In this workshop we will study angular momentum. Specifically, we will look at “rotational collisions” where two objects each with their own initial angular momentum collide. Just like linear momentum is conserved in a linear collision, if there are no external forces acting on the objects, angular momentum is conserved if there are no external torques acting on the objects. To start consider the following scenario:

1. A small merry-go-round of radius $R$ and mass $M$ is rotating at an initial angular speed of $\omega_i$. You decide to hop on the merry-go-round and see what happens. Your mass is $\frac{1}{6} M$ and you jump on at a position $\frac{R}{2}$ from the center of the merry-go-round. Assume you are small enough to treat all of your mass as being located at $\frac{R}{2}$ from the center.
   a) What is the initial angular momentum of the merry-go-round before you jump on in terms of $M$, $R$, and $\omega_i$?

   b) What is your initial angular momentum, assuming you drop straight down onto the merry-go-round?

   c) What is the angular momentum after the “rotational collision” assuming there are no external torques acting on the system?

   d) Using what you know from part c), find an expression for $\omega_f$, the final angular speed of you and the merry-go-round after the collision in terms of $M$, $R$, and $\omega_i$.

   e) If $M = 240$ kg, $R = 2.0$ m, and $\omega_i = 30$ rpm use your expression from d) to determine the numerical value of $\omega_f$. Correct answers have correct units.

Now you will conduct a similar experiment using the rotating table and ring at your desk.
2. Recall what the conservation of angular momentum is and express it as a mathematical relationship.

3. Think of how this applies using the equipment in front of you. What assumptions would you have to make to test the mathematical relationship above using the equipment?

4. In the table, record the mass $M$ and the radius $R$ of the disk, and the mass $m$ and radius $r$ of the ring.

5. Give the disk a slow spin and use the stopwatch on your phone to determine the period $T$ and angular speed $\omega$. Explain how you did this.

Now, without disturbing anything, quickly and carefully drop the ring onto the disk from a height of a few mm. Make sure their centers are lined up as perfectly as possible (the ring should fit into the slot carved out onto the disk). Don’t hold onto the ring when it touches the disk.

6. Measure the angular speed of this new system. How is this new system different from the initial system?

7. Compare the final angular momentum of the system to the initial. Is angular momentum conserved? If not, why might the discrepancies exist?

8. What do you think is the largest source of error in this experiment? Explain.