Regis University – Physics 305A – Fall 2019
Lab 11: Moments of Inertia

In this lab, you will measure the moments of inertia of a number of different objects, comparing your experimental results with calculations based on the geometry of the objects. Just like last week, you will need to think through the details of how to do the experiment.

1. Connect the rotational motion sensor to the computer through the DIG/SONIC 1 port on the Vernier LabPro interface, and run the Logger Pro software. This is one of the few sensor types that cannot be automatically detected and configured by the software; you will need to select it using the dialog box that appears when you choose the menu option "Experiment → Set Up Sensors → LabPro: 1." In that dialog box, use the pop-up menu under DIG/SONIC 1 and select "Choose Sensor... → Rotary Motion." This sensor measures the angle through which the pulley on top is turned. Collect some practice runs, turning the pulley by hand, to convince yourself that you understand what the computer is displaying.

2. Mount the rotational motion sensor on a support rod and clamp it to the edge of your table. Tie a thread onto one of the small holes in the pulley on top of the sensor, and route the thread over the clamp-on "Super Pulley" and towards the floor. This configuration is illustrated in the left photograph below. Tie a hanger with a known mass to the other end of the thread.


3. Wind the thread up around the top pulley. While collecting data with the computer, allow the mass hanger to drop through a known distance to the floor. This will convert the gravitational potential energy primarily into (a) rotational kinetic energy of the spinning pulley (and the gear system to which it is attached), and (b) translational kinetic energy of the mass hanger.

4. The computer will read out for you the total angle θ through which the pulley has been turned (units of radians), as well as the angular speed $\omega = \frac{d\theta}{dt}$ (units of radians per second). How can you use this information to measure the linear speed at which the mass hanger fell? (What other measurements will you neeed to make?) You will need to know this speed in order to account for its translational kinetic energy.

5. Based on your data, and using the law of conservation of energy, determine the moment of inertia of the rotational motion sensor and the pulley attached to it.

6. Mount the aluminum disk on top of the pulley, as shown in the photograph on the right above. Use the same technique to experimentally determine its moment of inertia. (Remember to subtract the moment of inertia of the pulley system.)

7. Measure the mass and the diameter of the aluminum disk, and *calculate* its moment of inertia (via $I = \alpha MR^2$). Compare with your experimental result.

8. Place the steel ring on top of the aluminum disk; the bumps on the bottom of the ring fit into the holes on the disk to secure it. Find the moment of inertia of the steel ring.

9. Measure the mass and diameter of the steel ring, and *calculate* its moment of inertia. Compare with your experimental result.

In summary, you should measure the moments of inertia of:

- The “bare” pulley system.
- The aluminum disk.
- The steel ring.

...and compare your experimental measurements against calculations based on their geometries. If you have the time and interest, you can also experiment with a light rod to which sliding masses may be attached.