Angular Momentum

Definitions:

Linear momentum:

$$\vec{p} = m\vec{v}$$

Relationship to Force:

$$\vec{F}_{\text{net}} = \sum \vec{F} = \frac{d\vec{p}}{dt}$$

Linear Momentum Conservation:

$$\sum \vec{p}_i = \sum \vec{p}_f$$

Angular momentum:

$$\vec{L} = \vec{r} \times \vec{p} \ , \ \ \vec{L} = I\vec{\omega}$$

Relationship to Torque:

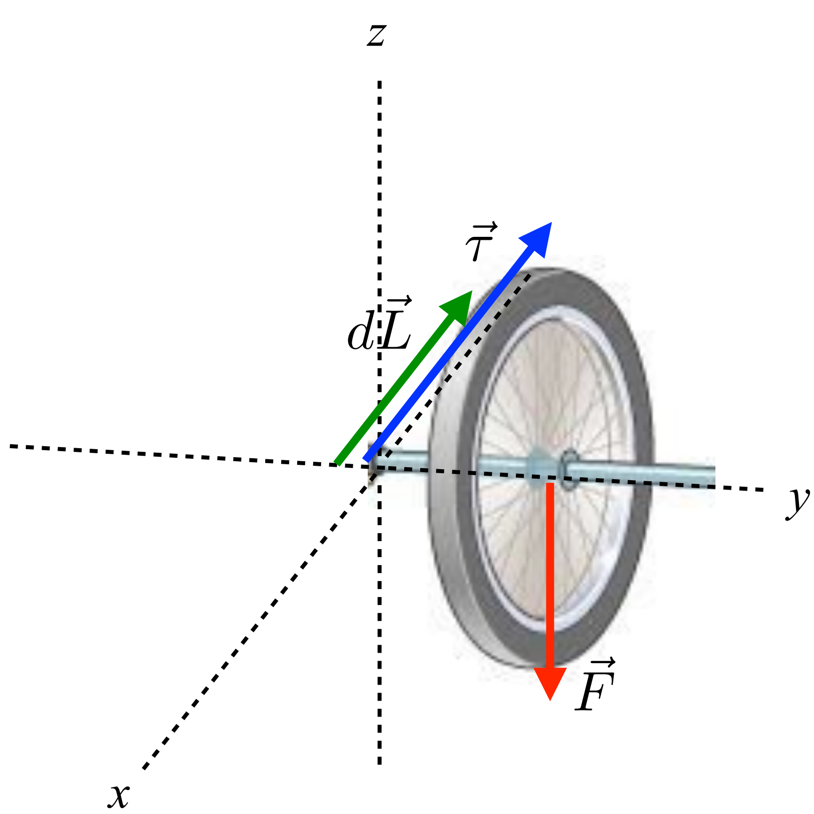
$$\vec{\tau}_{\text{net}} = \sum \vec{\tau} = \frac{d\vec{L}}{dt}$$

Angular Momentum Conservation:

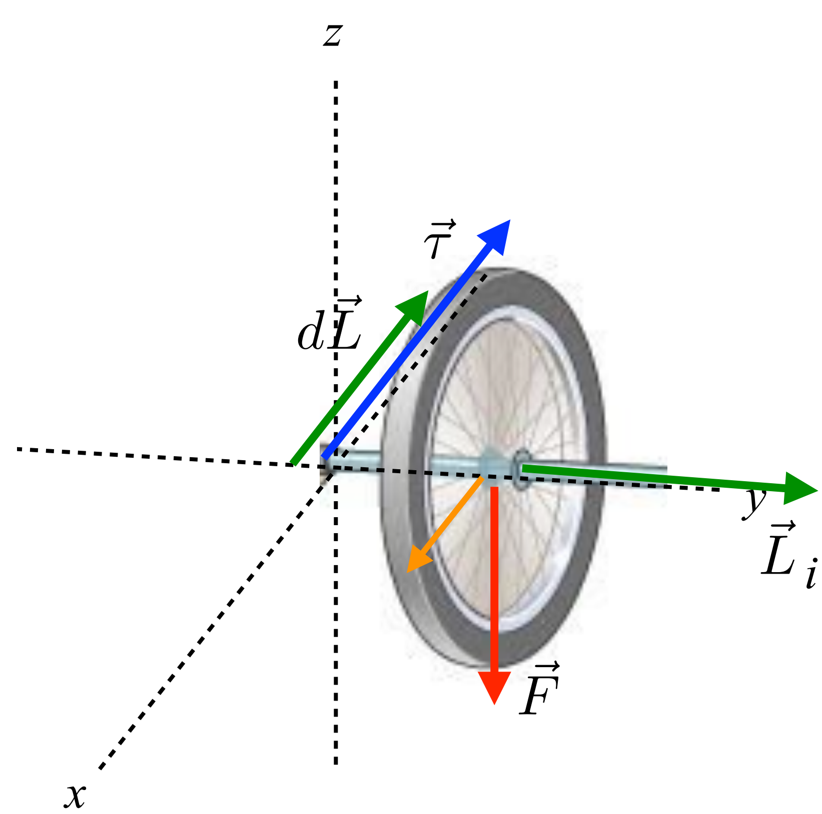
$$\sum \vec{L}_i = \sum \vec{L}_f$$

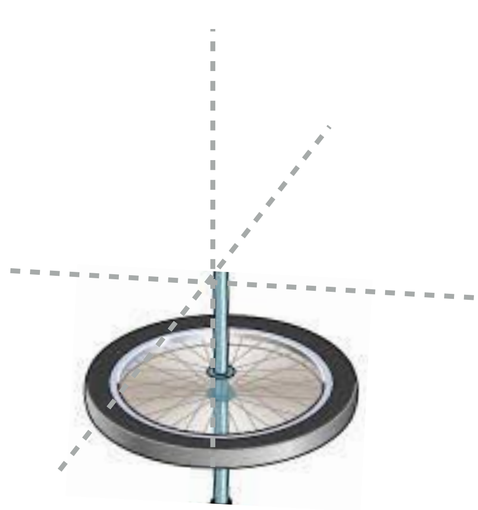
Example: Angular Momentum of a Wheel

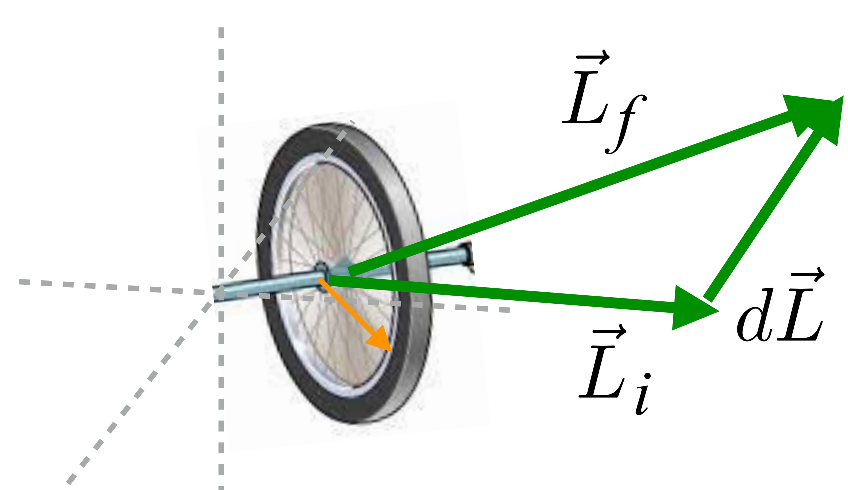
Wheel at rest



Spinning wheel



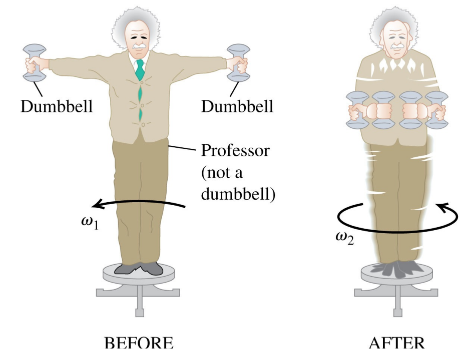




Person on Turntable (clicker)

A physics professor stands at the center of a frictionless turntable with arms outstretched and a dumbbell in each hand. He is set rotating about the vertical axis, making one rotation per second. If he pulls his arms to his stomach, the rotational inertia is reduced by 1/5. His final angular velocity:

a. is reduced by 1/5.
b. stays the same.
c. is increases by 5.
d. increases, but not quite 5 times.
e. not possible to determine.



Person on Turntable

A physics professor stands at the center of a frictionless turntable with arms outstretched and a 5 kg dumbbell in each hand. He is set rotating about the vertical axis, making one revolution in 2.0 s (π rad/s). Find his final angular velocity in rad/s if he pulls the dumbbells in to his stomach. His moment of inertia (without the dumbbells) is 3.0 kg m^2 with arms outstretched and 2.2 kg m^2 with his hands at his stomach. The dumbbells are 1.0 m from the axis initially and 0.20 m at the end.