Rotational vs. Linear Motion

Rotational Motion	**Linear Motion**
angular velocity, $\underline{\omega} = d\underline{\theta}/dt$	linear velocity, $\underline{v} = d\underline{x}/dt$
moment of inertia, I	mass, m
angular momentum, $\underline{L} = I\,\underline{\omega}$	linear momentum, p
torque, $\underline{\tau} = d\underline{L}/dt$	force, $\underline{\mathbf{f}} = d\underline{p}/dt$
work, $\Delta W = \underline{\tau} \cdot \underline{\Delta\theta}$	work, $\Delta W = \underline{f} \cdot \underline{\Delta x}$

Application Notes:

(a) All underlined quantities are vectors. The direction of the angular velocity, angular momentum, and torque are in the direction of an axis of rotation, couter-clockwise positive, clockwise negative.

(b) In problems involving tidal friction and precession, torques are given by the vector cross product of a lever arm and force,
$\underline{\tau} = \underline{r} \times \underline{f}$. The force, f in these problems is computed from mass times the spatial gradient of a gravity potential, $\underline{f} = - m\, \underline{\text{grad } V}$.

(c) Unless a force or torque is acting, $\underline{L}$ and $\underline{\tau}$ is constant, $d\underline{L}/dt = 0$ and $d\underline{p}/dt = 0$. For rotating objects in which mass or moment of inertia is constant, this means that either the angular velocity or linear velocity are constant, not changing either their magnitude or their orientation.

(d) If a force or torque is acting, $\underline{L}$ and or $\underline{\tau}$ is not constant. The derivatives $d\underline{L}/dt$ or $d\underline{p}/dt$ are set equal to the force or torque respectively. This kind of problem is an *equation of motion*.