$$m\ddot{x} = -kx \implies \ddot{x} = -\frac{k}{m}x$$

$$\boxed{\ddot{x} = -Cx}$$ $\longleftrightarrow$ simple harmonic oscillator

$$\boxed{\begin{aligned} x(t) &= A \cdot \cos(\omega t + \varphi) \\ \omega &= \sqrt{C} \end{aligned}}$$

solution

for spring and mass

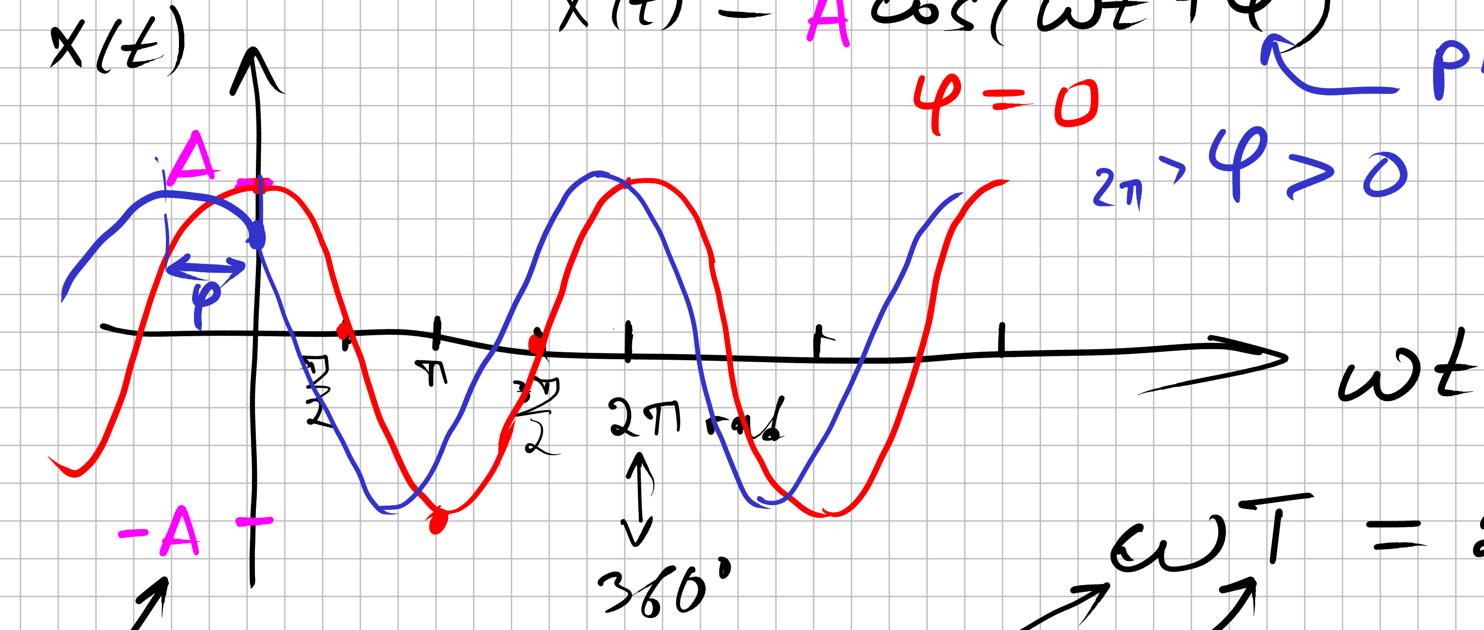
$$\omega = \sqrt{\frac{k}{m}}$$

$$x(t) = A\cos(\omega t + \varphi)$$

phase

$\varphi = 0$

$2\pi > \varphi > 0$



Amplitude ⟺ A

$$\omega T = 2\pi$$

angular frequency

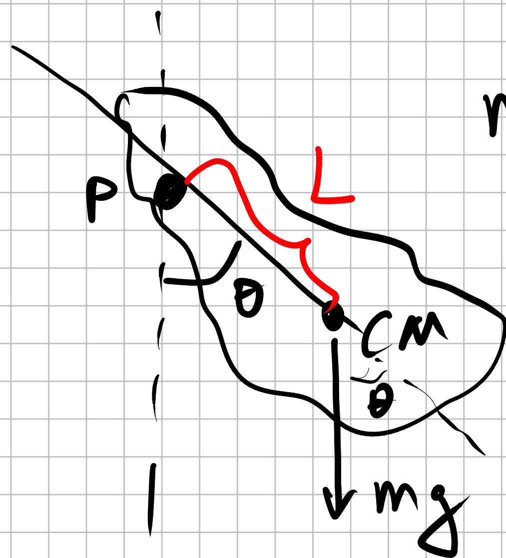
period

$$\omega = \frac{2\pi}{T} = 2\pi f$$

frequency

$$f = \frac{1}{T}$$

Physical pendulum



$$m\,,\quad I_p = I_{cm} + mL^2$$

$$I_p \alpha = \tau_{net_p}$$

$$I_p \ddot{\theta} = \tau_{net_p} = -L \cdot mg \sin\theta$$

assuming $\theta \ll 1 \Rightarrow \sin\theta \approx \theta$

$$I_p \ddot{\theta} \approx -L \cdot mg \cdot \theta$$

$$\boxed{\ddot{\theta} = -\frac{L \cdot mg}{I_p}\,\theta}$$

$$\ddot{x} = -Cx$$

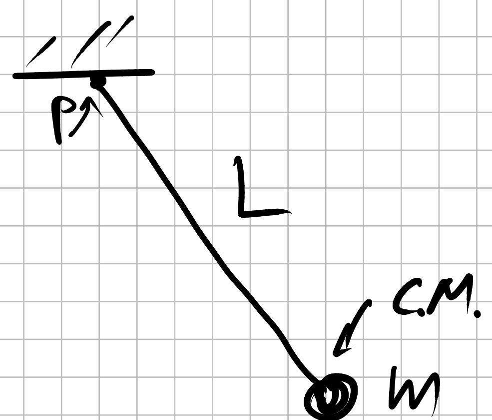
mentally $\theta \to x$

$$\frac{Lmg}{I_p} \to C$$

$$\omega = \sqrt{C} = \sqrt{\frac{Lmg}{I_p}}$$

$I_p \sim m D^2 \cdot$ coef.

simple pendulum



$$I_p = I_{cm} + mL^2 = mL^2$$

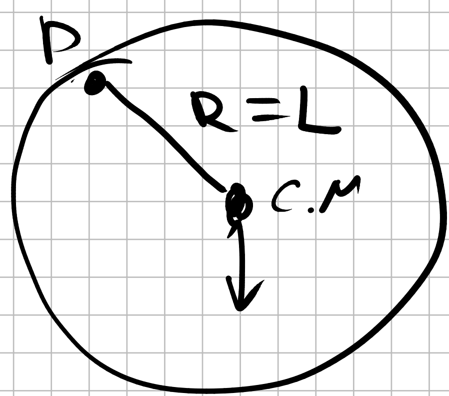
$I_{cm} \approx 0$

object is small relative to 'L'

$$\omega = \sqrt{\frac{L\cancel{m}g}{\cancel{m}L^2}} = \sqrt{\frac{g}{L}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{L}{g}}$$

Hoope on a pivot



$$I_p = I_{cm} + mL^2 = \underbrace{I_{cm}}_{= mR^2} + mR^2$$

$$I_p = 2mR^2$$

$$\omega = \sqrt{\frac{R\cancel{m}g}{2\cancel{m}R^2}} = \sqrt{\frac{g}{2R}}$$