10 Oscillations

Simple Harmonic Motion

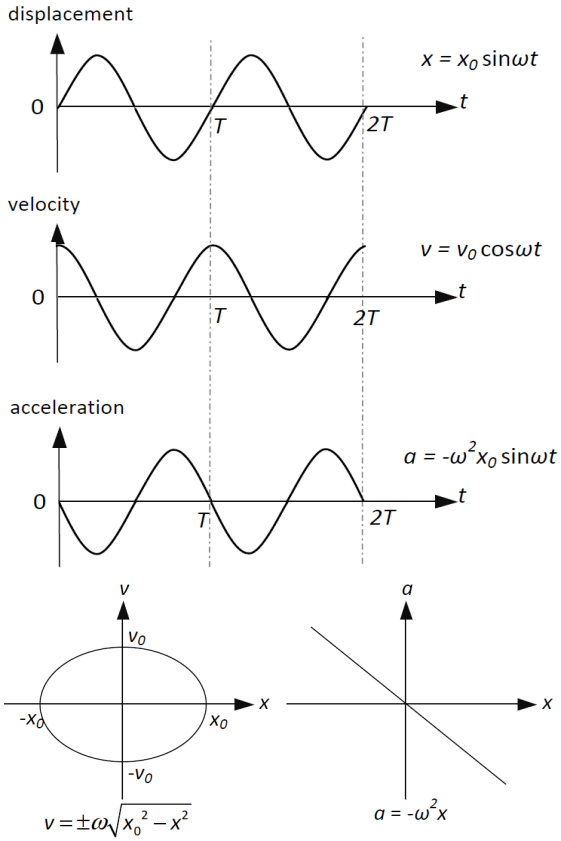
Terminology

Angular frequency ω $\omega = 2\pi f = \frac{2\pi}{T}$	Rate of change of phase angle
Phase difference $\Phi = \frac{\Delta t}{T} 2\pi$	Difference in phase angle between 2 oscillations

Simple Harmonic Motion (SHM) is the motion where acceleration of an object is proportional to its displacement from a fixed point and is directed opposite to displacement.

Kinematics of Oscillations

Defining equation for SHM: $a = -\omega^2 x$
When x = 0 and t = 0, displacement and velocity are as shown in the diagram (given), and max. velocity $v_0 = \omega x_0$. $\therefore v = \pm\omega\sqrt{x_0^2 - x^2}$

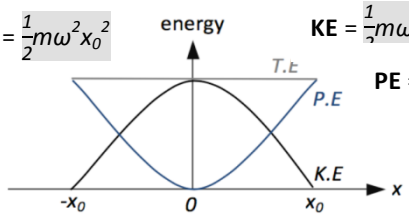


Dynamics of Oscillations

There must be a restoring force for resultant force to be proportional to displacement and pointing towards eq^{m}. $F_{net} = F_{restoring} \therefore ma = m\omega^2 x$

Energy in SHM

TE = $\frac{1}{2}m\omega^2 x_0^2$ **KE** = $\frac{1}{2}m\omega^2(x_0^2 - x^2)$ **PE** = $\frac{1}{2}m\omega^2 x^2$



Note: the PE graph above only holds true if at x = 0, PE = 0.

Damped Oscillations

Damping is when total energy of oscillating system decreases with time. The three degrees of damping are **light**, **critical**, and **heavy** damping.

Forced Oscillation and Resonance

Free oscillation is an oscillation that takes place without any external driving force and at natural frequency, while **forced oscillation** is one induced by application of periodic force.
Resonance is when a body oscillates with greatest amplitude due to max. energy transfer when driving frequency of periodic force = natural frequency of body.

Frequency-response Graph