Noah Daniel Mr. White AP Physics 02 May 2025

Angular Momentum

Background: Angular momentum explores how objects rotate and how rotational motion is affected by torque and moment of inertia. Similar to linear momentum, angular momentum is conserved in the absence of external torque. This unit builds on rotational dynamics, covering concepts like the angular forms of Newton's laws and the principle of conservation of angular momentum.

Topics:	Vocabulary:	Formulas:
Angular momentum of a point mass	Angular Momentum (L) – rotational equivalent of	$s = x_{cm} = r\theta$
Angular momentum of a rigid body	linear momentum Torque (τ) – rotational	$v_{cm} = r\omega$
Moment of inertia	force; causes change in angular momentum	$u_{cm} = r\alpha$
Torque and angular momentum	Moment of Inertia (I) –	$\vec{L} = \vec{r} \cdot \vec{x} \cdot \vec{p}$
Conservation of angular	mass	$L = I\omega$
Rolling motion	Angular Velocity (ω) – rate of rotation	L = mvr
Rotational kinetic energy	Rigid Body – object with	$\vec{\tau} = \frac{dL}{dt}$
	fixed shape, doesn't deform when forces act	$\vec{\tau}\Delta t = \Delta \vec{L}$
		$I = \sum mr^2$
		$I = I_{cm} + Md^2$
		$K_{rot} = \frac{1}{2}I\omega^2$
		$K_{total} = \frac{1}{2}Im_{cm}^2 + I\omega^2$



Moment of inertia

Questions:

(All questions have been borrowed from the Chapter 11 review questions from University Physics Volume 1 by Jeff Sanny, Samuel J. Ling, and William Moebs)

- A bowling ball rolls up a ramp 0.5 m high without slipping to storage. It has an initial velocity of its center of mass of 3.0 m/s. (a) What is its velocity at the top of the ramp? (b) If the ramp is 1 m high does it make it to the top?
- 2. A boulder of mass 20 kg and radius 20 cm rolls down a hill 15 m high from rest. What is its angular momentum when it is half way down the hill? (b) At the bottom?
- 3. A 0.2 kg ball is tied to a 0.5 m long string and spun in a horizontal circle at a constant speed of 4.0 m/s. What is its angular momentum?

Answers:



