Nov 20: Get Clickers and Whiteboards

**Demo**

Why does distribution of mass matter?

\[ I = m_1r_1^2 + m_2r_2^2 + \cdots \]

The rod is easier to spin because \( I \) is small.

**Discussion**

Moment of inertia refers to distribution of mass.

Indicates how easy it is to rotate object about a specific axis.

\[ I \] blue easy

\[ I \] red hard

\[ \omega \text{ angular speed } \left( \text{rad/s} \right) \]
\[ K_{\text{rot}} = \frac{1}{2} I \omega^2 = \frac{L^2}{2I} \]

\[ K_{\text{trans}} = \frac{1}{2} m v^2 = \frac{P^2}{2m} \]

Analog between mass & moment of inertia  
Speed & angular speed
Example

\[ m = 2.0 \text{ kg} \quad \text{3 turns in 1 sec} \]

\[ I = \frac{1}{2} ML^2 \]

\[ \vec{L}_{\text{rot}} = \vec{I} \omega \quad \text{c} \]

\[ \frac{3 \times 2\pi}{15} \quad \text{c} = 61 \text{ kg m}^2/\text{s} \quad \text{c} \]

\[ \vec{L}_{\text{trans}} = \vec{I} \mathbf{v} \quad \text{c} \]

\[ = m r^2 \omega = 2 \times 1 \text{ m}^2 \times \frac{5 \text{ rad}}{s} \quad \text{c} \]

\[ = 10 \text{ kg m}^2/\text{s} \quad \text{c} \]

\[ \vec{L}_{\text{tot}} = \vec{L}_{\text{rot}} + \vec{L}_{\text{trans}} = 8.9 \text{ kg m}^2/\text{s} \quad \text{c} \]
Ponderable: Car Tires

Left CV
Right CCW
Ponderable: Seesaw

Where does Randa need to sit to balance?

\[ T \text{orque same} \]

\[ 190d_L = 145d_B \]

\[ d_B = \frac{190}{145} d_L = 1.33 \text{m} \]
Demo: Spin that wheel!

Best place to throw outside
far from axle

Best way to throw was perpendicular
to radius
Discussion: Torque

Only meaningful about a ref point

\( \overrightarrow{\mathcal{L}} = I \overrightarrow{\omega} \quad \overrightarrow{\mathcal{L}} = \overrightarrow{r} \times \overrightarrow{p} \)

\( \overrightarrow{\tau} = \overrightarrow{r} \times \overrightarrow{F} \)
Discussion: Angular Momentum Principle

\[ \vec{L} \rightarrow \text{J想象力} \]

\[ \frac{d\vec{L}}{dt} = \vec{\tau}_\text{net,ext} \]

\[ \vec{\tau}_f = \vec{\tau}_i + \vec{\tau}_\text{net,ext} \]

\[ L = I\omega \]

\[ K_{rot} = \frac{1}{2}Iu^2 = \frac{L^2}{2I} \]