PHYS 125 : Fundamentals of Physics

Topics Covered:

Part 1: Simple Harmonic Motion, Waves, and Sound

Chapter 15.	Oscillatory Motion
Chapter 16.	Wave Motion
Chapter 17.	Sound Waves
Chapter 18.	Superposition and Standing Waves

Part 2: Optics

Chapter 35.	Light and Geometric Optics
Chapter 36.	Image Formation
Chapter 37.	Interference of Light Waves
Chapter 38.	Diffraction and Polarization

Part 3: Modern Physics – topics selected from:

Chapter 39.	Relativity
Chapter 40.	Quantum Physics
Chapter 41.	Quantum Mechanics
Chapter 42.	Atomic Physics
Chapter 44.	Nuclear Structure
Chapter 45.	Applications of Nuclear Physics

Chapter 15. Oscillatory Motion

Periodic motions – motions that repeat themselves. The repetitive movements of an object are called **Oscillations**.

- Pendulum of an old clock,
- Atoms of a solid vibrate about their fixed positions,
- Light.

15.1. Simple Harmonic Motion (SHM)

What is SHM ? It is the *simplest* form of oscillation.

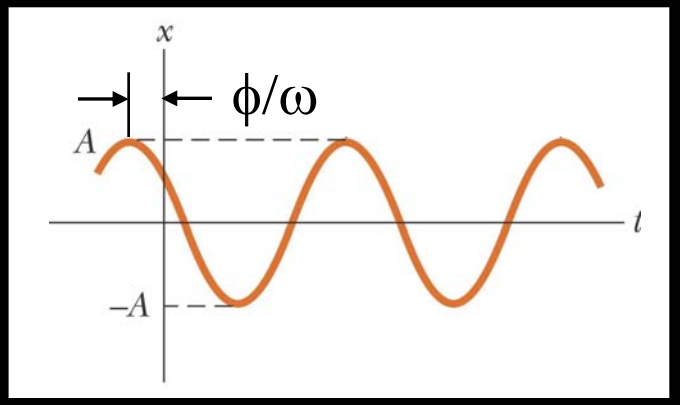
Any oscillating system for which the net restoring force is directly proportional to the negative of the displacement (e.g., as in Hooke's law, $F = -kx$) is said to exhibit SHM.

Example 1 : A block, attached to the end of a spring.

Example 2 : Swinging of a child on a playground swing.

15.2. Mathematical description of Simple Harmonic Motion

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



where x – Displacement

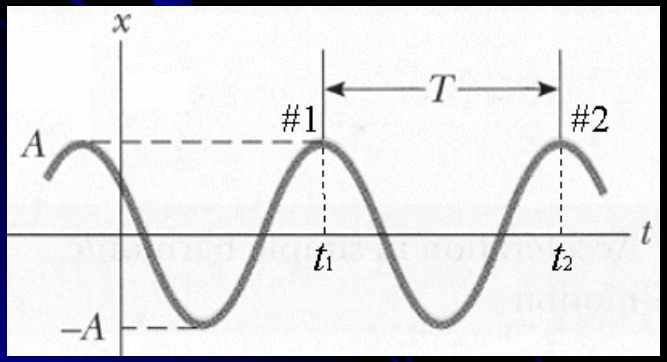
A – Amplitude (= maximum displacement x_m from equilibrium, not the total swing)

ω – Angular frequency (rad/sec)

ϕ – Phase constant (*or* initial phase angle)

} $(\omega t + \phi)$: Phase of motion

(1) Concept of ***PERIOD*** T.



{ t_1 = time at crest #1,
t_2 = time at crest #2.

T = Time between two adjacent crests.

(*equivalently*)

T = Time taken for one full cycle.

SHM repeats after each T ;

$\therefore\ x(t_2) = x(t_1 + T)$

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

(2) Concept of ***FREQUENCY*** *f*.

f = Inverse of the period *T*, and represents *the number of complete oscillations per second*.

$$\boxed{f = \frac{1}{T} = \frac{\omega}{2\pi}}$$

Units : s^{-1} or Hz

$\therefore$ 1 Hz = 1 cycle per second (s^{-1})

(3) Concept of ***VELOCITY*** and ***ACCELERATION*** for SHM

Suppose SHM along the *x*–axis :

$$x(t) = A\cos(\omega t + \phi) \qquad (1) \quad (\text{DISPLACEMENT})$$

$$v_x(t) = dx/dt = -\omega A \sin(\omega t + \phi) \qquad (2) \quad (\text{VELOCITY})$$

$$a_x(t) = dv_x/dt = -\omega^2 A \cos(\omega t + \phi) \qquad (3) \quad (\text{ACCELERATION})$$

$$\boxed{a_x(t) = -\omega^2 x(t)}$$

Hallmark of SHM : $a_x(t)$ is proportional to $x(t)$ but opposite in sign, and the two quantities are related by ω^2.