Rotational Conservation Laws: Analogies

The purpose of this pod is to draw analogies between the quantities used in rotational motion and those used in linear motion.

Quantities:
Every quantity in rotational motion has an analogous quantity in linear motion:

Rotational Motion Quantity	**Symbol**	**SI Unit**		**Linear Motion Quantity**	**Symbol**	**SI Unit**
Moment of Inertia	I	kg m^2		inertial mass	m	kg
Angular velocity	ω	radians per second		Velocity	v	m/s
Angular momentum	L	Kg m^2 radians per second		Momentum	p	kg m /s
torque	τ	Newton-meters		Force	F	Newtons
Rotational Kinetic Energy	RKE, K, or K_r	Joules (J)		Translational Kinetic Energy	KE or K	Joules (J)

No questions yet

Formulas

Most of the rotational motion formulas have an analogous linear motion formula

Rotational Motion Formula	**Linear Motion Formula**
$I = mr^2$	None
$L = I\omega$	$p = mv$
$\Sigma\tau \cdot \Delta t = \Delta L$	$\mathrm{J} = \Sigma F \cdot \Delta t = \Delta p$
$K_r = \frac{1}{2}mv^2$	$K = \frac{1}{2}I\omega^2$

Formula	**Name**	**Notes**
$I = mr^2$	Moment of inertia of a point mass	This formula gives the moment of inertia of one point mass. It was discussed in a pervious pod.
$L = I\omega$	Definition of Angular Momentum	
$\Sigma\tau \cdot \Delta t = \Delta L$	Impulse Formula for Momentum	Analogous to the *impulse formula* for linear motion
$K_r = \frac{1}{2}mv^2$	Definition of *rotational kinetic energy*	Analogous to the *definition of linear kinetic energy.*

No questions yet

Conservation Laws:

If you recall that when learning about linear motion, the **Law of Conservation of Momentum** was one of our crucial laws.
For rotational motion, there is an analogous law, the *Law of Conservation of Angular Momentum!*

The Law of Conservation of Momentum:
In any system with no external forces, the total momentum of the system remains the same.

The Law of Conservation of Angular Momentum:
In any system with no external torques, the total angular momentum remains the same.

If you recall when learning about energy, there was a crucial law (in fact the most crucial law in all of science), called the *Law of Conservation of Energy*.
There isn't an analogous law for rotational motion. Instead, rotational kinetic energy is included as one of the new forms of energy!

The Law of Conservation of Energy:
In any system that experiences no external work, the total energy remains the same.
Kinetic energy can include translational or rotational kinetic energy.

The work-energy theorem related the work done on a particle to its kinetic energy. This theorem must also be modified to include *both* forms of kinetic energy.

The Work-Energy Theorem:
The total work done on a particle equals the change in kinetic energy of that particle.
Kinetic energy can include rotational or translational kinetic energy.