Simple Harmonic Motion

① Spring Oscillator

$$ma = F = -kx$$

$$\Rightarrow m\frac{d^2x}{dt^2} = -kx$$

$$\Rightarrow \boxed{\frac{d^2x}{dt^2} + \overset{\omega^2}{\underset{}{\left(\frac{k}{m}\right)}}x = 0}$$

2nd order linear homogenous differential equation with constant coefficient

$$x = A\cos(\omega t + \varphi), \qquad \omega = \sqrt{\frac{k}{m}}$$

2. Simple pendulum

angular acceleration

$$-mg\sin\theta = ma_t = mL\alpha = mL\frac{d^2\theta}{dt^2}$$

small angle only $\qquad \sin\theta \doteq \theta$

$$-mg\theta = mL\frac{d^2\theta}{dt^2}$$

$$\Rightarrow \boxed{\frac{d^2\theta}{dt^2} + \overset{\omega^2}{\underset{}{\frac{g}{L}}}\theta = 0} \qquad \omega^2 = \frac{g}{L}$$