

SIMPLE HARMONIC MOTION

Time Period

- (i) Simple pendulum: $T = 2\pi\sqrt{\frac{l}{g}}$
- (ii) Physical pendulum: $T = 2\pi\sqrt{\frac{I}{mgl}}$
- (iii) Torsional pendulum: $T = 2\pi\sqrt{\frac{I}{C}}$

Equation of SHM

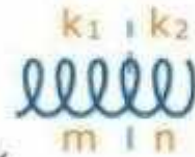
- (i) Linear : $a = -\omega^2 x$
- (ii) Angular : $\alpha = -\omega^2 \theta$

Mass Spring system

- (i) $T = 2\pi\sqrt{\frac{m}{k}}$
- (ii) Two bodies system $T = 2\pi\sqrt{\frac{\mu}{K}}$
Where $(\mu) = \frac{m_1 m_2}{m_1 + m_2}$

Combination of Springs

- (i) Series : $\frac{1}{k_{\text{eff}}} = \frac{1}{k_1} + \frac{1}{k_2}$
- (ii) Parallel : $k_{\text{eff}} = k_1 + k_2$
- (iii) Spring cut into two parts in ratio $m:n$
 $k_1 = \frac{(m+n)k}{m}$, $k_2 = \frac{(m+n)k}{n}$



Composition of 2 SHM

$$x_1 = A_1 \sin \omega t$$

$$x_2 = A_2 \sin (\omega t + \phi)$$

$$x = A \sin (\omega t + \delta) \text{ Where}$$

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1 A_2 \cos \phi}$$

$$\text{and } \tan \delta = \frac{A_2 \sin \phi}{A_1 + A_2 \cos \phi}$$

Linear SHM

- (i) Displacement : $x = A \sin (\omega t + \phi)$
- (ii) Velocity : $\frac{dx}{dt} = A\omega \cos(\omega t + \phi)$
 $= \omega \sqrt{A^2 - x^2}$
- (iii) Acceleration : $\frac{d^2x}{dt^2} = -A\omega^2 \sin(\omega t + \phi)$
 $= -\omega^2 x$
- (iv) Phase : $\omega t + \phi$
- (v) Phase Constant : ϕ

Energy in SHM

- (i) K.E. = $\frac{1}{2} m\omega^2(A^2 - x^2)$
- (ii) $U = \frac{1}{2} m\omega^2 x^2$
- (iii) $E = K + U = \frac{1}{2} m\omega^2 A^2$
 $= \text{Constant.}$

Angular SHM

- (i) Displacement : $\theta = \theta_0 \sin (\omega t + \phi)$
- (ii) Angular Velocity : $\frac{d\theta}{dt} = \theta_0 \omega \cos(\omega t + \phi)$
- (iii) Acceleration : $\frac{d^2\theta}{dt^2} = -\theta_0 \omega^2 \sin(\omega t + \phi)$
 $= -\omega^2 \theta$
- (iv) Phase : $\omega t + \phi$
- (v) Phase Constant : ϕ

SHM