

PRAYAS

JEE 2025



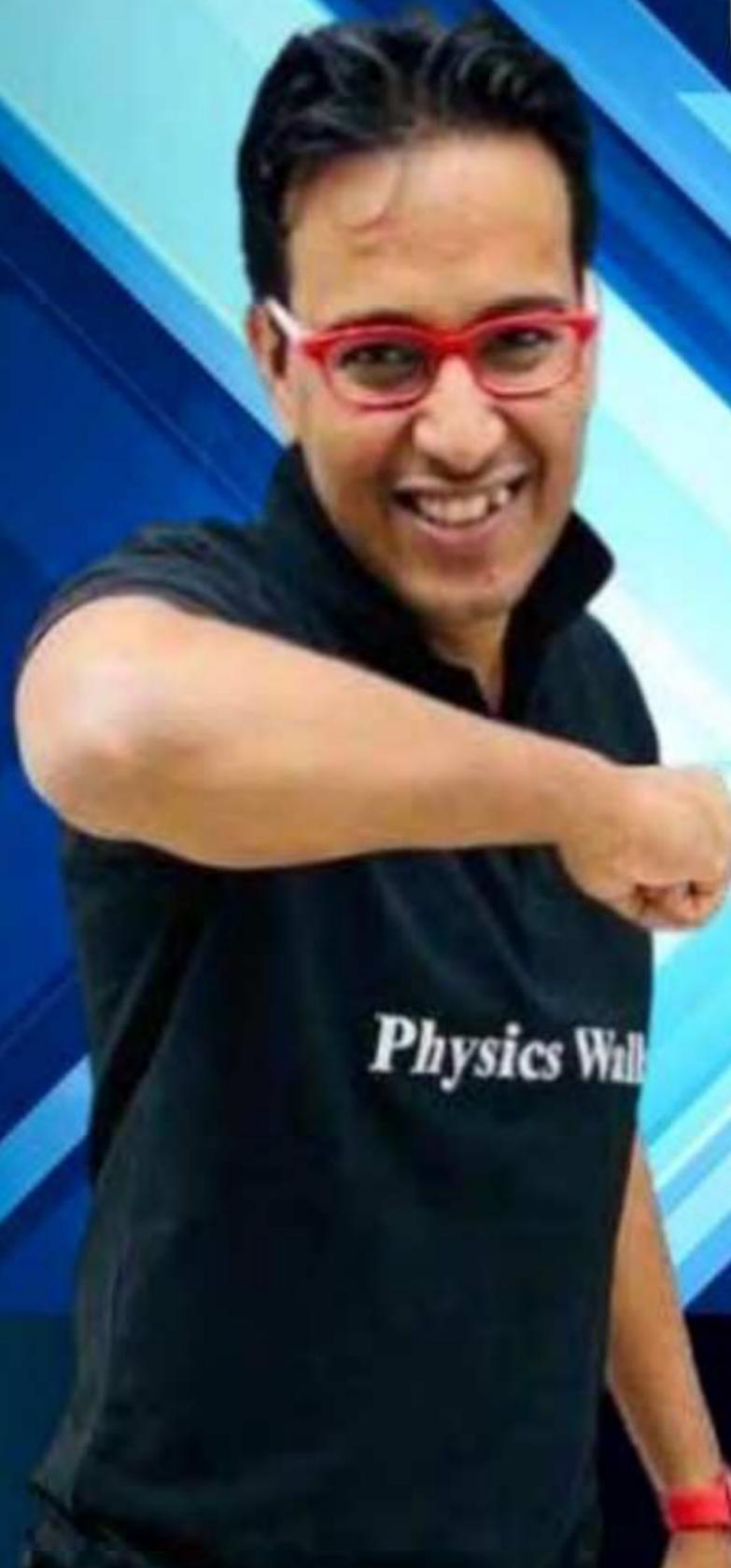
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Lecture - 03

Physics

Circular Motion

By- Saleem Ahmed Sir





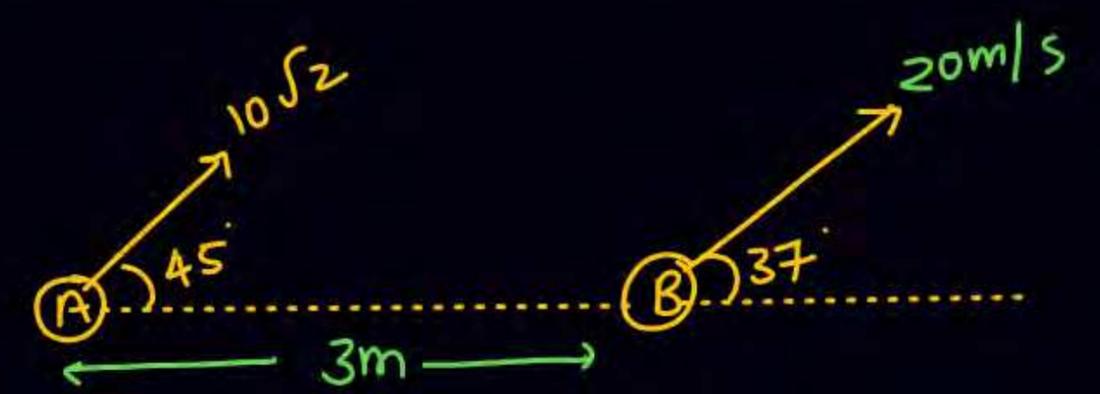
Topics *to be covered*

- 1 Circular motion kinematics
- 2 Centripetal force.
- 3
- 4

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Q



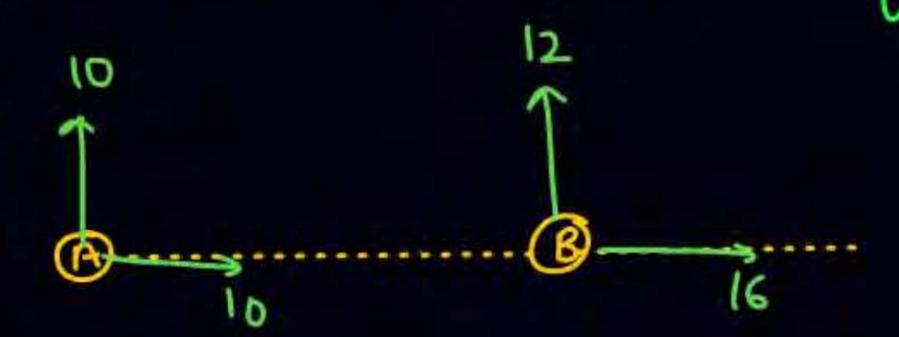
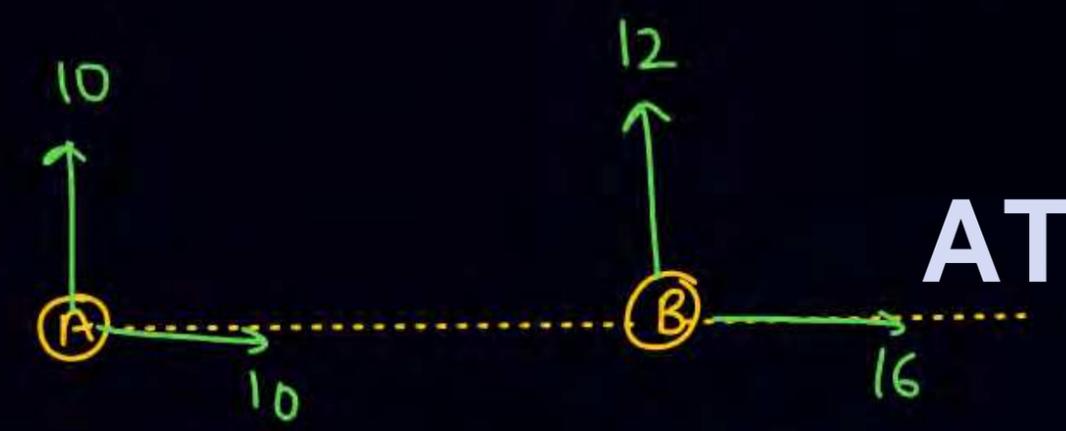
$$\omega_{B/A} = \frac{2}{3}(\text{Acw})$$

~~$$\omega_{A/B} = \frac{2}{3}(\text{Cw})$$~~

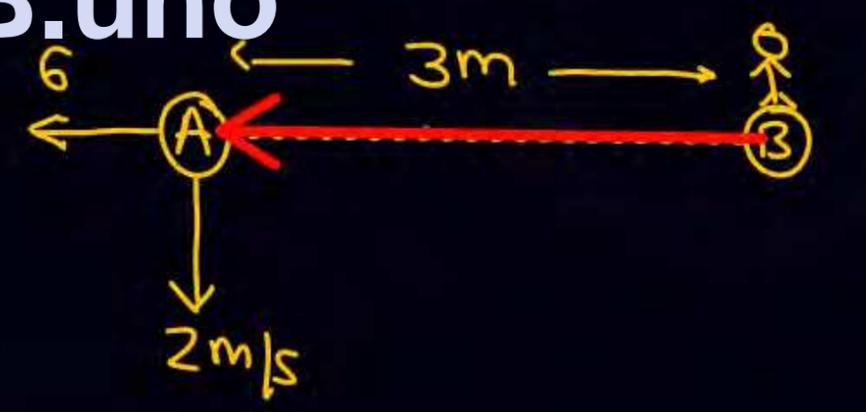
(b) $\omega_{A/B} = \frac{2}{3}(\text{Acw})$

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

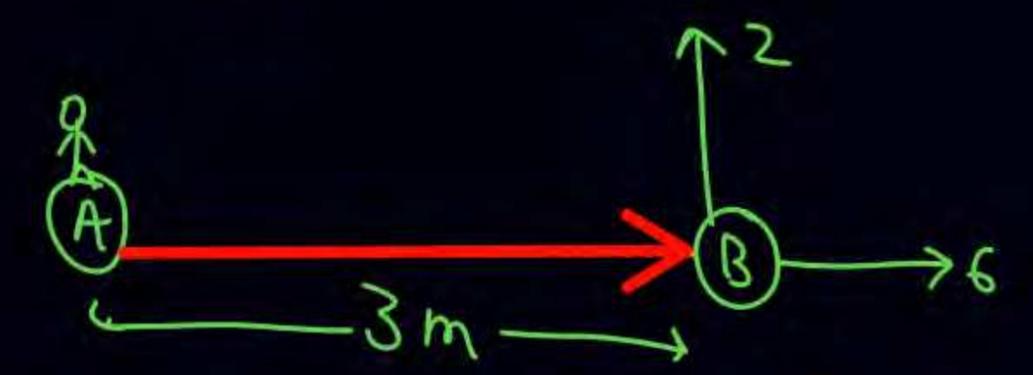
$$\vec{\omega}_{A/B} = \vec{\omega}_{B/A}$$



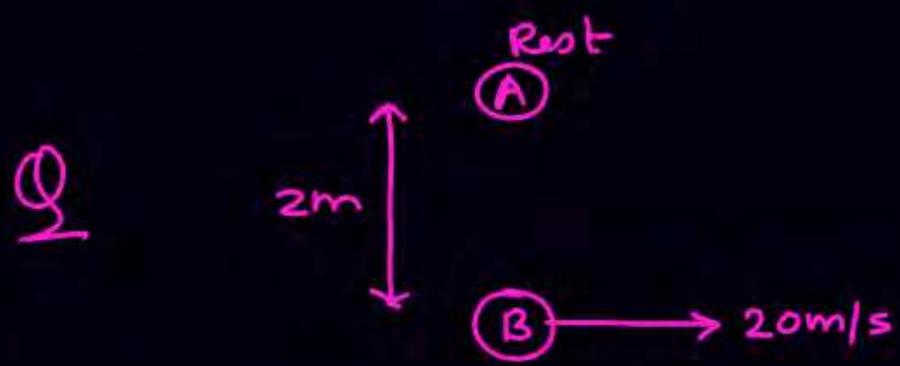
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$$\omega_{A/B} = \frac{2}{3}(\text{Acw})$$

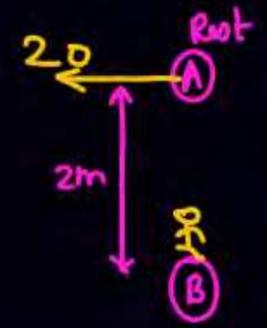


$$\omega_{B/A} = \frac{2}{3}(\text{Acw})$$

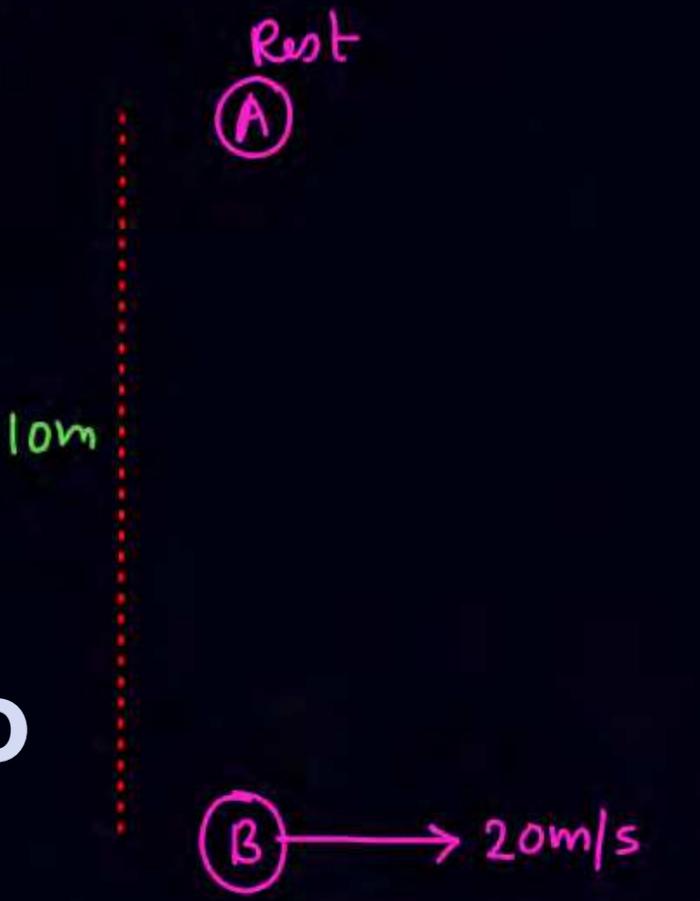


$$\omega_{A/B} = \frac{20}{2} \text{ (A CW)}$$

$$= 10$$



Q

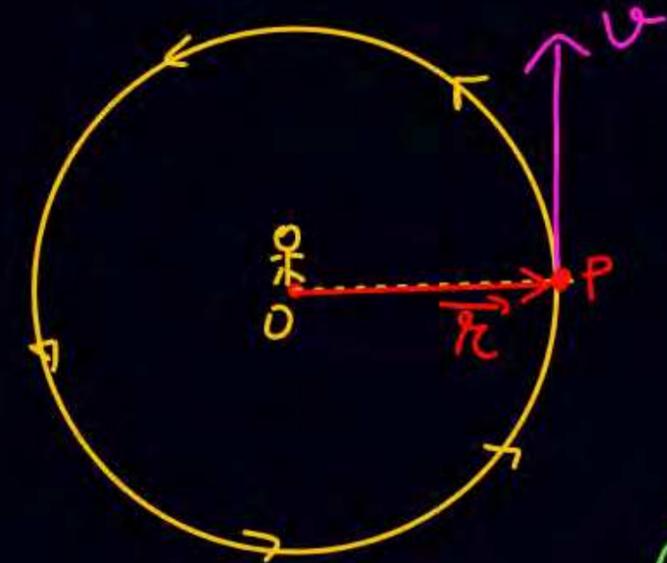
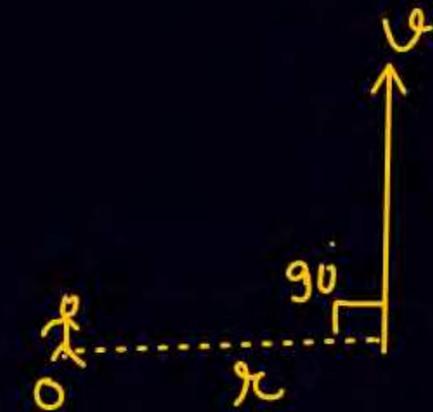


$$\omega_{A/B} = \frac{20}{10} \text{ (A CW)} = 2 \text{ (A CW)}$$

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Circular motion



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

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

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

Speed

$$v = R\omega$$

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

$$a_t = R\alpha$$

angular acc

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

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$$\vec{\omega} = \frac{\vec{v}}{R}$$

$$v = R\omega$$

$$a = R\alpha$$

tangential acc

Q

A wheel start rotating from rest s.t its angular acc is 4 rad/sec^2 at $t=0$.
 Radius of wheel is 5 m . find
 (const)



(a) angular velocity at $t=10 \text{ sec}$.

(b) angle rotated in 10 sec .

Solⁿ

$$\omega_i = 0$$

$$\alpha = 4$$

$$t = 10$$

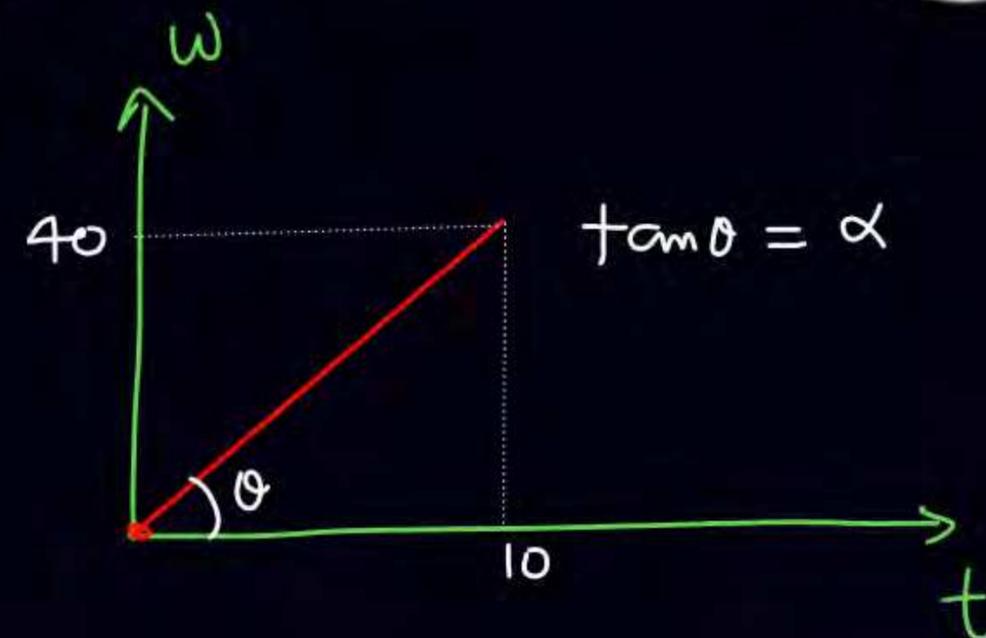
$$\omega_f = \omega_i + \alpha t$$

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

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

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

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



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

speed $V = 2t^2$

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

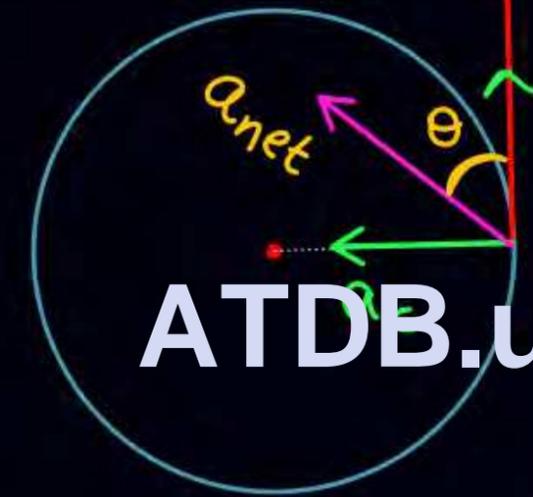
time ↑, speed ↑

solⁿ

① $V = 2t^2$

$a_t = 4t$

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



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

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

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

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

$v = R\omega$

$8 = 8\omega$

$(\omega = 1 \text{ rad/sec})$

$a_t = R\alpha$

$8 = 8\alpha$

$\alpha = 1 \text{ rad/sec}^2$

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

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

$\theta = 45^\circ$



घूर्णन का सूत्र

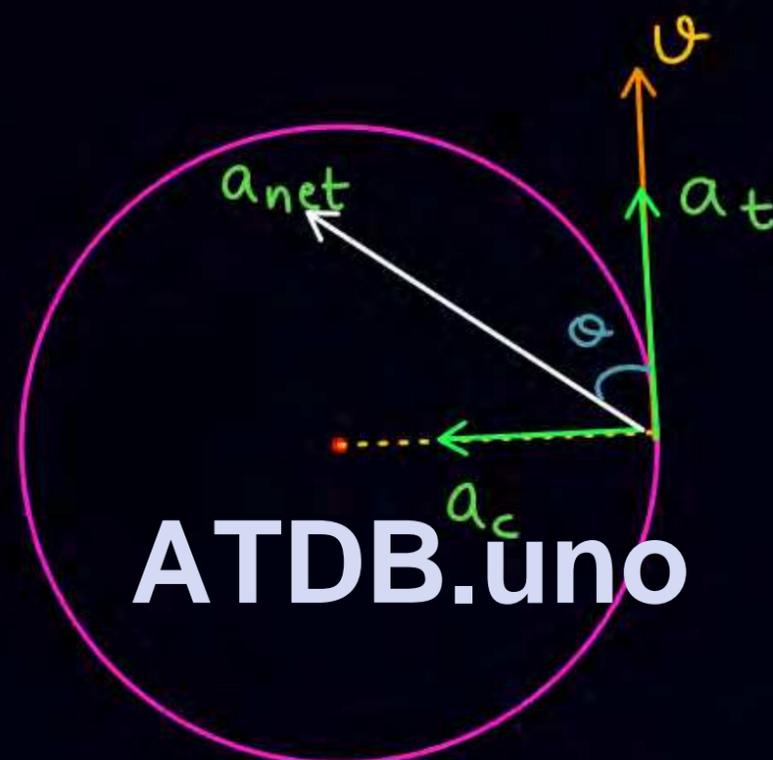
* $\omega = R\omega$
 ↓
 Speed

* $a_t = R\alpha$

* $\alpha = \frac{d\omega}{dt}$

* $a_c = \frac{v^2}{R} = R\omega^2 = v\omega$

* $a = \sqrt{a_t^2 + a_c^2}$



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

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

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

- ① $v, \omega, \alpha, a_c, a_t, a_{net}$ at $t = 2 \text{ sec}$
- ② angle made by \vec{a} with \vec{v} at $t = 2 \text{ sec}$.

Solⁿ

$$t = 2, v = 8 \text{ (speed)}$$

$$a_t = 4$$

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

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

$$v = R\omega$$

$$8 = 2\omega$$

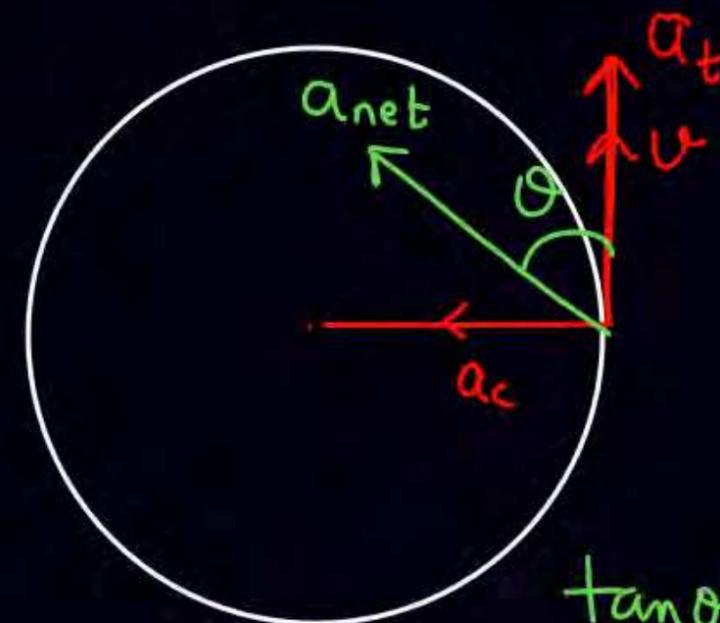
$$\omega = 4$$

$$a_t = R\alpha$$

$$4 = 2 \times \alpha$$

$$\alpha = 2$$

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



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

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



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 $t=2\text{sec}$

$$\theta = t^2$$

↓
Angle rotated

Solⁿ

$$\theta = t^2$$

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

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

$$t=2 \Rightarrow \omega = 4$$

$$\alpha = 2$$

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

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

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

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

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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

$$\theta = \frac{t^3}{3}$$

Solⁿ

$$\omega = t^2$$

$$\alpha = 2t$$

$$t=2,$$

$$\omega = 4, R=8$$

$$\alpha = 4$$

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

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

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



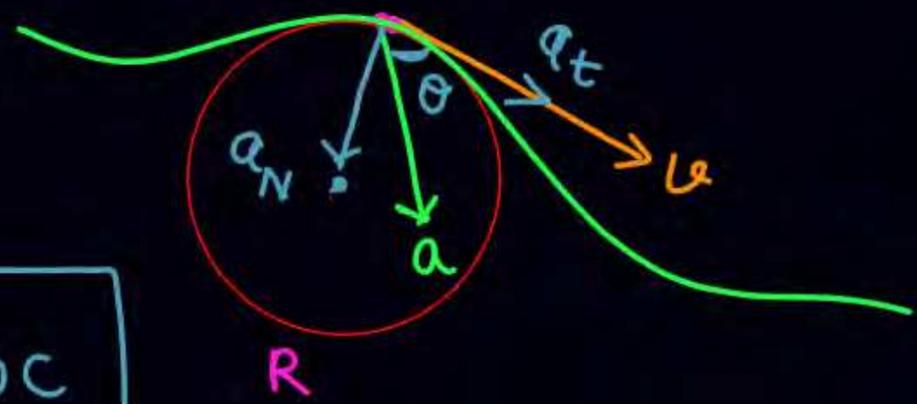


find ROC when particle is at
① highest point

ROC

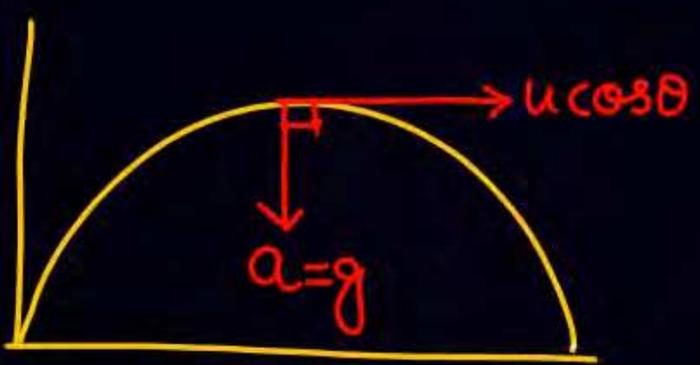
$$a_N = \frac{v^2}{R}$$

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



Solⁿ

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



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at any time

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

$$a_t = \checkmark$$

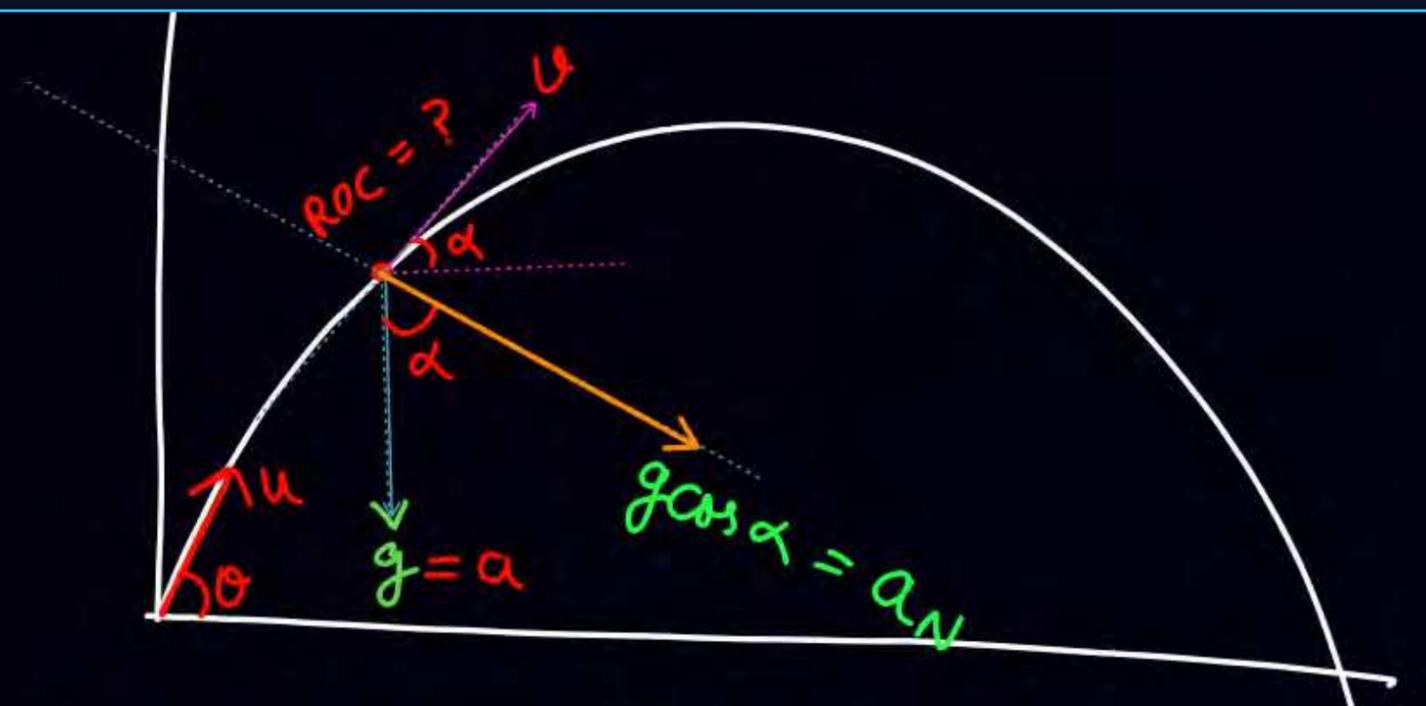
$$a_N = \checkmark$$



Q

find ROC when velocity makes angle α with horizontal

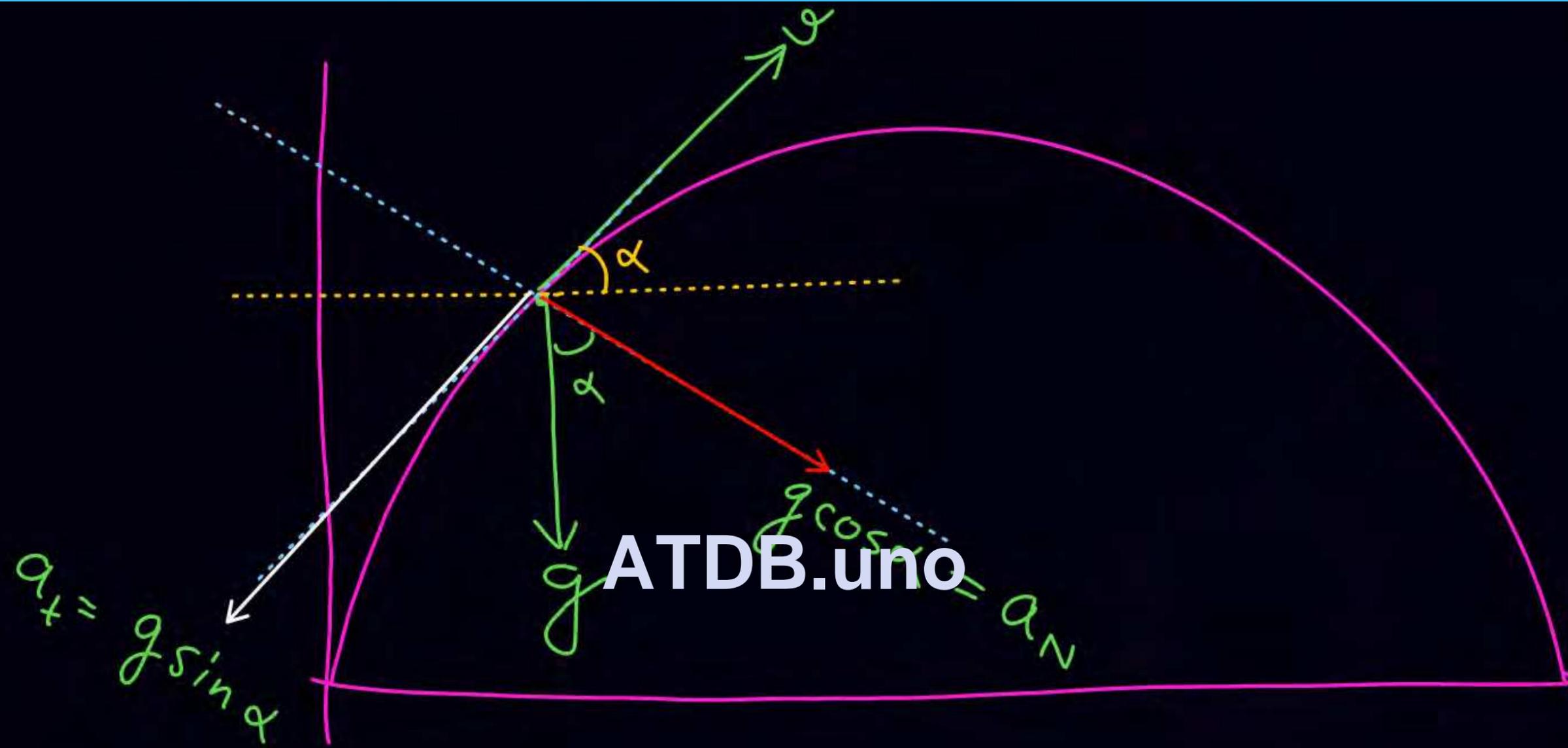
($u, \theta \rightarrow$ given)



Solⁿ

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

$$u \cos \theta = U \cos \alpha$$



$$a_t = g \sin \alpha$$

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$$g \cos \alpha = a_n$$

Circular motion dynamics



Resultant of all the forces
 Centripital force

|||
 Net force towards the
 Center = $m a_c$

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

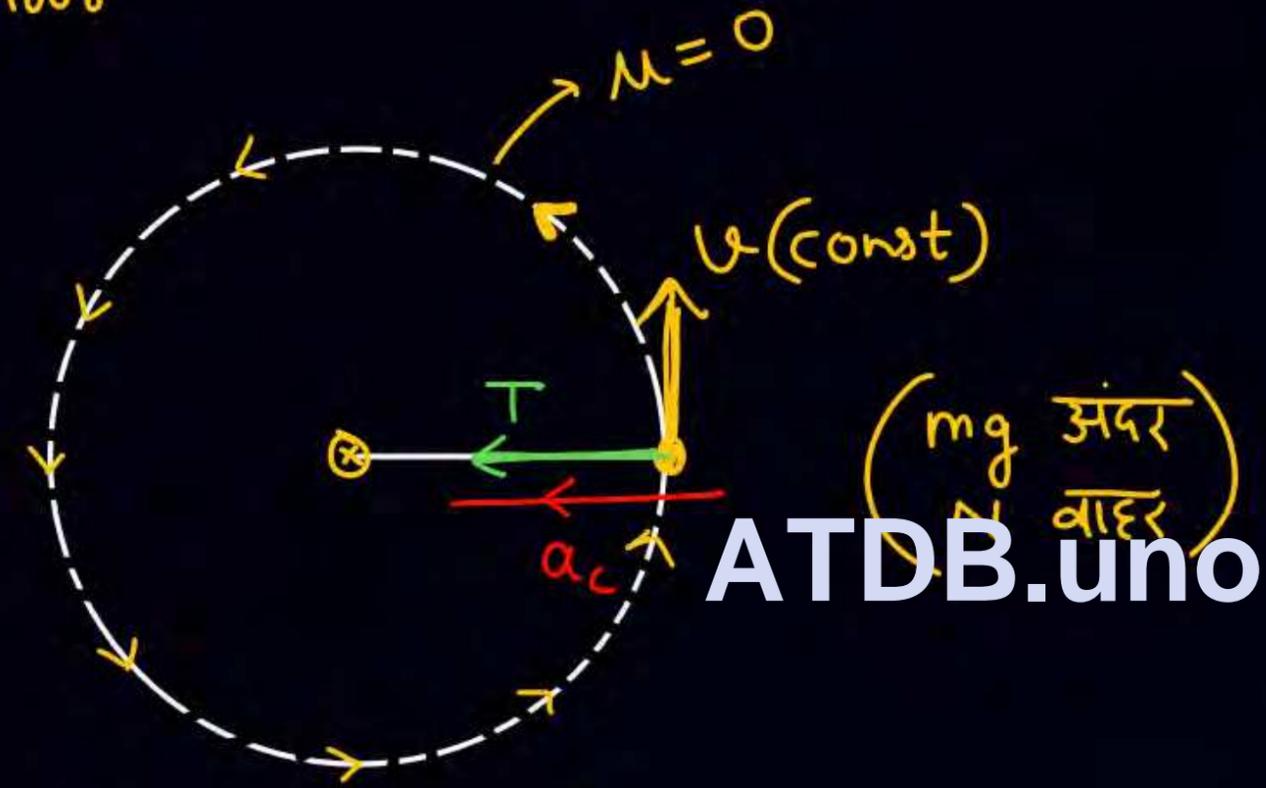
$$= m v \omega$$





Q
①

H₃- floor

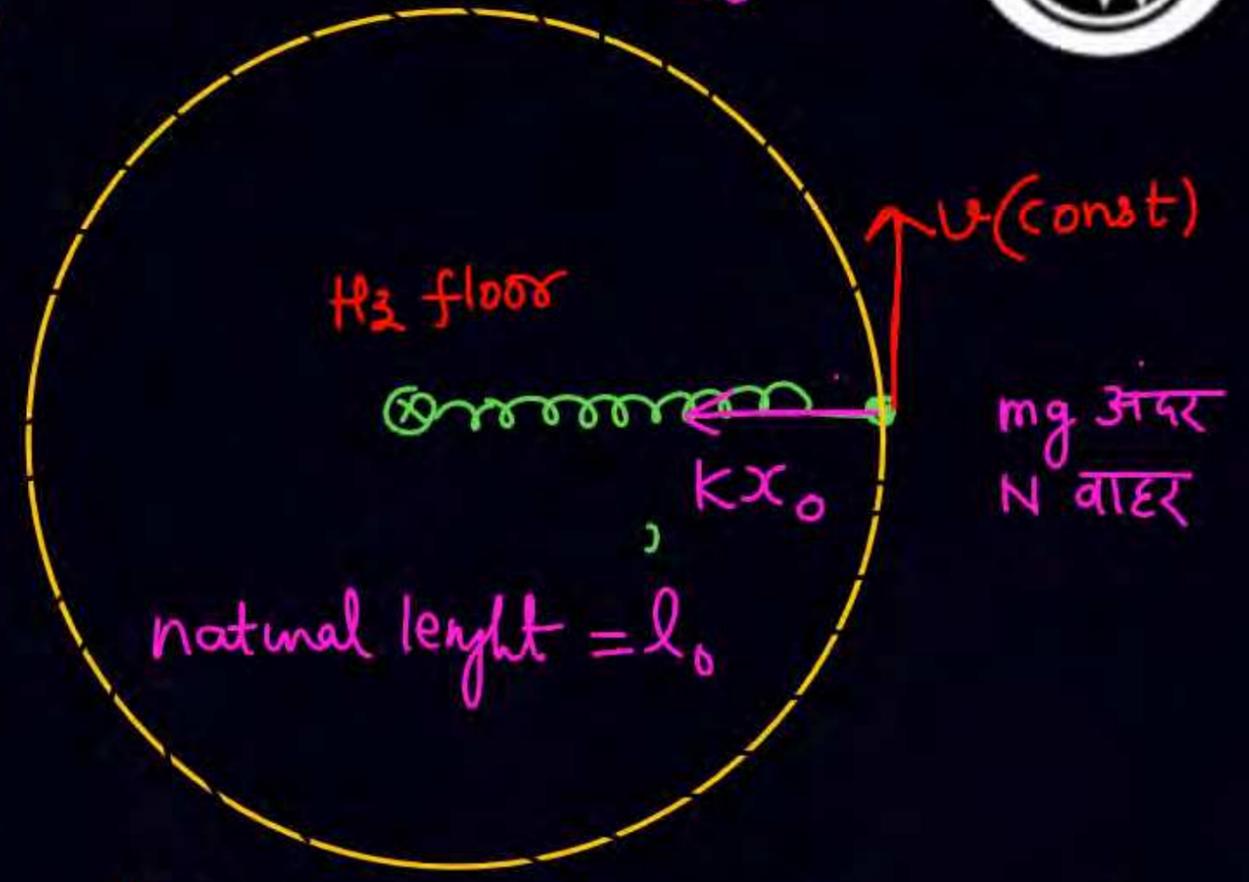


$$T = ma_c = \frac{mv^2}{R}$$

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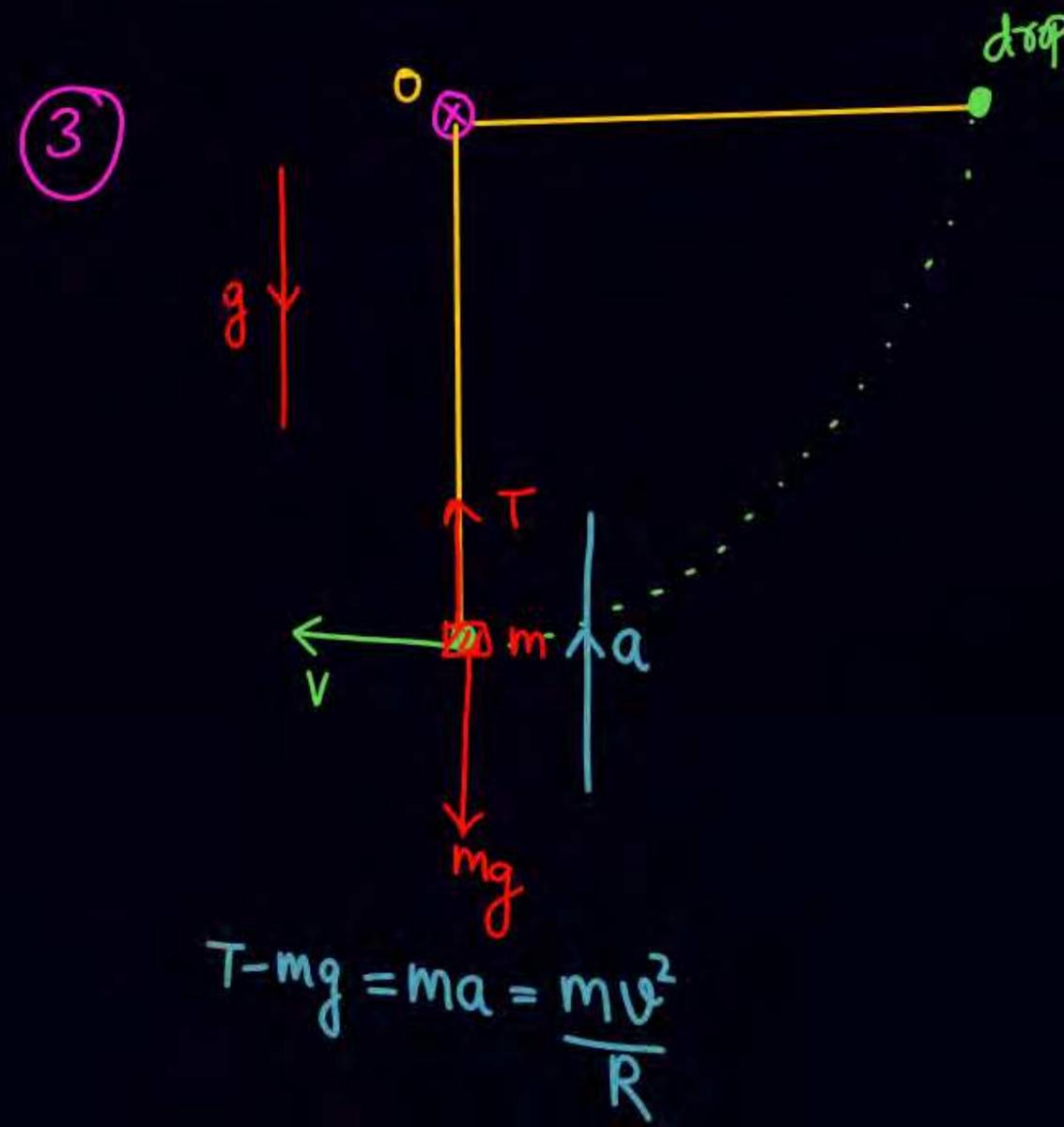
②

find elongation in spring x_0

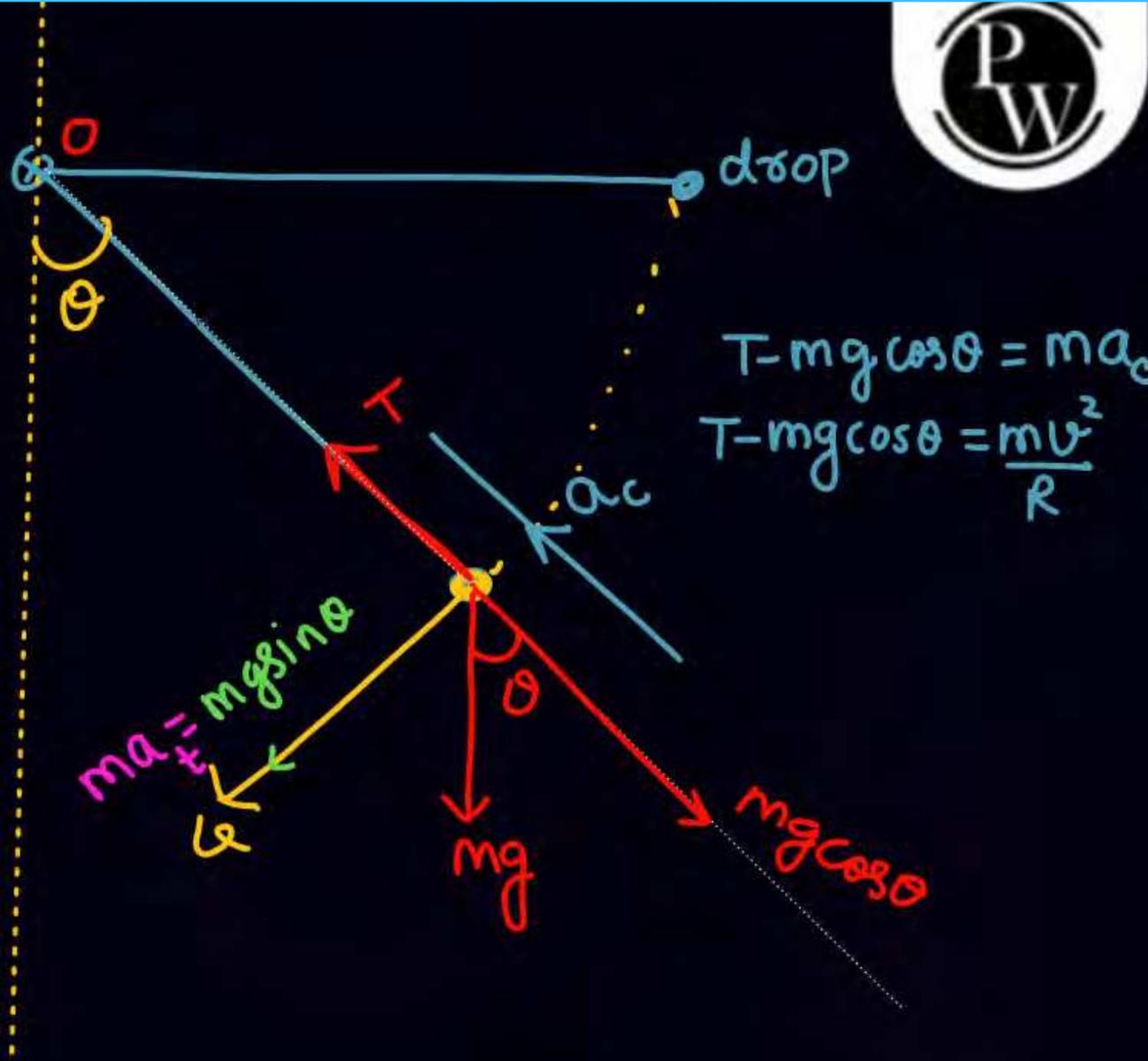


$$kx_0 = ma_c = \frac{mv^2}{R} = \frac{mv^2}{(l_0 + x_0)}$$

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



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H.W

- DPP-01, 02
- Complete your backlog's ⁴

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THANK YOU

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