

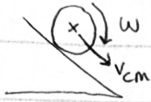
## Rotation and Kinetic Energy

PH 112

$$KE = \sum \frac{1}{2} m_i v_i^2 = \sum \frac{1}{2} m_i \omega^2 r_i^2 = \frac{1}{2} I \omega^2 \text{ J}$$

$$v = r\omega$$

↑ same for all



$$KE = \frac{1}{2} m v_{cm}^2 + \frac{1}{2} I \omega^2$$

### Example #1

$M, R, H$

$v = ?$

$$KE_0 + PE_0 = KE + PE$$

$$PE_0 = KE$$

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$$

$$\omega = \frac{v}{R}$$

$$I = \frac{2}{5} m R^2$$

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \left(\frac{v}{R}\right)^2 = \frac{1}{2} v^2 \left(m + \frac{I}{R^2}\right)$$

$$mgh = \frac{1}{2} v^2 \left(m + \frac{2}{5} m\right)$$

$$gH = \frac{1}{2} v^2 \left(\frac{7}{5}\right)$$

$$v = \sqrt{\frac{10}{7} gH}$$

### Example #2

$R, \theta, d$

$v = ?$

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

$$\omega = \frac{v}{R} \quad I = \frac{1}{2} M R^2 \quad H = d \sin \theta$$

$$gd \sin \theta = \frac{1}{2} v^2 + \frac{1}{4} v^2 = \frac{3}{4} v^2$$

$$v = \sqrt{\frac{4}{3} g d \sin \theta}$$