Teaching Demonstration

Using the principles of Conservation of Angular Momentum, describe the motion of a rigid body for a calculus-based physics course.

1. **Objective:**
   To clearly explain the physical concept of angular momentum conservation and apply it to the motion of a rigid body, using calculus-based reasoning suitable for undergraduate students.

2. **Define Angular Momentum (L):**

$$\vec{L} = \vec{r} \times \vec{p} \quad \text{or for a rigid body,} \quad \vec{L} = I\vec{\omega}$$

   where I is the moment of inertia and ω is angular velocity.

3. **State the Law of Conservation:**
   If no external torque acts on a system, the total angular momentum remains constant:

$$\frac{d\vec{L}}{dt} = \vec{\tau}_{\text{ext}} = 0 \Rightarrow \vec{L} = \text{constant}$$

4. **Explain with a Physical Example:**
   - A spinning ice skater pulling arms in to spin faster.
   - A rotating platform with a person moving weights inward/outward.
     Use equations:

$$I_1\omega_1 = I_2\omega_2$$

5. **Include Calculus-based Reasoning:**

   Where does this law come from?

- The **Conservation of Angular Momentum** is a direct consequence of **Newton's Second Law for Rotation**:

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

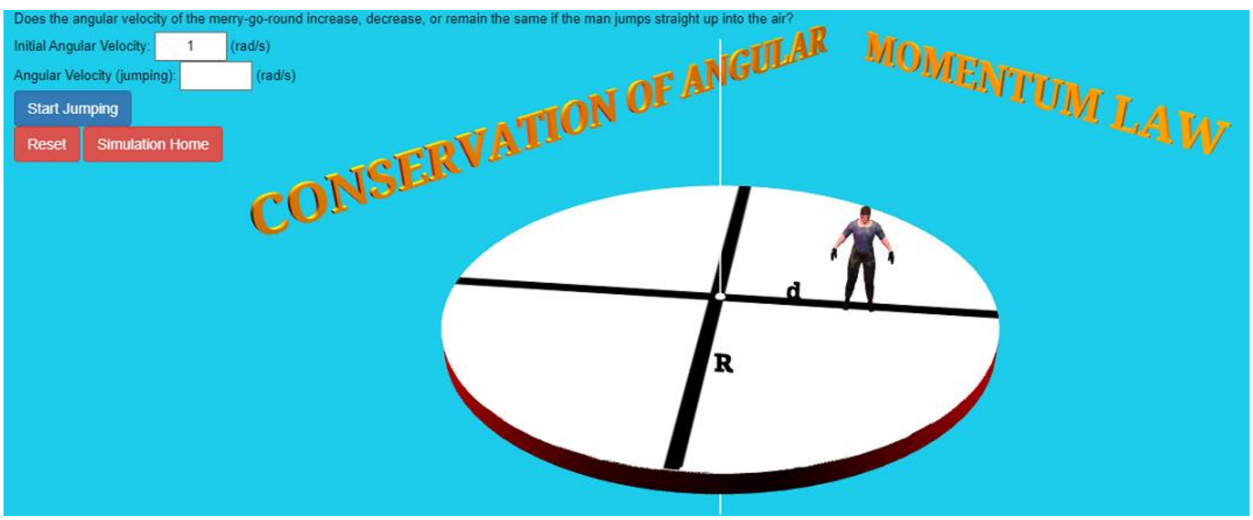
When the **net external torque** $\vec{\tau}_{\text{ext}} = 0$, it implies:

$$\frac{d\vec{L}}{dt} = 0 \Rightarrow \vec{L} = \text{constant}$$

- More fundamentally, from a theoretical physics perspective, conservation of angular momentum is rooted in **rotational symmetry of space** (Noether's Theorem):
  If the laws of physics do not change under rotation, angular momentum is conserved.

6. **Optional Visual Aid or Simulation:**
   Use a basic diagram or reference to visualize the concept.

   https://www.new3jcn.com/Phyc240/angular-momentum-law.html



7. **Engagement Prompt:**
   Question: *"What happens to angular velocity if the moment of inertia decreases? Why?"*