels up on a table or shelf that is at least a meter long. Open the iOLab app, and in the window select the Force display only.

Press the Record button on the iOLab window. Without any of the jewellers' weights on the iOLab, pull the device by the string or thread for three seconds or more in a horizontal direction and so that the iOLab moves at a constant speed across the table or shelf. Then Stop the data recording. You should have a graph that looks something like this:



Place the cursor on the force graph at the left end of the period of constant force (in the above picture, that is at about 3 seconds). Left click (and hold) and move the cursor to the right until you come to the right end of the period of constant force (about 5 seconds in the above picture). By doing so, you will shade a part of the graph. The statistics above the shaded section will tell you the mean value (denoted by μ in the display) and the standard deviation (denoted by σ) of the force you exerted on the string or thread to move the iOLab at a constant velocity.

Take a screen shot of this plot and copy it into a Microsoft Word document.

Since you were pulling the iOLab at a constant velocity, there was no acceleration and no net force on the iOLab. So the horizontal force you were exerting with the string or thread was equal in magnitude and opposite in direction to the friction force between the device and the table or shelf – and you measured the magnitude of the friction force.

The friction force depends on the force between the object and the surface on which it sits. In this case, that force is equal to the weight (the force of gravity) on the iOLab. To measure the weight of the iOLab, hang it by the string or thread (still attached to the screw eye) and press the Record button. Collect for several seconds and then use the graph to determine the weight with the same click-and-drag procedure you used to determine the friction force above.

Of course, the friction force you measured (we'll denote that by F_{fr}) is quite a bit smaller than the force between the table and the iOLab that you determined (which we'll call the "normal force", F_N). The ratio F_{fr}/F_N is called the coefficient of friction, which is usually denoted by μ.

Type the friction force you determined, the weight of the iOLab that you measured, and your result for μ into your Microsoft Word document underneath the plot you inserted above.

The coefficient of friction is generally different depending on whether the object is moving (as yours was) or stationary – and it is usually a little bigger when stationary. However, the measurement we are doing here is not sensitive enough to measure the difference.

If the friction force depends on the normal force, then when we increase the normal force the friction force should increase. We can increase the normal force here by stacking jewellers' weights on top of the iOLab. Place the 100 g and 50 g masses on top of the iOLab and remeasure the friction force using the same method you used to measure the friction force without the jewellers' weights. Take a screen shot of the force graph with the jewellers' weights with your result for the force into your Word document. Is the friction force larger with the jewellers' weights than without? How big is the normal force with the jewellers' weights? Given the coefficient of friction you determined above and the normal force including the jewellers' weights, does your friction force make sense? Type the answers to these questions into the Word document and submit via Canvas.