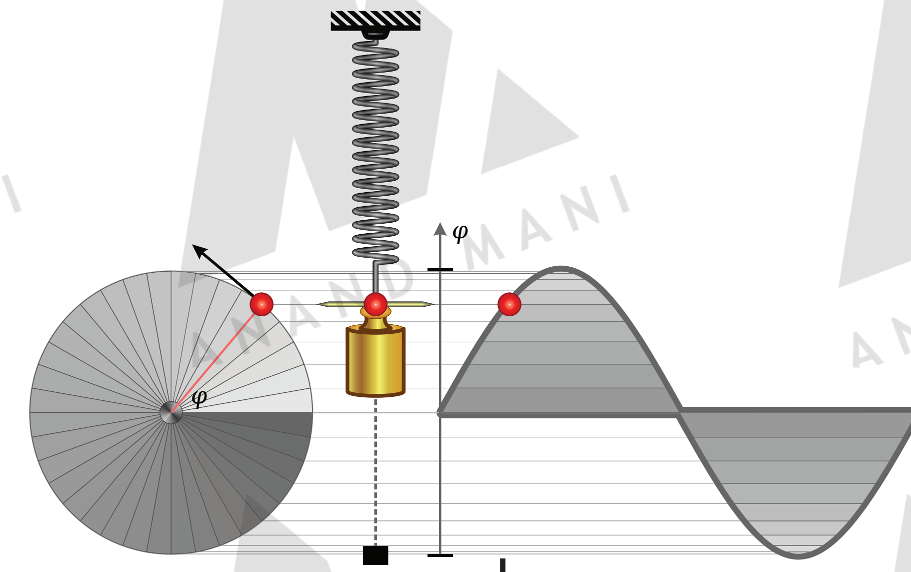
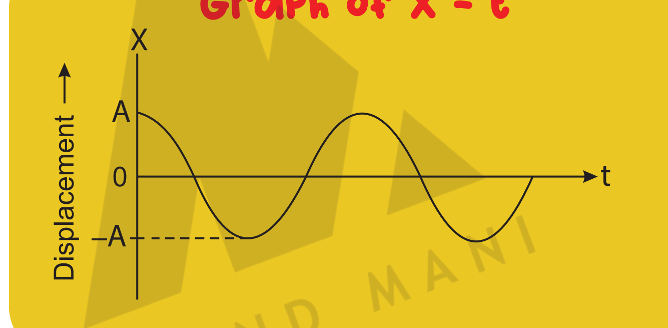
SIMPLE HARMONIC MOTION



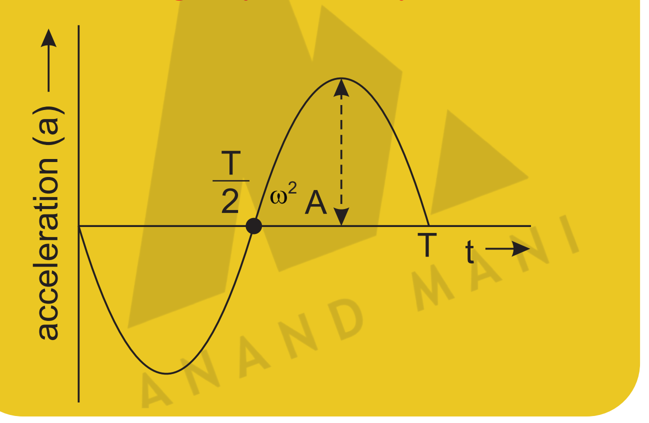
CHARACTERISTICS OF LINEAR SHM

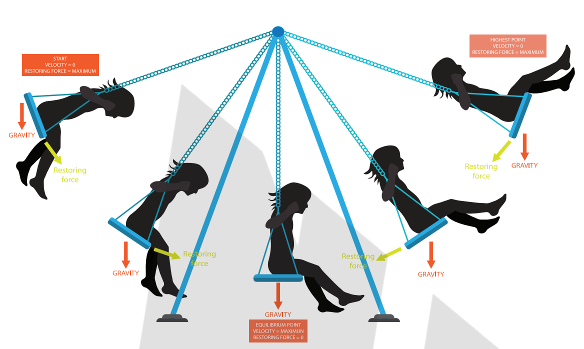
- **Differential Equation of S.H.M** $\frac{d^2x}{dt^2} + \omega_x^2 = 0$
- **Displacement** - $x = A \sin(\omega t + \phi)$
- **Velocity** - $V = \frac{dx}{dt} = \omega A \cos(\omega t + \phi)$
- **Acceleration** - $a = A \sin(\omega t + \phi) = -\omega^2 x$

Graph of X - t

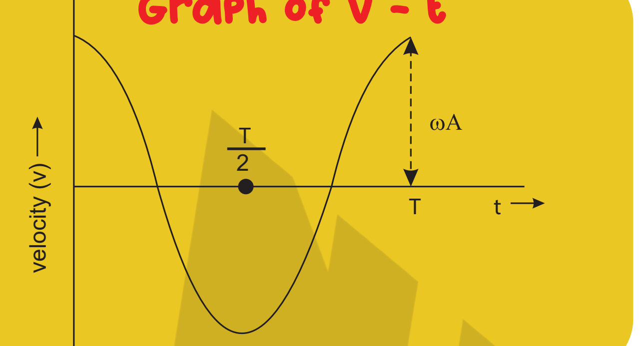


Graph of a - t





Graph of v - t



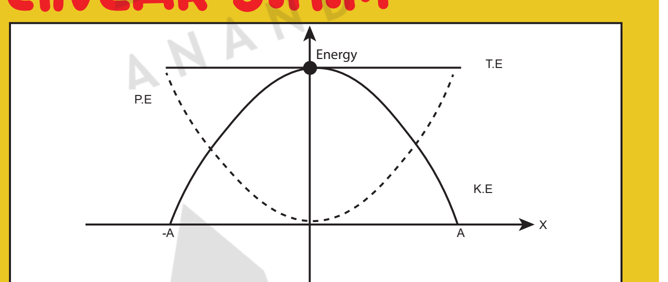
ENERGY OF LINEAR S.H.M

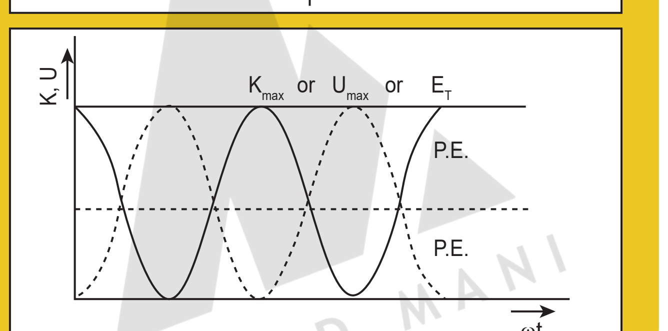
$\rightarrow$ P.E $\rightarrow U = \frac{1}{2}Kx^2$

K.E $\rightarrow K = \frac{1}{2}K(A^2 - x^2)$

$\rightarrow$ P.E $\rightarrow U = \frac{1}{2}KA^2\sin^2(\omega t + \phi)$

K.E $\rightarrow K = \frac{1}{2}KA^2\cos^2(\omega t + \phi)$





TIME PERIOD CALCULATION

(1) Force $\rightarrow \vec{F} = -m\omega_x^2$ or $\vec{F} = -k\vec{x}$; $\left(\omega = \sqrt{\frac{k}{m}}\right.$ Time period $T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$

K $\rightarrow$ spring Constant

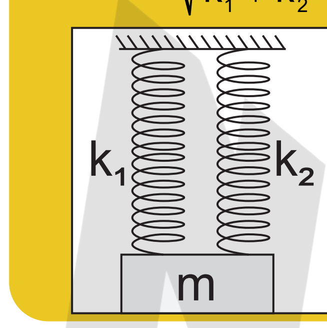
Spring Block System

Time Period $\rightarrow T = 2\pi\sqrt{\frac{m}{k_{eq}}}$

(i) $k_{eq} = K_1 + K_2$

$T = 2\pi\sqrt{\frac{m}{k_{eq}}}$;

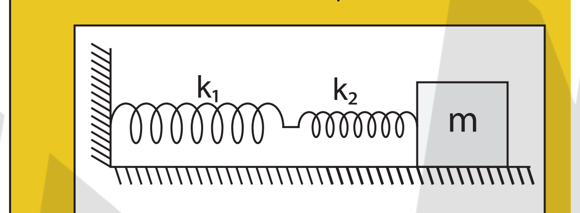
$T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$



(ii) $K_{eq} = \frac{K_1K_2}{K_1 + K_2}$;

$T = 2\pi\sqrt{\frac{m}{k_{eq}}}$

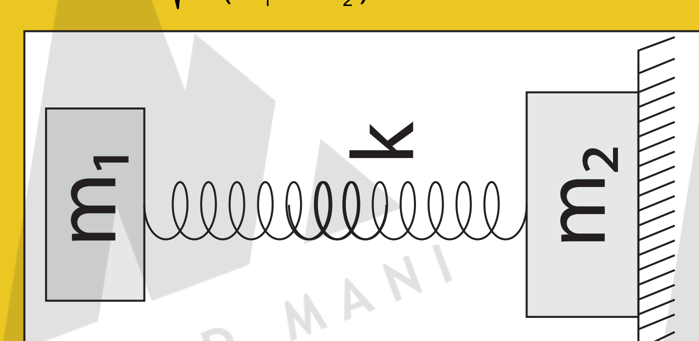
$T = 2\pi\sqrt{\frac{m(k_1 + k_2)}{K_1K_2}}$



TWO BLOCKS SPRING SYSTEM

Reduced Mass: $\mu = \frac{m_1m_2}{m_1 + m_2}$

$T = 2\pi\sqrt{\frac{m_1m_2}{K(m_1 + m_2)}} = 2\pi\sqrt{\frac{\mu}{k}}$



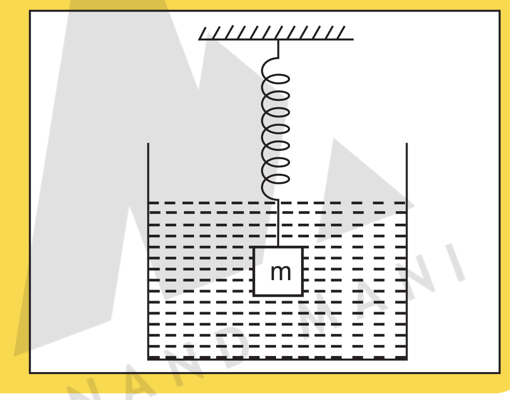
DAMPED AND FORCE OSCILLATIONS

DAMPED OSCILLATION

(1) Amplitude $\rightarrow A^1 = Ae^{-bt/2m}$

(2) Angular Frequency $\rightarrow w^1 = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$,

where - b = damping Constant



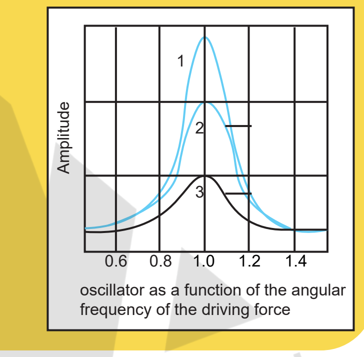
FORCED OSCILLATION

(1) Amplitude (For $\rightarrow w_d >> \omega$) $\rightarrow A^1 = \frac{F_o}{m(w^2 - w_d^2)}$

(2) Amplitude $\rightarrow A^1 = F_o/w_d b$

$\omega_d \rightarrow$ Driving Frequency

$\omega \rightarrow$ Natural Frequency



ANGULAR S.H.M

(i) Different Equation $\rightarrow \frac{d^2\theta}{dt^2} + \omega^2\theta = 0$

$\Rightarrow$ Displacement $\rightarrow \theta = \theta_o \sin(\omega t + S)$

$\Rightarrow$ Torque $\rightarrow T = K\theta$

$\Rightarrow$ Angular Velocity $\rightarrow W = \sqrt{\frac{K}{I}}$; Angular accelartion $\rightarrow \propto = \frac{-K\theta}{I}$

$\Rightarrow$ Time period - $T = 2\pi\sqrt{\frac{I}{K}}$

PENDULUM

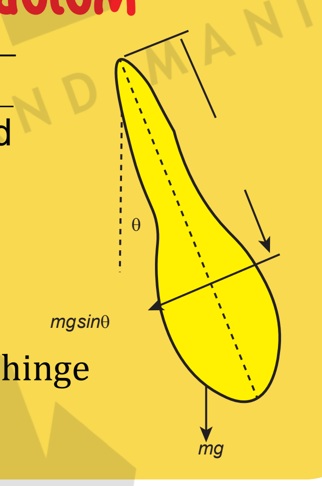
Physical Pendulum

:- Time period $\rightarrow T = 2\pi\sqrt{\frac{I}{mgd}}$

I : MoI of system

M : Mass of System

d: distance between com and hinge

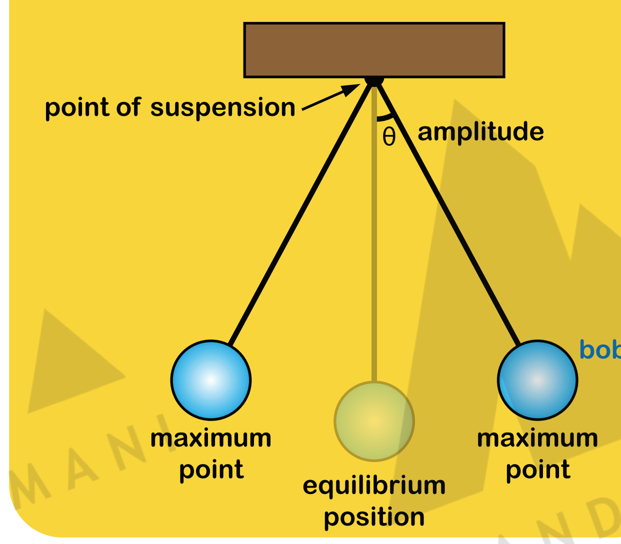


Simple Pendulum

$F \propto -\theta$;

$F = -K\theta$;

Time period $\rightarrow = 2\pi\sqrt{\frac{\ell}{g}}$



Torsional Pendulum

$T \propto \theta$

$T = -C\theta$ [C = Torsional Constant]

Time period - $T = 2\pi\sqrt{\frac{I}{C}}$

I : Moment of Inertia