

↻ Last Lecture

- ↻ Energy and Momentum of rotation

↻ Today

- ↻ More about Momentum of rotation

↻ Important Concepts

- ↻ Equations for angular motion are mostly identical to those for linear motion with the names of the variables changed.
- ↻ Kinetic energy of rotation adds a new term to the same energy equation, it does not add a new equation.
- ↻ Momentum of rotation gives an additional equation
 - ↻ There is the additional complication that the moment of inertia can change.

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Moment of Inertia

$$\text{↻ } I = \sum m_i r_i^2 = \int r^2 dm$$

- ↻ Hoop (all mass at same radius) $I=MR^2$
- ↻ Solid cylinder or disk $I=(1/2)MR^2$
- ↻ Rod around end $I=(1/3)ML^2$
- ↻ Rod around center $I=(1/12)ML^2$
- ↻ Solid sphere $I=(2/5)MR^2$

- ↻ The same object could have a different moment of inertia depending on the choice of axis.
- ↻ In the equation: $\Sigma \vec{\tau} = I\vec{\alpha}$ all three quantities need to be calculated using the same axis.

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Angular Momentum

- ↻ Conserved when external torques are zero or when you look over a very short period of time.
 - ↻ True for any fixed axis and for the center of mass
- ↻ Formula we will use is simple: $\vec{L} = I\vec{\omega}$
 - ↻ Vector nature (CW or CCW) is still important
- ↻ Point particle: $\vec{L} = \vec{r} \times \vec{p}$
- ↻ Conservation of angular momentum is a separate equation from conservation of linear momentum
- ↻ Angular impulse: $\vec{\tau} = \frac{d\vec{L}}{dt} \quad \Delta\vec{L} = \int \vec{\tau} dt$

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Torque Checklist

- ↻ Make a careful drawing showing **where** forces act
 - ↻ Clearly indicate what axis you are using
 - ↻ Clearly indicate whether CW or CCW is positive
- ↻ For each force:
 - ↻ If force acts at axis or points to or away from axis, $\tau=0$
 - ↻ Draw (imaginary) line from axis to point force acts. If distance and angle are clear from the geometry $\tau=Fr\sin(\theta)$
 - ↻ Draw (imaginary) line parallel to the force. If distance from axis measured perpendicular to this line (lever arm) is clear, then the torque is the force times this distance
- ↻ Don't forget CW versus CCW, is the torque + or -

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