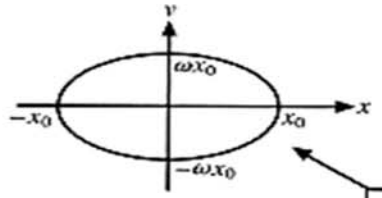
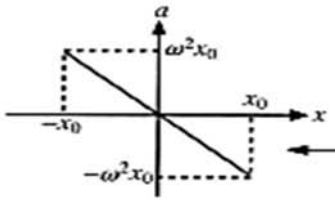
OSCILLATIONS / SIMPLE HARMONIC MOTION





$v = \pm\,\omega\sqrt{x_0^2 - x^2}$ with x

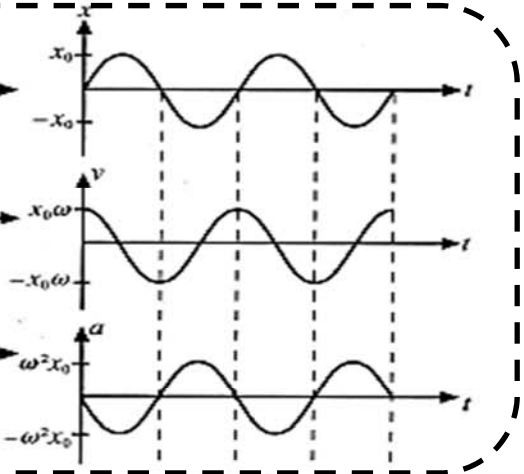
$a = -\omega^2 x$ with x

Variation of x with time → $x = x_0 \sin \omega t$

Variation of v with time → $v = x_0\omega \cos \omega t$

Variation of a with time → $x = -x_0\omega^2 \sin \omega t$

$t = 0, x = 0$



Terminology

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

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

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

means

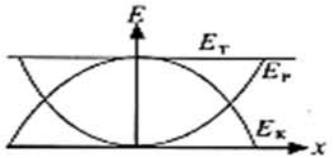
- To and fro motion about equllibrium position
- acceleration ∝ displacement
- acceleration is always directed towards equilibrium position

absence of external dissipative force

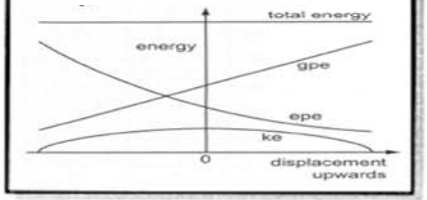
Total energy of the oscillating system is a constant

Kinetic Energy	Potential Energy	Total Energy
$E_K = \frac{1}{2}m\omega(x_0^2 - x^2)$	$E_P = \frac{1}{2}m\omega^2 x^2$	$E_T = \frac{1}{2}m\omega^2 x_0^2$

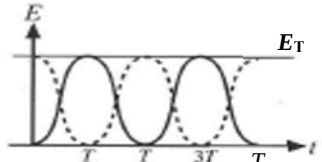
Energy variation with displacement



Energy of spring-mass system (vertical oscillation)



Energy variation with time



Velocity	Kinetic Energy	Total Energy	Potential Energy
$\omega x_0 \cos\omega t$	$\frac{1}{2} m\omega^2 x_0^2 \cos^2\omega t$	$\frac{1}{2} m\omega^2 x_0^2$	$\frac{1}{2} m\omega^2 x_0^2 \sin^2\omega t$
$\omega x_0 \sin\omega t$	$\frac{1}{2} m\omega^2 x_0^2 \sin^2\omega t$	$\frac{1}{2} m\omega^2 x_0^2$	$\frac{1}{2} m\omega^2 x_0^2 \cos^2\omega t$

Damped Oscillations

Light Damping | Heavy Damping | Critical Damping

Displacement against time