Rotational Dynamics

Basics

Angular velocity	ω = rdn/sec	
Angular acceleration	$\alpha = \Delta\omega/\Delta t = \tau / I$	← I - moment of inertia
	$\alpha = d\omega/dt$	← *i.e.*, the derivative of ω over time
Tangential velocity	$v_t = r\omega$	
Tangential acceleration	$a_t = r\alpha$	
Angle traversed in time *t*	$\theta = \frac{1}{2}\alpha t^2$	

Moment of Inertia, *I*, and Angular Momentum, *L*

Equivalent of linear motion's inertia; think of it as "rotational inertia."

Body rotating about axis:	$I = mr^2$	
Composite systems	$I_{total} = \sum m_i r_i^2$	
	$I = \int r^2 dm$	
Parallel Axis Theorem	$I = I_{cm} + md^2$	I_{cm}: I at center of mass; *d*: dist. from cm → pivot pt.
Angular momentum	$L = I\omega$	
Kinetic energy of rotation	$KE = \frac{1}{2}L\omega = \frac{1}{2}I\omega^2$	

Ball Hitting a Rod...

When a ball hits a rod (or vice versa), treat the ball as though it has angular momentum about the axis of the rod.

Torque, τ, Work, *W*

Torque is the force causing the angular motion. It is positive if counterclockwise.

Torque	$\tau = rF_\perp$	← $F_\perp$ is the force component ⊥ to the lever arm
	$\tau = rF\sin\theta$	← *r*: lever arm; *F*: force; θ: angle from *r* to *F*
	$\tau = I\alpha$	
	$I\alpha = rF_\perp$	← I seem to use this one a lot
	$\tau = \frac{dL}{dx}$	
Work	$W = \tau\Delta\theta$	← Rotational version of *W* = force x distance

Miscellaneous

Centripetal force	$F_c = \frac{mv^2}{r}$