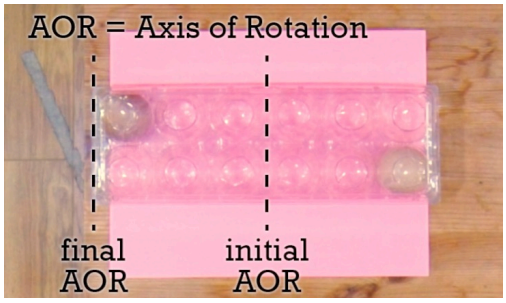
Flipping Physics Lecture Notes:

Eggs in a Carton Moment of Inertia Example Problem

Example: Two equal mass eggs are placed at either end in an egg carton of negligible mass. The egg carton is initially rotated about its middle. If the egg carton is now rotated about one end, what is the final moment of inertia of the eggs relative to their initial moment of inertia?



Two objects are in the system, so the moment of inertia equation has two expressions, one for each egg:

$$I = \sum_i m_i \left(r_i\right)^2 \Rightarrow I = m_1\left(r_1\right)^2 + m_2\left(r_2\right)^2$$

The mass of each egg is the same: $m_1 = m_2 = m$

Initially both eggs are roughly the same distance "r" from the middle of the egg carton, the initial axis of rotation: $r_{1i} = r_{2i} = r$

$$\Rightarrow I_i = m_1\left(r_{1i}\right)^2 + m_2\left(r_{2i}\right)^2 = mr^2 + mr^2 = 2mr^2$$

The final distances from the axis of rotation are: $r_{1f} \approx 0$ & $r_{2f} \approx 2r_i \approx 2r$

Therefore, the final moment of inertia is:

$$I_f = m_1\left(r_{1f}\right)^2 + m_2\left(r_{2f}\right)^2 = m\left(0\right)^2 + m\left(2r\right)^2 = 4mr^2 = 2\left(2mr^2\right)$$

And we can substitute the initial moment of inertia in for $2mr^2$, therefore:

$$\Rightarrow \boxed{I_f \approx 2I_i}$$

In other words, moving the axis of rotation from the middle of the egg carton to the end of the egg carton doubles the moment of inertia. That means it is twice as difficult to cause the two eggs to angularly accelerate around the axis of rotation.