SHM

$a \propto -x \Rightarrow \boxed{a = -\omega^2 x}$

$$\boxed{x = A \sin(\omega t + \phi)}$$

$$\boxed{v = A\omega \cos(\omega t + \phi)}$$

$$\boxed{a = -A\omega^2 \sin(\omega t + \phi)}$$

Time :- i) from $x = 0 \rightarrow x = \frac{A}{2}$ is $\frac{T}{12}$

ii) from $x = \frac{A}{2} \rightarrow x = A$ is $\frac{T}{6}$

iii) From $x = 0 \rightarrow x = A$ is $\frac{T}{4}$

$$\boxed{v = \omega\sqrt{A^2 - x^2}}$$

$$\boxed{v_{max} = A\omega \text{, At } x = 0}$$ → Mean Position

& $$\boxed{v = 0 \text{, At } x = \pm A}$$ → extreme position

Also, K.E. = 0, At $x = \pm A$

~~$a_{min} = 0$~~ K.E. max At $x = 0$

$$\boxed{a = 0 \text{, At } x = 0}$$

$$\boxed{a_{max} = \omega^2 A}$$ → At extreme

$$\boxed{\omega = \frac{a_{max}}{v_{max}}}$$ $$\boxed{A = \frac{v_{max}^2}{a_{max}}}$$

Energy in S.H.M.

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

$$\boxed{T.E. = \frac{1}{2}KA^2 \text{ (const)}}$$

$$\boxed{T.E. = U_{max}}$$

ESTIMATE

$$\boxed{k = m\omega^2}$$ $$\boxed{A = L\theta}$$

→ Force const.

$$K.E._{min} + U_{max} = T.E.$$

$$K.E._{max} + U_{min} = T.E.$$

Energy have double the frequency than x, a, v

$$A = \frac{mg}{K}$$

$$\omega = \sqrt{\frac{K}{m}}$$

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Combination of $x_1 = A_1 \sin \omega t$
$x_2 = A_2 \sin(\omega t + \phi)$

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

$$x = A \sin(\omega t + \delta)$$

If $A_1 = A_2 = A_0$

$$\boxed{A = 2A_0 \cos\left(\frac{\phi}{2}\right)}$$

Time Period

For Single Spring System →

$$\boxed{T = 2\pi\sqrt{\frac{m}{K}}}$$

& for any combination of Springs,

$$\boxed{T = 2\pi\sqrt{\frac{m}{K_{eff}}}}$$

for Two Block System of masses m_1 & m_2

$$\boxed{T = 2\pi\sqrt{\frac{\mu}{K}}}$$

where $\left\{\mu = \frac{m_1 m_2}{m_1 + m_2}\right\}$

ESTIMATE & For Pulley Question

$$\boxed{\frac{1}{K_{eff}} = \sum_{i=1}^{n} \frac{P_i^2}{K_i}}$$

P_i → coefficient of tension in the string

If cylinder displaced already by h & then displaced more by ~~x~~, then

$$\boxed{T = 2\pi\sqrt{\frac{h}{g}}}$$

For tunnel & Satellite revolving around earth & for infinite pendulum :-

$$\boxed{T = 2\pi\sqrt{\frac{R}{g}} = 84.6\ min}$$

Angular SHM

$$\boxed{\alpha = -\omega^2 \theta}$$

$$\boxed{\omega = \sqrt{\frac{g}{l}}} \quad \boxed{T = 2\pi\sqrt{\frac{l}{g}}}$$

$$\boxed{T_{moon} = \sqrt{6}\, T_{earth}}$$

In general

$$\boxed{T = 2\pi\sqrt{\frac{l}{g_{eff.}}}}$$

Physical Pendulum

$$\boxed{f = \frac{1}{2\pi}\sqrt{\frac{C}{I}}}$$

moment of inertia

$$\boxed{T = 2\pi\sqrt{\frac{I_{hinge}}{Mgd}}}$$

d = distance b/w hinge & C.O.M.

Damped Oscillation

$$F = -kx - \underbrace{bv}_{\text{Drag force}}$$

$$\boxed{x = A\sin(\omega t + \phi)}$$

A → variable

$$\boxed{A = A_0 e^{-bt/2m}}$$

* Time in which amplitude reduces to half

ESTIMATE

$$\boxed{t = \frac{2m}{b} \ln 2}$$

* Time in which T.E. reduces to half

$$\boxed{t = \frac{m}{b} \ln 2}$$

Forced Oscillations

$$\boxed{x = A \sin(\omega_d t + \phi)}$$

for $\{F = -Kx - bv + F_0 \sin(\omega_d t)\}$