



I

$\vec{v} = \frac{d\vec{r}}{dt}$	$\vec{\omega} = \frac{d\vec{\theta}}{dt}$
$\vec{a} = \frac{d\vec{v}}{dt}$	$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$
$\vec{F} = m\vec{a}$	$\vec{L} = I\vec{\omega}$
$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$	$\vec{\tau} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$
$\frac{d\vec{p}}{dt} = \vec{F}$	$\frac{d\vec{L}}{dt} = \vec{\tau}$

Work-Energy theorem:  
 $W = \int \vec{F} \cdot d\vec{r} = \int m \frac{d\vec{v}}{dt} \cdot d\vec{r} = \int m \vec{v} \cdot d\vec{v} = \frac{1}{2} m v^2$

Rotational Work-Energy theorem:  
 $W = \int \vec{\tau} \cdot d\vec{\theta} = \int I \frac{d\vec{\omega}}{dt} \cdot d\vec{\theta} = \int I \vec{\omega} \cdot d\vec{\omega} = \frac{1}{2} I \omega^2$

Conservation of Energy:  
 $mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$

For a rolling object:  
 $v = R\omega$   
 $mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \left(\frac{v}{R}\right)^2$

Diagram of a rolling object on an inclined plane. The height is  $h$ , the radius is  $R$ , and the angle is  $\theta$ . The center of mass is at the top of the object.

Equations:  
 $mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$   
 $v = R\omega$   
 $mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \left(\frac{v}{R}\right)^2$   
 $mgh = \frac{1}{2} m v^2 \left(1 + \frac{I}{mR^2}\right)$   
 $v = \sqrt{\frac{2mgh}{1 + \frac{I}{mR^2}}}$

