Moment of Inertia and Rotational Motion Lab

Setup the apparatus

1. The Rotary Motion Sensor, Super Pulley, 3-step pulley, and rod should already be assembled as shown in the drawing. (A photo is on the web.) The Rotary Motion Sensor should already be plugged into the computer interface. If the interface is turned off, the computer will usually need to be rebooted before it will “see” the interface and sensor.

2. Remove the two masses and weigh them together. Enter their mass in Table 1.1.

3. Attach a mass to each end of the rod, equidistant from the center of the rod. You may choose any radius you wish. The masses do not have to be at the end as shown in the picture, but do not put them too close to the center of rotation.

4. Measure the distance from the axis of rotation to the center of each mass. Be sure the distance is the same to both and record this radius in Table 1.1.

5. Attach one end of the thread to the 3-step pulley and the other end to the mass hanger. (Important: Do not use too much thread. The effective radius of the pulley changes as you wind the thread around it, and excess thread will complicate your measurement.) The thread will be wound around the middle pulley, so you can either (a) tie the thread to the small hole in the pulley or (b) tie it loosely around the top pulley and then run it through the notch in the pulley to secure it.

6. Drape the thread over the Super Pulley as indicated in the drawing. The clamp-on Super Pulley must be set at an angle so the thread goes straight over the Super Pulley and is tangent to the point where it leaves the 3-step pulley. Be sure the mass hangar can fall freely without hitting the table.

7. Measure the diameter of the middle pulley with a vernier caliper.

8. **Calculate** the radius of the pulley and enter its radius in Table 1.1.
Set up the “DataStudio” program

1. Double-click on the DataStudio icon.

2. If the “How would you like to use DataStudio?” window comes up, click on the red X to close it.

3. Use the pull-down menu under “Experiment” to select the “Change Interface...” option. This will bring up the box shown below. Select the “SW700” and click OK.

4. The “Experiment Setup” window will appear. There is an alphabetical list of sensors in the left-hand column. Click on the “Rotary Motion Sensor”. After you do this, an icon of the sensor will appear, showing how it is supposed to be plugged into the SW700 interface. See picture below. The yellow connector should be plugged into the left-most socket.

5. Double-click on the icon for the Rotary Motion Sensor to bring up the “Sensor Properties” box shown at right. Be sure the “General” settings are what you see here: “10 Hz” and “fast”.

6. Click on the “Measurement” tab.
7. We want to measure and display the angular velocity in units of rad/s. Be sure the box for “Angular Velocity” for Channels 1&2 with units of (rad/s) is checked and that none of the other boxes is checked. It should look like the example shown at right.

8. Click OK.

9. There is a list of display options at the bottom of the left column of the Setup window. Double-click on the one that says “Graph”, and a display called “Graph 1” will open up. This is where our data will appear.

10. Resize the “Graph 1” window so it fills most of the screen. We are now ready to take data.

Collect and analyze the data

1. Select the amount of mass to put on the mass hanger (30 g to 50 g works well) and weigh them along with the mass hanger on your balance. Enter the value in the first column of Table 1.2.

2. Carefully wind the string onto the middle pulley, checking that the Super Pulley turns freely and that the string goes straight over the Super Pulley. One person should hold onto the rod until you are ready to start.

3. Release the rod and click on the “Start” button. Data analysis is simplified if you start collecting data just after the rod is released, like we did in the air table experiments.

4. Click the “Stop” button to end the collection of data. Again, data analysis will be simpler if you stop collecting data before you run out of string and/or the mass hits the floor, but there is an easy work-around if you don’t.
5. You will now have a set of data displayed in your “Graph 1” window. The buttons across the top of this window (see below) are used to analyze the data. If you position the mouse cursor over a button, a window will tell you what it does. We will mainly use the leftmost button (to select part of the data to view or fit), the menu under the “Fit” button, and the menu under the “Data” button.

![Graph 1 Button Menu](image1)

6. A sample data set is shown at right. If your data look like this bogus set, you need to start over and try again, but these data make it easy to see how the options work.

7. Here we have data both before and after the acceleration took place. We can click on the left-most button, which is a selection tool, and use the cursor to click-and-drag a box around the portion of the data we want to fit as shown here.

![Graph 1 Data Selection](image2)

8. Use the pull-down menu under “Fit” to select a “Linear Fit”.

![Graph 1 Fit Options](image3)

9. The fitted line will be shown along with a box containing the fit parameters. The fit parameters are the same ones we get from “Graphical Analysis”. We get uncertainties as well as the correlation coefficient “r”. Notice that the data being fit are highlighted in yellow.

![Graph 1 Fit Result](image4)

10. Record the slope $\pm$ its uncertainty in Table 1.2 along with the correlation coefficient “r”.

11. Remove the two masses from the rod and repeat steps 1 through 10. Because the moment of inertia of the rod and the rest of the apparatus is so small, you must use less mass this time. Usually the mass hangar alone (about 10 g) is enough. Record those data in the second column of Table 1.2.

12. You can either delete the previous run or have the new data appear over the old ones. The “Data” menu controls which set is active and being fit.

![Graph 1 Data Menu](image5)