# Simple Harmonic Motion

A particle undergoes harmonic motion if it experiences a restoring force proportional to its displacement

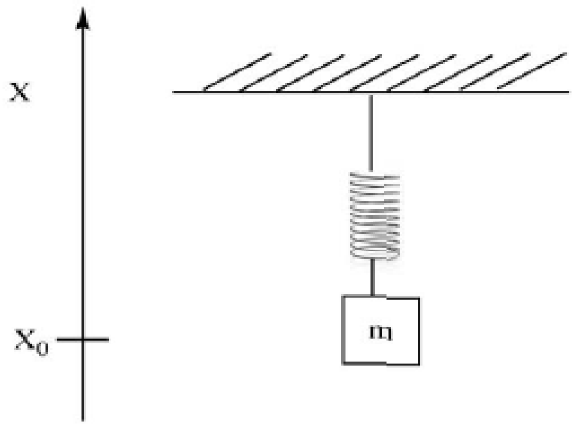
F= - k x

Where k is the force constant , the stiffer the spring the greater the value of k .

F= force , k= force constant , x = displacement .

The negative sign in F signifies that the direction of the force is opposite to that of the displacement .

Let's first focus on a simple harmonic oscillator in classical mechanics.




Hooke's Law

$$F = \underbrace{-k(X - X_0)}_{\text{force is } - \text{ gradient of potential}}$$

$$F = -\frac{dV}{dX}$$

When $X > X_0$
Force pushes mass back down toward $X_0$

When $X < X_0$
Force pulls mass back up toward $X_0$

Newton Equation

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

Substitute and rearrange

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

$x = A \sin\& \, t$

$\frac{dx}{dt} = A \,\& \cos \& \, t$

$\frac{d^2x}{dt^2} = -A \,\&^2 \sin\& \, t$ ............ $A \sin\& \, t = X$

$\frac{d^2x}{dt^2} = -\&^2 x$

$-\frac{k}{m} x = -\&^2 x$

$$x = A \sin \sqrt{\frac{k}{m}} \, t$$

$t = \hat{J}$

$X = A \sin \sqrt{\frac{k}{m}} t$

$\sqrt{k/m}\,\hat{J} = 2\pi$

$1/\hat{J} = \sqrt{\frac{k}{m}} \frac{1}{2\pi}$

$1/\hat{J} = v$ ... $v = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$

$$V = c/\lambda = c\,\bar{v} \quad \ldots\ \bar{V} = V/c = \frac{1}{2\pi c}\sqrt{k/m}$$

$m = m_1 m_2 / m_1 + m_2$ ....m= mass reduce

K= force constant (N/m) , V=frequency ($s^{-1}$),

$\bar{V}$= wave number ($cm^{-1}$)