Flipping Physics Lecture Notes:

Angular Momentum of Rigid Objects with Shape Introduction

We already know the equation for the linear momentum of an object: $\vec{p} = m\vec{v}$

An object can also have angular momentum: $\vec{L} = I\vec{\omega}$

- The symbol for angular momentum is capital L.
- Linear momentum has inertial mass; angular momentum has rotational inertia.
- Linear momentum has linear velocity; angular momentum has angular velocity.
- Angular momentum is a vector and its direction is the same as the direction of the angular velocity of the object.
- Angular momentum has an **axis of rotation!** (which you must identify)
- The units for angular momentum are:
    - $$\vec{L} = I\vec{\omega} \Rightarrow \left(kg \bullet m^2\right)\left(\frac{rad}{s}\right) \Rightarrow \frac{kg \bullet m^2}{s}$$

$\vec{L} = I\vec{\omega}$ is the equation for the angular momentum of Rigid Objects with Shape. In other words, objects which do not change shape easily and are larger than point particles. For example, disks, cylinders, spheres, planets, etc.

Example: Determine the angular momentum of a 141 g, 31.4 cm diameter record rotating clockwise at 45 revolutions per minute. $I_{disc} = \frac{1}{2}MR^2$

Knowns: $m = 141g \times \frac{1kg}{1000g} = 0.141kg;\ Dia = 31.4cm;\ R = \frac{31.4}{2} = 15.7cm \times \frac{1m}{100cm} = 0.157m;$

$\omega = -45\frac{rev}{\min} \times \frac{1\min}{60\sec} \times \frac{2\pi rad}{1rev} = -4.7124\frac{rad}{s};\ I_{disk} = \frac{1}{2}MR^2;\ L = ?$ Axis of rotation at Center of Mass of Disk.

$$\vec{L} = I\vec{\omega} = \frac{1}{2}MR^2\vec{\omega} = \frac{1}{2}\left(0.141\right)\left(0.157\right)^2\left(-4.7124\right) = -0.00818899 \approx -0.0082\frac{kg \cdot m^2}{s}$$

But what about the direction? According to the right-hand rule, the fingers of your right hand curl in the direction the record is rotating and you stick out the thumb of your right hand which points in the direction of the angular velocity and angular momentum, which is into the page, which is negative.

$$\boxed{\vec{L} \approx -0.00819\frac{kg \bullet m^2}{s}}$$