

② Car



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



$$T = 2\pi \sqrt{\frac{l}{g \sin \theta}}$$

③ Car at circular track —

$$T = 2\pi \sqrt{\frac{l}{g^2 + \frac{v^2}{R^2}}}$$

④ Pendulum in liquid



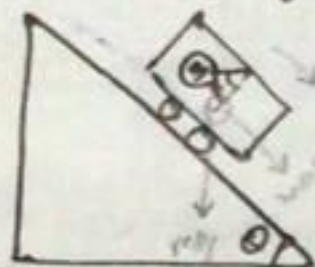
$$T = 2\pi \sqrt{\frac{l}{g - \frac{\rho V g}{M}}}$$

$$T = 2\pi \sqrt{\frac{l}{g(1 - \frac{\rho}{\sigma})}}$$

V = vol of bob
 ρ = density of liq
 M = mass of bob
 σ = density of bob

→ Pendulum to rise fluid media to TP bodega ↑

⑤ Angle made by pendulum with ceiling is 90° .



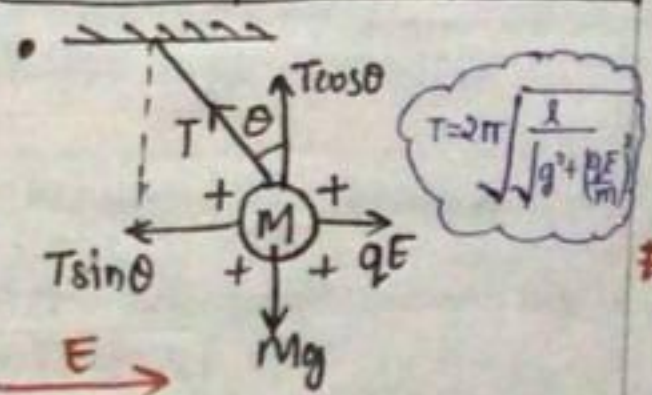
$$T = 2\pi \sqrt{\frac{l}{g \cos \theta}}$$

⑥ Time Period in EF:-

$$T = 2\pi \sqrt{\frac{l}{g - \frac{qE}{M}}}$$

$$T = 2\pi \sqrt{\frac{l}{g + \frac{qE}{m}}}$$

$$T = 2\pi \sqrt{\frac{l}{g - \frac{qE}{m}}}$$



⑦ Time Period when length of simple pendulum is very large:-

$l \gg R$

$$T = 2\pi \sqrt{\frac{l}{g(1 + \frac{l}{R})}}$$

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

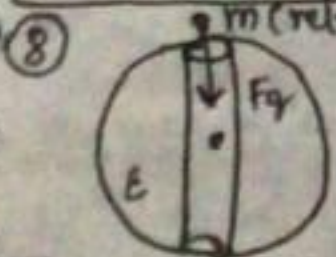
$l = R$

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

$l \ll R$

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

$T = 24.6 \text{ min}$



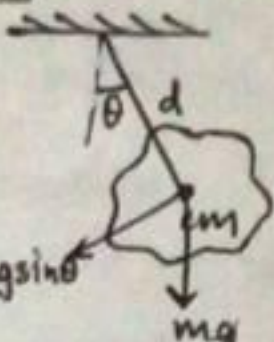
⑧ Second Pendulum

length = 1m
Time period = 2sec
 $f = 0.5 \text{ Hz}$

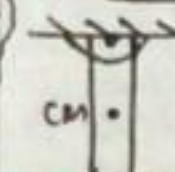
TP of Physical Pendulum:-

$$T = 2\pi \sqrt{\frac{I}{mgd}}$$

I = MOI of object wrt point of suspension.
 d = distance of O and CM



Ex:- Vertical Rod hinged about 1 end.



$$I = \frac{ML^2}{3}$$

$$T = 2\pi \sqrt{\frac{2L}{3g}}$$

• Special Case:-

① TP of solid cylinder performing SHM if it is slightly displaced downward and released.

$$T = 2\pi \sqrt{\frac{m}{\rho A g}}$$

$$T = 2\pi \sqrt{\frac{\rho_0 L}{\rho g}}$$

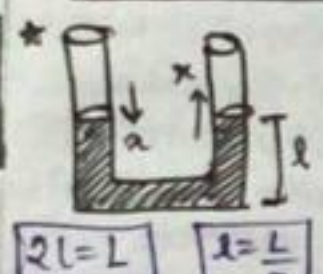
$$\rho L = \rho_0 L$$

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$T = \sqrt{\frac{2H}{\rho g}}$$

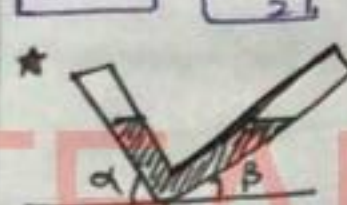
L = length of cylinder inside the liquid.

② Oscillation of liquid column -



$$T = 2\pi \sqrt{\frac{M}{2\rho A g}}$$

$$T = 2\pi \sqrt{\frac{L}{g}}$$



$$T = 2\pi \sqrt{\frac{L}{g(\sin \alpha + \sin \beta)}}$$

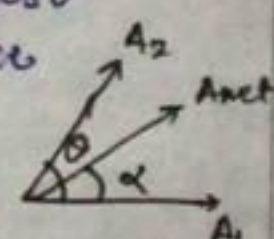
L = length of water column.

Superposition -

$$A_{\text{net}} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos \theta}$$

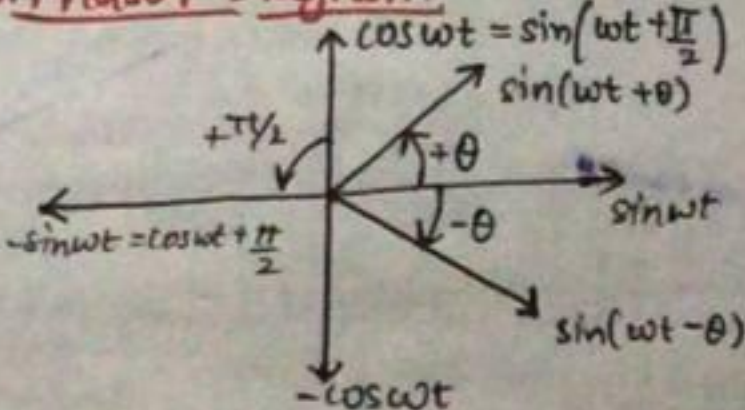
θ = initial phase difference

$$\tan \alpha = \frac{A_2 \sin \theta}{A_1 + A_2 \cos \theta}$$



α = Angle b/w A_{net} and 1st SHM

Phasor Diagram



① $x_1 = A \sin(\omega t)$
 $x_2 = A \cos(\omega t)$

$$x = \sqrt{2} A \sin(\omega t + \frac{\pi}{4})$$

② $x_1 = A \sin(\omega t)$
 $x_2 = A \sin(\omega t + \frac{\pi}{6})$

$$x = A \sin(\omega t + \frac{\pi}{3})$$

③ $x_1 = A \sin(\omega t - \frac{\pi}{6})$
 $x_2 = A \cos(\omega t - \frac{\pi}{3})$

$$x = \sqrt{3} A \sin(\omega t)$$

④ $x_1 = A \sin(\omega t)$
 $x_2 = A \cos(\omega t)$

$$\text{Circle; } x^2 + y^2 = A^2$$

⑤ $x_1 = A \sin(\omega t)$
 $x_2 = A \sin(\omega t)$

$$\text{St Line; } x_1 = y_2$$

⑥ $x_1 = A \sin(\omega t + \frac{\pi}{3})$
 $x_2 = A \cos(\omega t + \frac{\pi}{6})$

$$x = \sqrt{3} A \cos \omega t$$