iOLab Impulse and Momentum

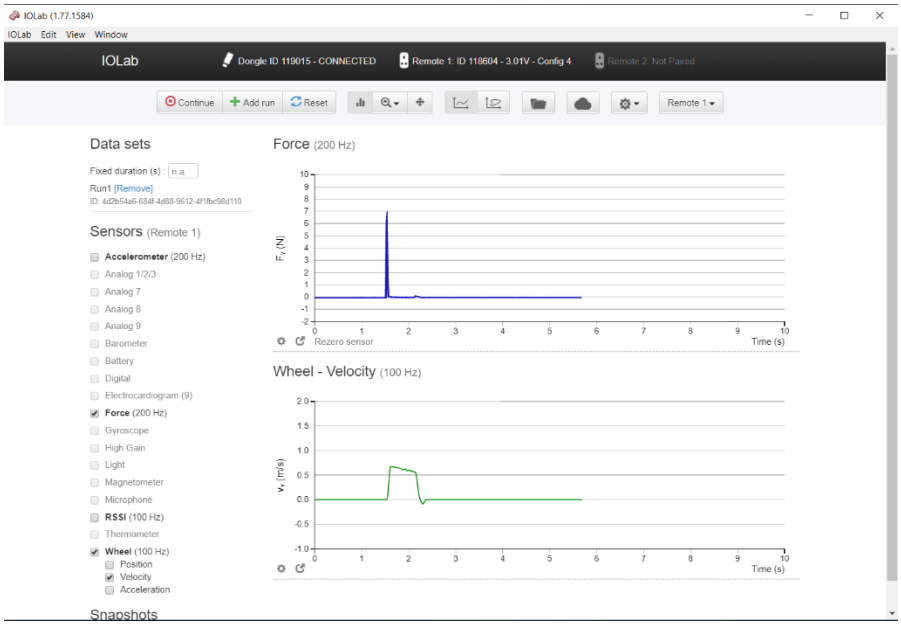
Purpose: To observe the relationship between impulse and momentum.

First, recalibrate your force sensor, following the instructions on the iOLab app.

Next, screw the push plate from your iOLab kit into the force sensor. Make sure that you screw it all the way in – it takes many turns. When you are done with this, your iOLab device should look like this:

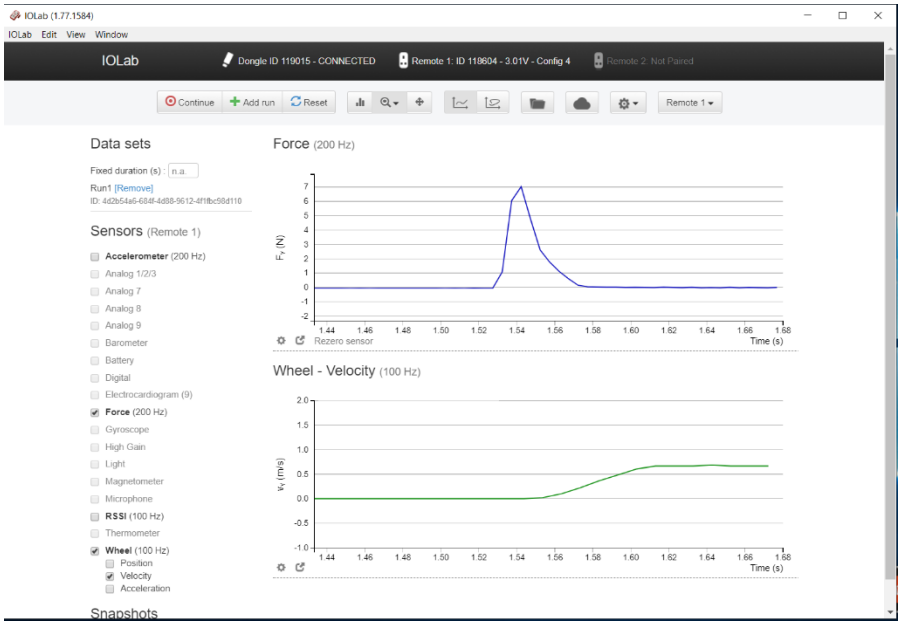
Place your iOLab wheels down on a table or shelf that is at least a meter long. In the iOLab app, select the Force and Wheel Velocity displays.

Start to record. Give the push plate a moderately sharp sudden push, and then let the iOLab roll a bit. Your data display will look something like this:



Make sure the maximum force reading on the force plot is between 5 N and 7 N. If it is larger than 7 N, your measurement of the impulse will not be accurate.

Press the magnifying glass button on the top of your iOLab display, and then left-click and drag to expand the part of the force plot that contains the peak. When you do this, you will see something like this:



Next we will integrate the force peak with respect to time to extract the impulse. Press the measurement mode button (the button with the bars on it). Then left click and drag until the entire area under the force graph is shaded. When you do that, several parameters will be displayed above the force graph. The parameter labelled “a” is the area under the curve – that is, the time integral of the force, which is the definition of impulse.

If impulse is indeed equal to the change of momentum, then the momentum of the iOLab device after the push should be equal to the impulse you have measured. Calculating the momentum requires both the final velocity and the mass of the iOLab. If you have the mass of the iOLab in your notes from earlier in the semester, you can use that here. Otherwise, insert the screw eye into the force sensor and record data for the force sensor while you hang the iOLab from the screw eye.

The velocity measurement requires some explanation, as you might have noticed in the picture above. The iOLab is traveling at its final velocity right when the force returns to zero – in the plot above that is at 1.57 seconds. But in the plot, it appears that the iOLab reaches its final velocity somewhat later – at 1.61 seconds. The reason for the delay in the velocity maximum shown above has to do with how the measurement was made: It was made on a shelf that has a relatively smooth surface. Because the surface is relatively smooth, the wheels on the iOLab didn’t immediately start turning and initially slid along the surface (for a few hundredths of a

second). The wheels were not fully turning until 0.04 seconds after the force had returned to zero.

Nevertheless, the maximum velocity, which occurred in the plot above at 1.61 seconds, is the velocity you need to test the relationship between impulse and momentum. If the surface you are using for your measurement is less smooth, your maximum velocity may be perfectly in time with the zeroing of the force.

Open a word document, and copy a screen shot of your expanded force and velocity plot into it. Beneath that, answer these questions: Is the final momentum of the iOLab equal to the impulse you applied? If not, what could explain the discrepancy?

Submit the Word document via Canvas.