PRAYAS

JEE 2025

Lecture - 03

Physics

Circular Motion

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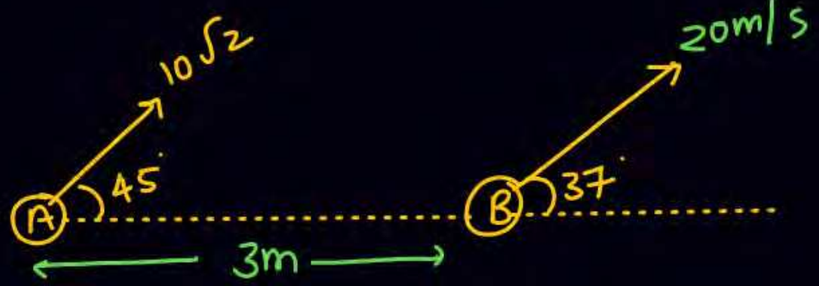
Topics to be covered

1. Circular motion kinematics
2. Centripital force.
3.
4.

Q

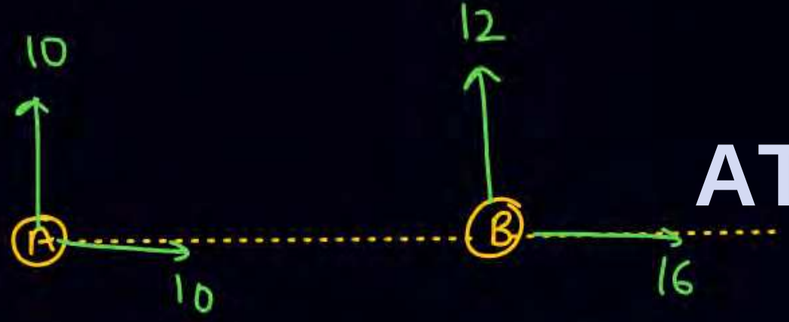


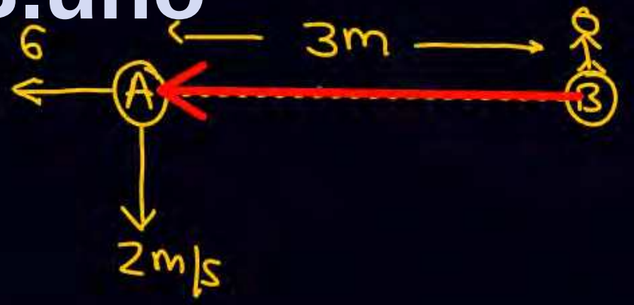
$\omega_{B/A} = \frac{2}{3}(Acw)$ $\omega_{A/B} = \frac{2}{3}(cw)$

(b) $\omega_{A/B} = \frac{2}{3}(Acw)$

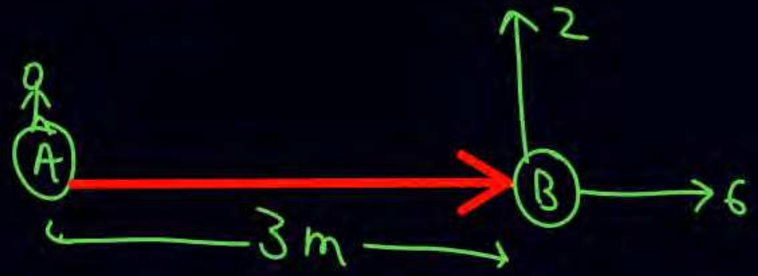
$\vec{v}_{A/B} = -\vec{v}_{B/A}$

$\vec{\omega}_{A/B} = \vec{\omega}_{B/A}$



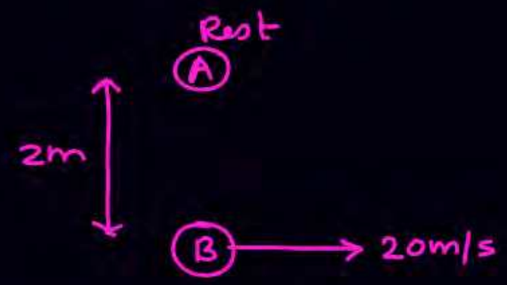


$\omega_{A/B} = \frac{2}{3}(Acw)$



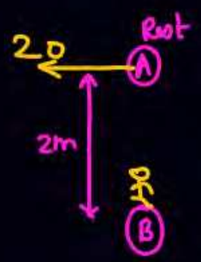
$\omega_{B/A} = \frac{2}{3}(Acw)$

Q

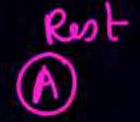


$\omega_{A/B} = \frac{20}{2}$ (Acw)

$= 10$



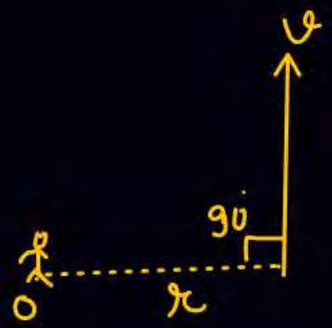
Q

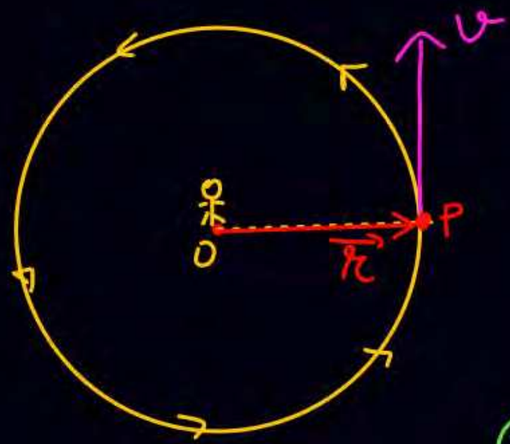


10m

$\omega_{A/B} = \frac{20}{10}$ (Acw) $= 2$(Acw)

Circular motion





$$\omega_{P/O} = \omega = \frac{v}{r}$$

$$\omega = \frac{V}{R} \text{ (magnitude)}$$

$$V = R\omega \text{ (magnitude)}$$

Speed

$$\omega_{P/O} = \frac{V_\perp}{r} = \frac{V}{r}$$

$$\vec{\omega} = \frac{\vec{V}}{R}$$ ✗

$$V = R\omega$$

$$a = R\alpha$$

tangential acc

$$V = R\omega$$

$$\frac{d(\text{speed})}{dt} = \frac{d}{dt}(R\omega)$$

$$\boxed{a_t = R\alpha}$$

angular acc

Q A wheel start rotating from rest s.t its angular acc is 4 rad/sec² at t=0 (const)
Radius of wheel is 5m. find

(a) angular velocity at t = 10 sec.

(b) angle rotated in 10 sec.

Soln

$\omega_i = 0$

$\alpha = 4$

$t = 10$

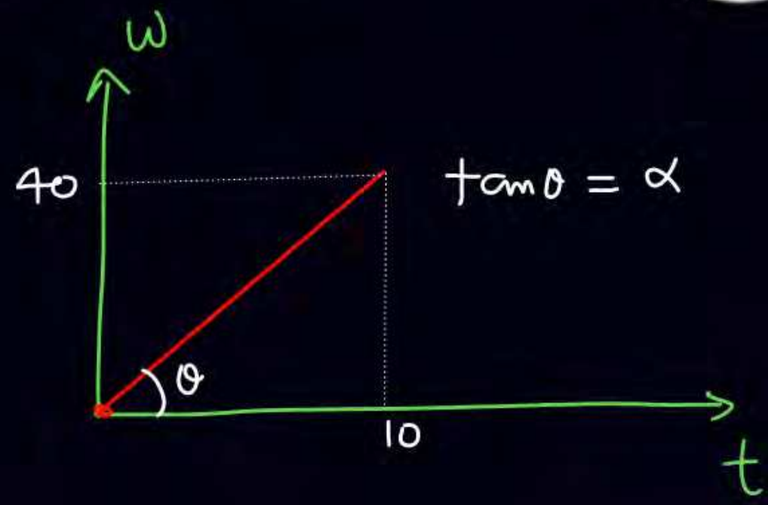
$\omega_f = \omega_i + \alpha t$

$\omega_f = 0 + 4 \times 10 = 40$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$\theta = 0 + \frac{1}{2} \times 4 \times (10)^2 = 200$ rad

No. of turn $= \frac{\theta}{2\pi}$



* Q A particle start moving in a circular path of radius 8m such that its speed Vs time relation is given as

$V = 2t^2$ ← speed

find acc. of particle at $t = 2$ sec

" everything " " "

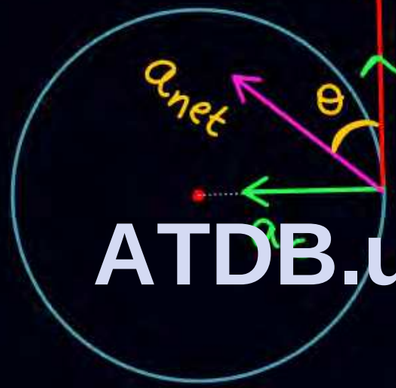
Soln

① $V = 2t^2$

$a_t = 4t$

$t = 2$ put $\Rightarrow a_t = 8$

② $v = 2t^2$ $t = 2$ sec $\Rightarrow$ **$v = 8$ m/s**



time ↑, speed up

S.K.C

③ $a_c = \frac{v^2}{R} = \frac{4t^4}{R}$

at $t = 2$ sec $a_c = \frac{8^2}{8} = 8$

④ $a_{cc} = a_{net} = \sqrt{a_t^2 + a_c^2} = \sqrt{8^2 + 8^2}$

$= 8\sqrt{2}$

⑤ find ω, α at $t = 2$ sec

$v = R\omega$ $\quad a_t = R\alpha$

$8 = 8\omega$ $\quad 8 = 8\alpha$

$(\omega = 1$ rad/sec$)$

$\alpha = 1$ rad/sec^2

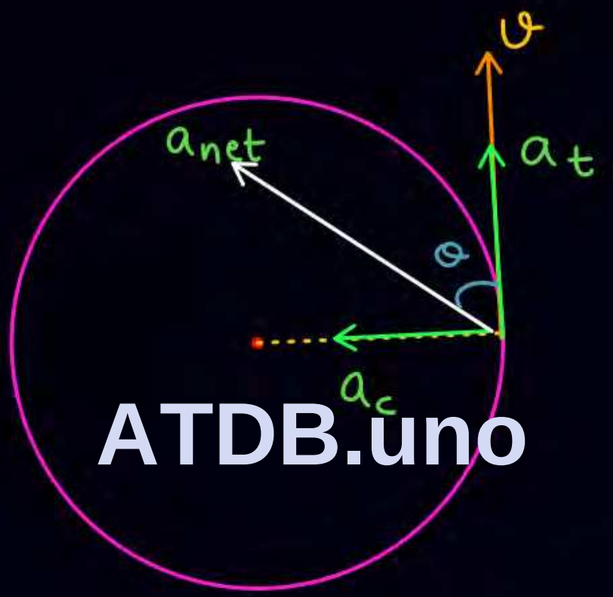
⑥ find angle made by $\vec{a}$ with $\vec{v}$ at $t = 2$ sec

$\tan\theta = \frac{a_c}{a_t} = \frac{8}{8} = 1$

$\theta = 45°$

काम का सवाल

* $v = R\omega$ → speed, $\alpha = \frac{d\omega}{dt}$
* $a_t = R\alpha$
* $a_c = \frac{v^2}{R} = R\omega^2 = v\omega$
* $a = \sqrt{a_t^2 + a_c^2}$



$$a_t = \frac{\vec{a}\cdot\vec{v}}{v} = \frac{d(\text{speed})}{dt}$$

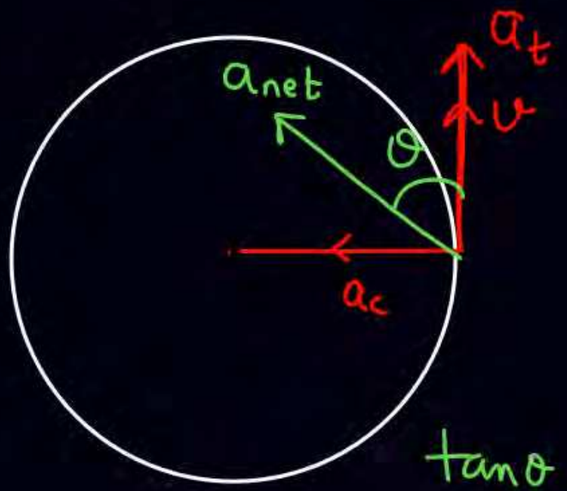
$$\tan\theta = \frac{a_c}{a_t}$$

Q A particle start motion in a circular path of radius 2m such that its speed is given by $V = 4t$.

find

① $v, w, \alpha, a_c, a_t, a_{net}$ at $t = 2$ sec

② angle made by $\vec{a}$ with $\vec{V}$ at $t = 2$sec.



Sol^n $t = 2$, $v = 8$ (speed)

$a_t = 4$ $\quad a_c = \frac{v^2}{R} = \frac{8^2}{2} = 32$

$a_{net} = \sqrt{4^2 + 32^2}$

$v = Rw$

$8 = 2w$ $\Rightarrow w = 4$

$a_t = R\alpha$

$4 = 2 \times \alpha$

$\alpha = 2$

$\tan\theta = \frac{a_c}{a_t} = \frac{32}{4}$

$\theta = \tan^{-1}(8)$

$a_c = Rw^2 = 2 \times 4^2 = 32$

Q A particle start motion in a circular path of radius 2m such that angle rotated by radius vector is given as find $\omega, \alpha, v, a_c, a_t, a_{net}$ at $t=2$ sec

$$\theta = t^2$$

↓

Angle rotated

Soln

$\theta = t^2$

$\omega = \frac{d\theta}{dt} = 2t$

$\alpha = \frac{d\omega}{dt} = 2 = \text{const}$

$t=2 \Rightarrow \omega = 4$

$\alpha = 2$

$v = R\omega = 2 \times 4 = 8$

$a_t = R\alpha = 2 \times 2 = 4$

$a_c = R\omega^2 = 2 \times 4^2 = 32$

$a_{net} = \sqrt{a_b^2 + a_c^2} = \sqrt{4^2 + (32)^2}$

Q A particle start motion in a circular path of radius 8m such that angle rotated by radius vector is given as $\theta = \frac{t^3}{3}$ find $\omega, \alpha, v, a_c, a_t, a_{net}$ at $t = 2$ sec

Sol^n $\omega = t^2$

$\alpha = 2t$

$t = 2, \quad \omega = 4, \quad R = 8$

$\alpha = 4$

$a_t = R\alpha = 8 \times 4 = 32$

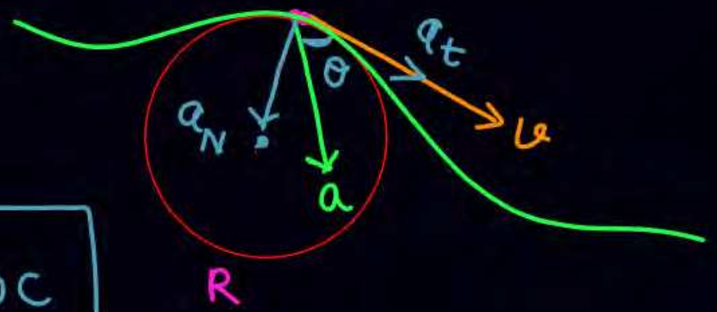
$a_c = R\omega^2 = 8 \times 4^2 = 128$

$a_{net} = \sqrt{a_c^2 + a_t^2} = \sqrt{(32)^2 + (128)^2}$

ROC

$$a_N = \frac{v^2}{R}$$

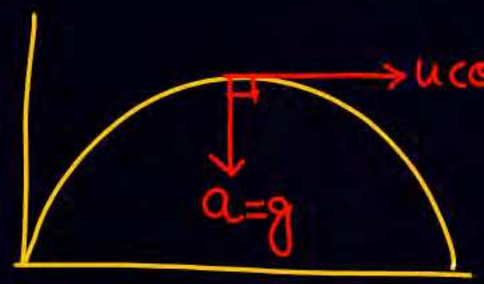
$$\boxed{R = \frac{v^2}{a_N} = ROC}$$



Q find ROC when particle is at
① highest point 2

Soln

$$ROC = \frac{v^2}{a_N} = \frac{(u\cos\theta)^2}{g}$$



at any time

$v = \checkmark$ $a = g \checkmark$

$a_t = \checkmark$

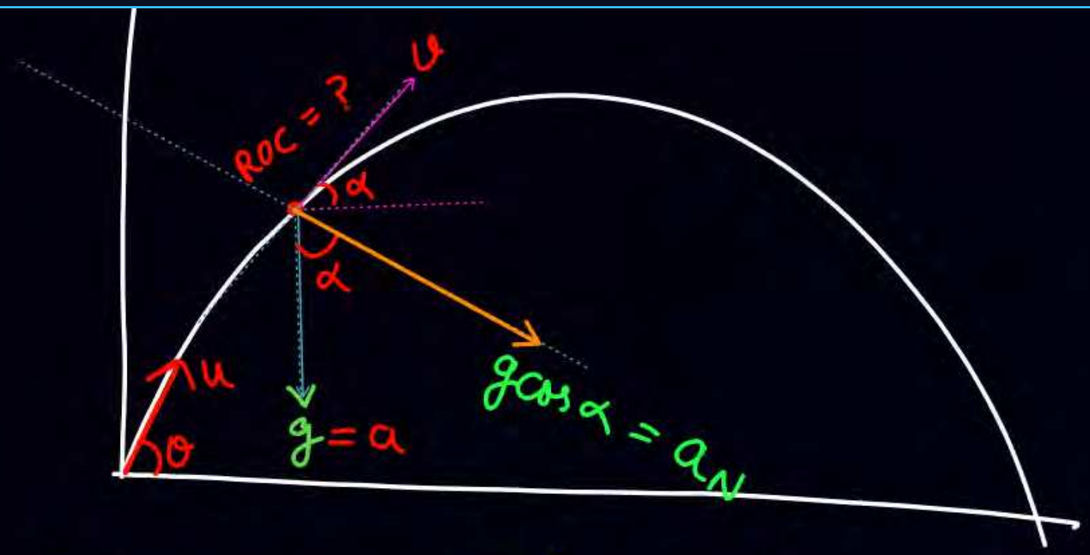
$a_N = \checkmark$

(R)

Q

find ROC when velocity makes angle α with horizontal

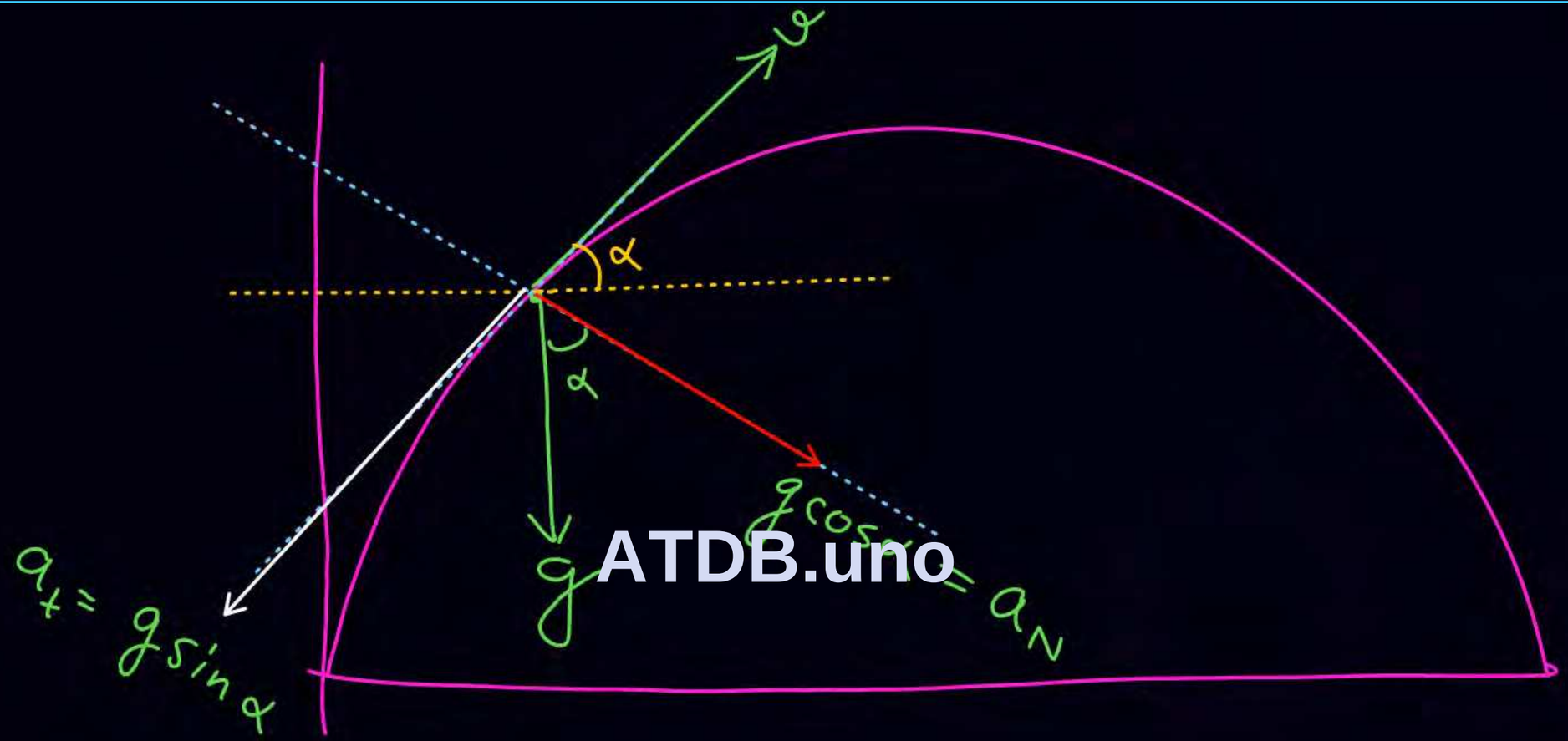
($u, \theta \rightarrow$ given)



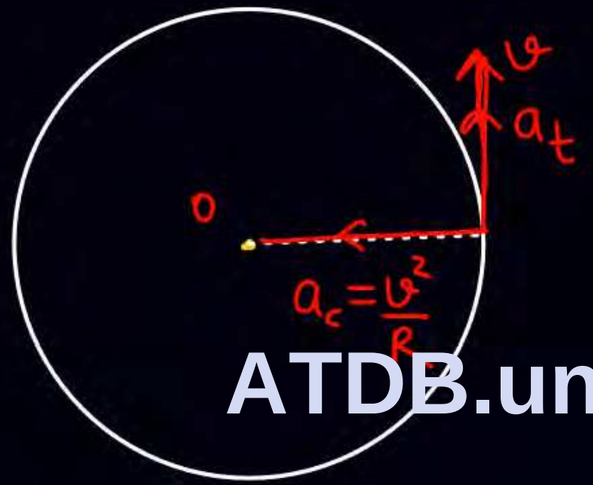
Sol^

$$ROC = \frac{v^2}{a_N} = \frac{v^2}{g\cos\alpha} = \left(\frac{u\cos\theta}{\cos\alpha}\right)^2 \times \frac{1}{g\cos\alpha}$$

$$u\cos\theta = v\cos\alpha$$



Circular motion dynamics



Centripital force

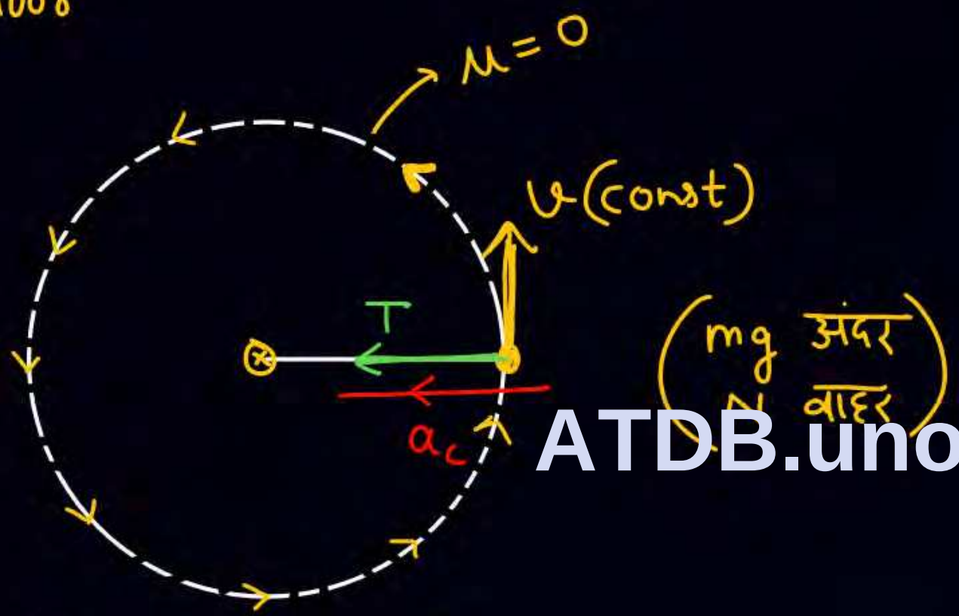
$\Rightarrow$ Resultant of all the force towards the Center $= m a_c$

$= \frac{m v^2}{R} = m R \omega^2$

$= m v \omega$

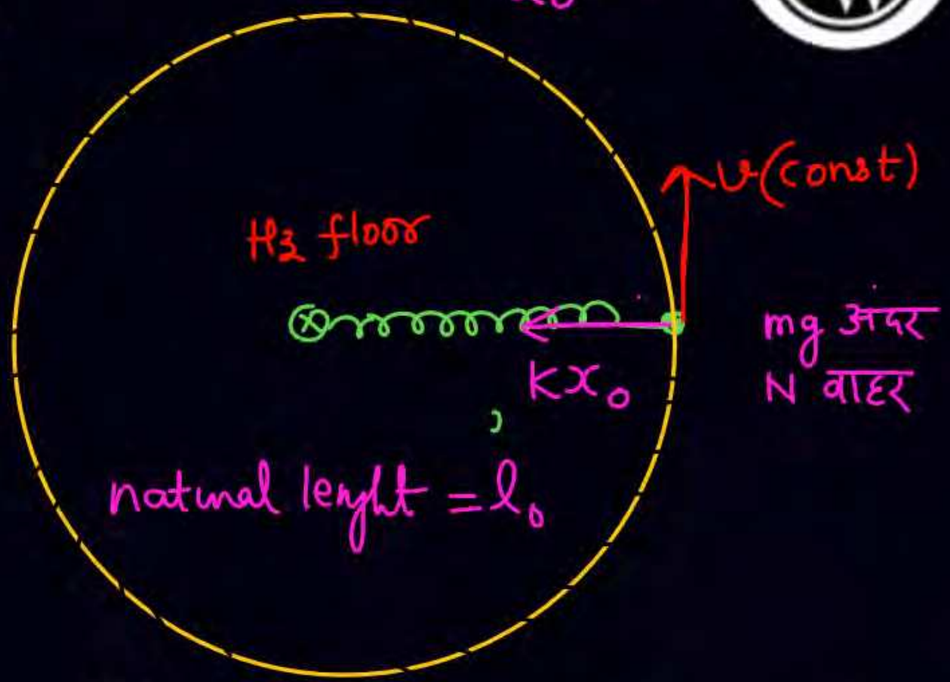
Q

(1) H_2. floor



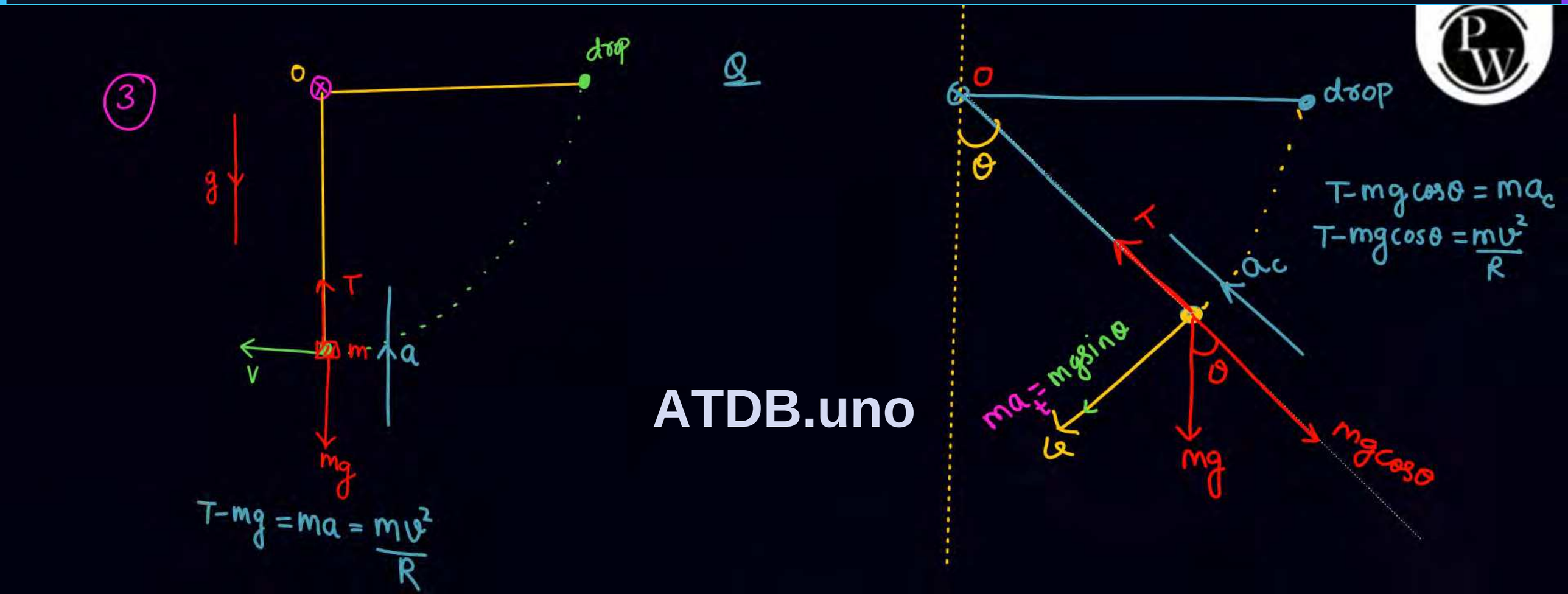
$$T = ma_c = \frac{mv^2}{R}$$

(2) find elongation in spring x_0



$$kx_0 = ma_c = \frac{mv^2}{R} = \frac{mv^2}{(l_0 + x_0)}$$

$$\boxed{kx_0 = m(l_0 + x_0)\omega^2}$$



H.W

- DPP-01, 02
- Complete yern backlogs