Stick (about center)

center of mass → center ... $I_0 = \frac{1}{12} ML^2$

Stick (about end)

axis

$I = \frac{1}{3} ML^2$

example of the **parallel axis therem**

$$I = I_0 + M\ell^2$$

I_0: moment of inertia about center of mass

ℓ is distance from center of mass to new axis

$$I = \frac{1}{12} ML^2 + M\left(\frac{L}{2}\right)^2$$

$$= \left(\frac{1}{4} + \frac{1}{12}\right) ML^2 = \left(\frac{3+1}{12}\right) ML^2$$

$$I = \frac{1}{3} ML^2$$

$F = ma \longrightarrow \tau = I\alpha$

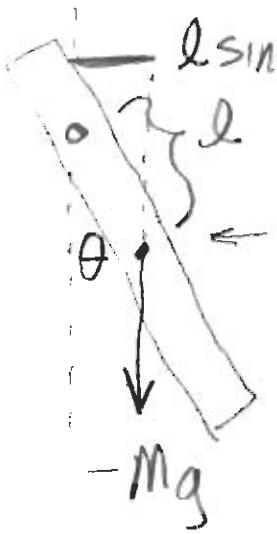
$\alpha = \dot{\omega} = \ddot{\theta}$

↑ ω of rotation!

Physical Pendulum

Extended Object made into Pendulum

Like a... stick!



torque... into page

$= -Mgl\sin\theta$

$= I\ddot{\theta}$

$I = I_0 + Ml^2$

↑ about center of mass

$= \frac{1}{12}ML^2$

$\left(\frac{1}{12}ML^2 + Ml^2\right)\ddot{\theta} \cong -Mgl\theta$

$\ddot{\theta} = -\omega^2\theta$

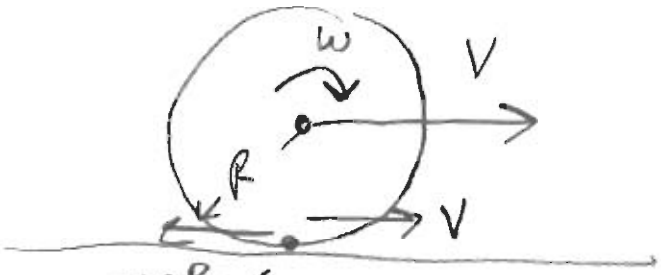
↑ ω of SHO

$\omega^2 = \frac{gl}{\frac{1}{12}L^2 + l^2}$

$\rightarrow \frac{g}{l} \quad (l \gg L)$

$\rightarrow 12\,g\,\frac{l}{L^2} \quad (l \ll L)$

Rolling (no slipping)



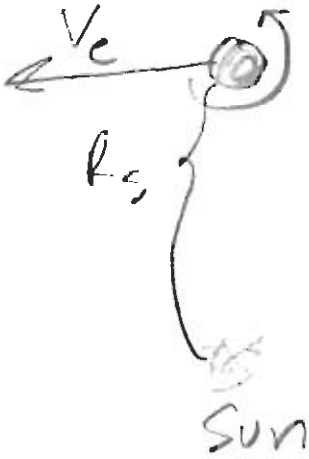
↳ that point at rest

$$V - \omega R = 0$$

$$V = \omega R$$

$$\dot{V} = a = \dot{\omega} R = \alpha R$$

$$L_{tot} = L_{COM} + L_{Internal\ Rotation}$$



(Fixed axis)

$$L_{tot} = M_e V_e R_s + I_e \omega_e$$