

PRAYAS

JEE 2025



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Lecture - 01

Physics

Circular Motion

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Topics *to be covered*

1

Angular Displacement

2

Angular velocity

3

$\omega_{B/A}$, a_t , a_n

4

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Angular displacement = θ (cw)

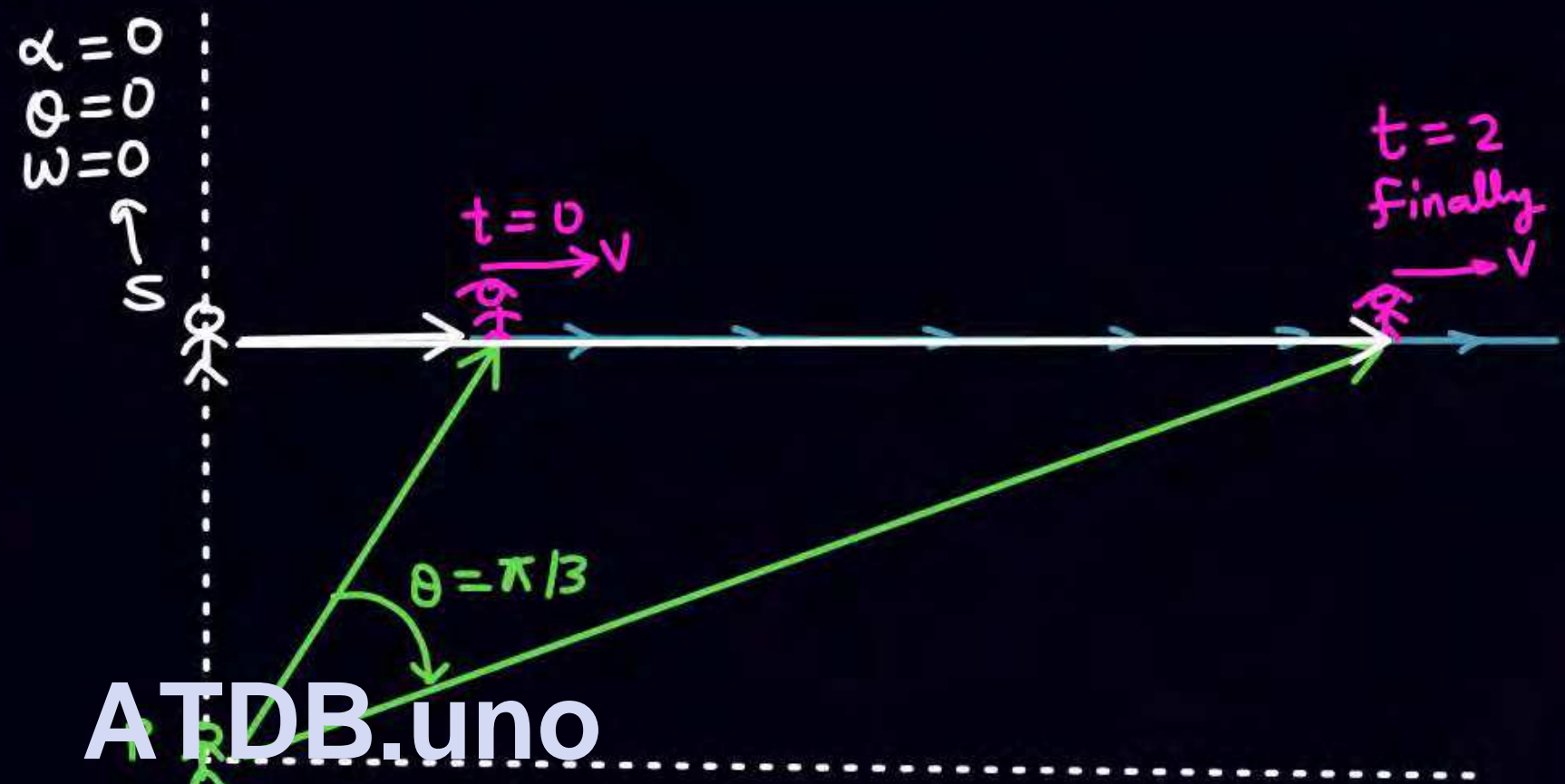
angular displacement
of position vector.



$\omega = \frac{d\theta}{dt}$ = angular velocity
of position vector

$\alpha = \frac{d\omega}{dt}$ = angular acc of P.V.

Circular
motion X



$p \Rightarrow$ angular displacement of P.V.
 $= \theta = \pi/3$ wrt P'/origin

$$\frac{d\theta}{dt} = \omega \neq 0$$

angular variable θ, ω, α
 frame dependent
 depends on observer

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Angular Velocity ω ————

Inst. angular velocity = $\omega = \frac{d\theta}{dt}$

Avg angular velocity = $\frac{\Delta\theta}{\Delta t} = \frac{\text{angle rotated}}{\text{total time}}$

Inst. angular acc. $\ddot{\alpha} = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$

Avg. angular acc = $\frac{\omega_f - \omega_i}{t_2 - t_1} = \frac{\Delta\omega}{\Delta t}$

$$\vec{v} = \frac{d\vec{x}}{dt}$$

$$\langle \vec{v} \rangle = \frac{\Delta\vec{x}}{\Delta t}$$

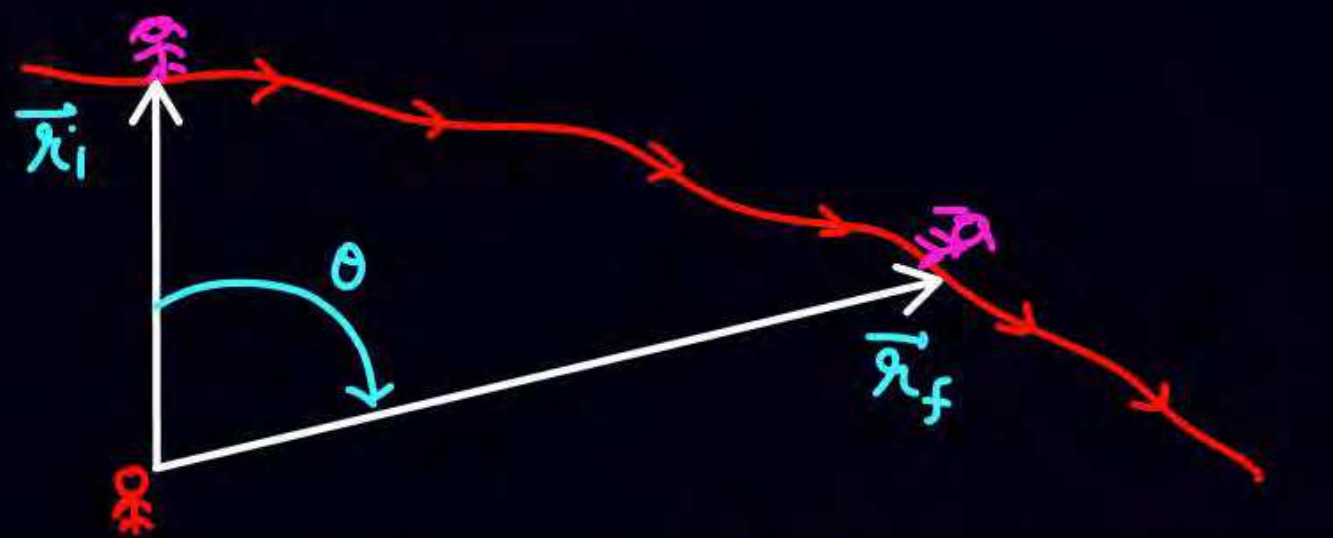
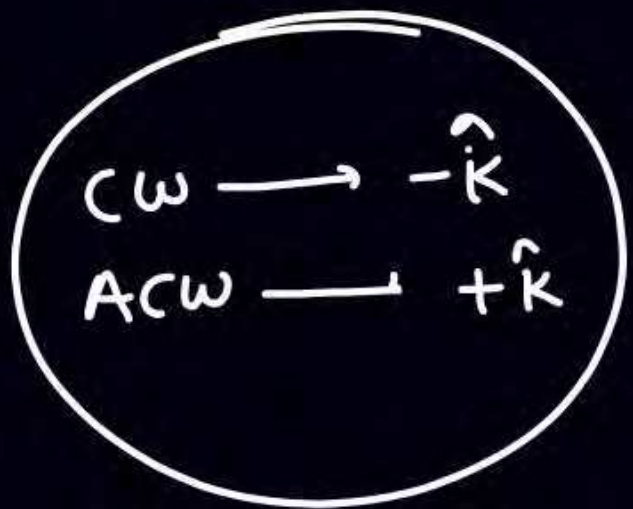
$$\vec{a}_{cc} = \frac{d\vec{v}}{dt}$$

$$\langle \vec{a} \rangle = \frac{\vec{v}_f - \vec{v}_i}{t_2 - t_1}$$

$$x \longrightarrow \theta$$

$$v \longrightarrow \omega$$

$$a \longrightarrow \alpha$$



θ \vec{r}_f \rightarrow clockwise, CW sense
 ω \rightarrow C.W

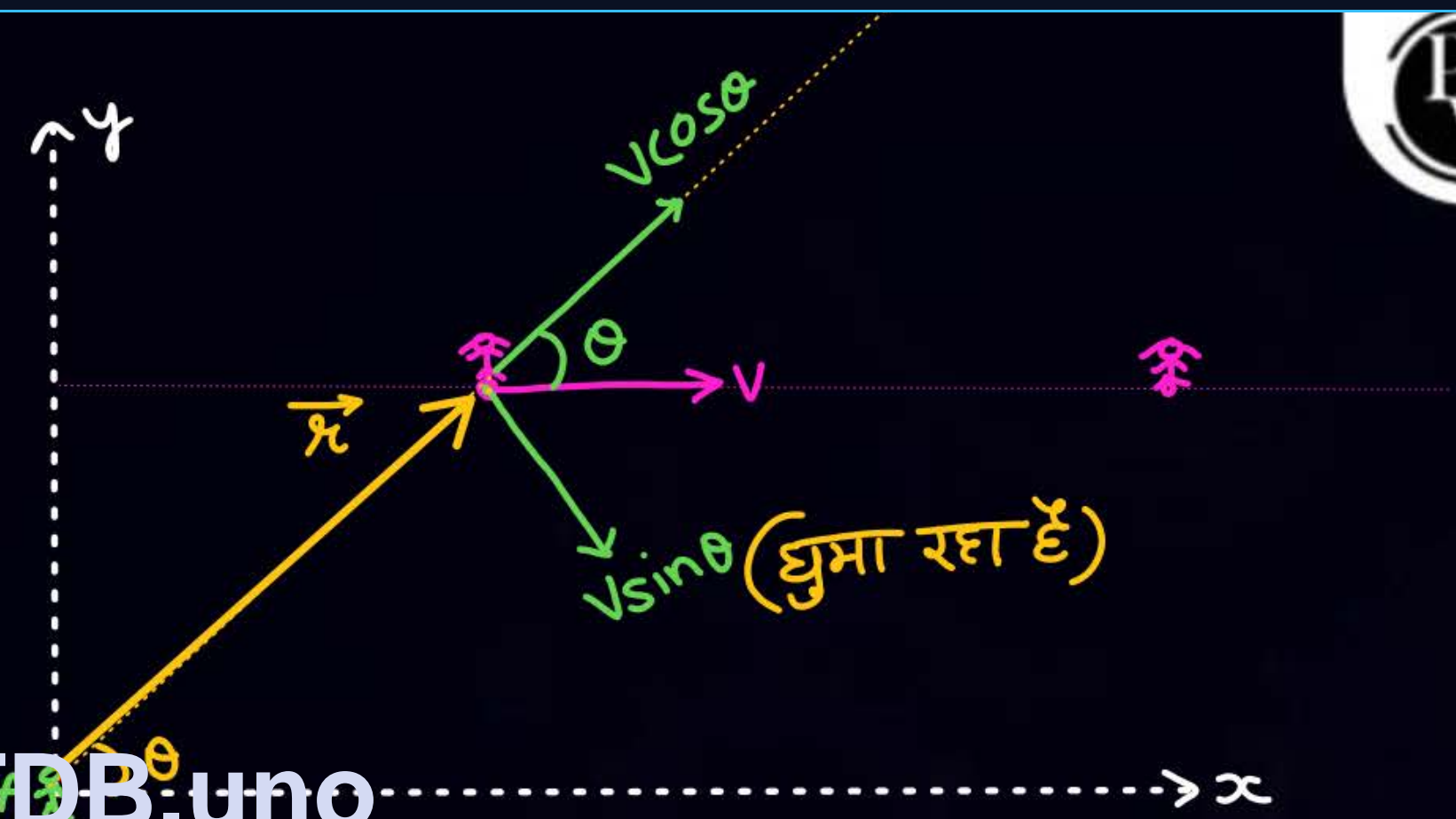
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* $\vec{\alpha} = \frac{d\vec{\omega}}{dt}$

* $\vec{\alpha}, \vec{\omega}$ Same dirⁿ \equiv speed up
 Same sign

dirⁿ \equiv Right hand thumb rule $\Rightarrow -\hat{k} \equiv (CW)^{**}$

* $\vec{\alpha}, \vec{\omega}$ direction opposite speed down
 " sign



$v \cos \theta =$ Rate of change of magnitude of \vec{r}

$$\omega_{P/A} = \frac{v \sin \theta}{r} = \frac{v_{\perp}}{r}$$

$$\vec{\omega}_{P/A} = \frac{v \sin \theta}{r} \text{ (cw)}$$

$$= \frac{v \sin \theta}{r} (-\hat{k})$$

Rate of change of separation from origin/A = $v \cos \theta$

$$= \frac{d|\vec{r}|}{dt}$$

If $v \cos \theta = 0$
circular motion

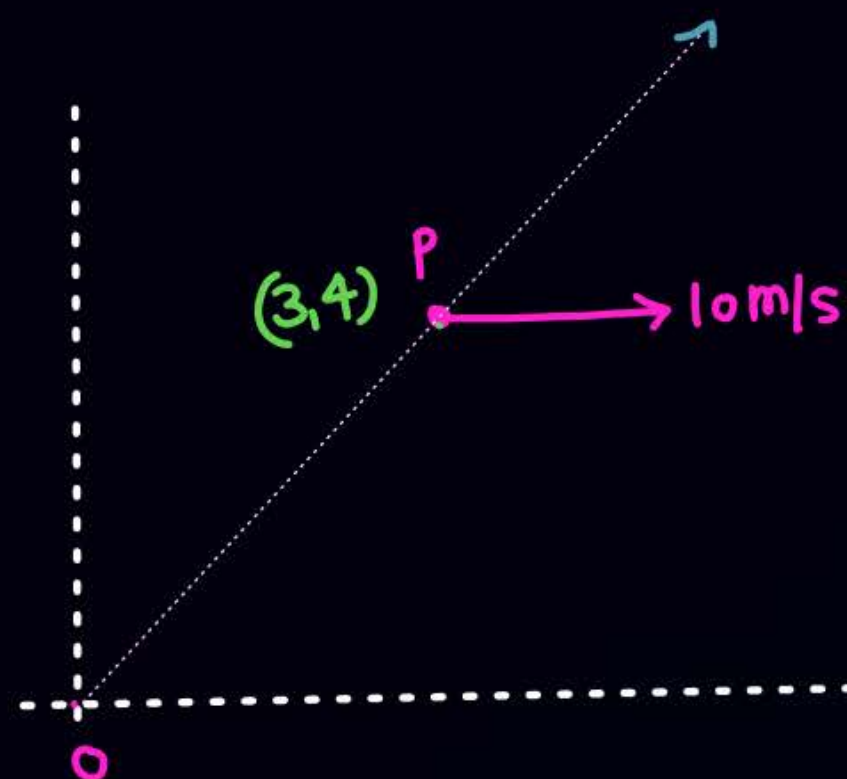
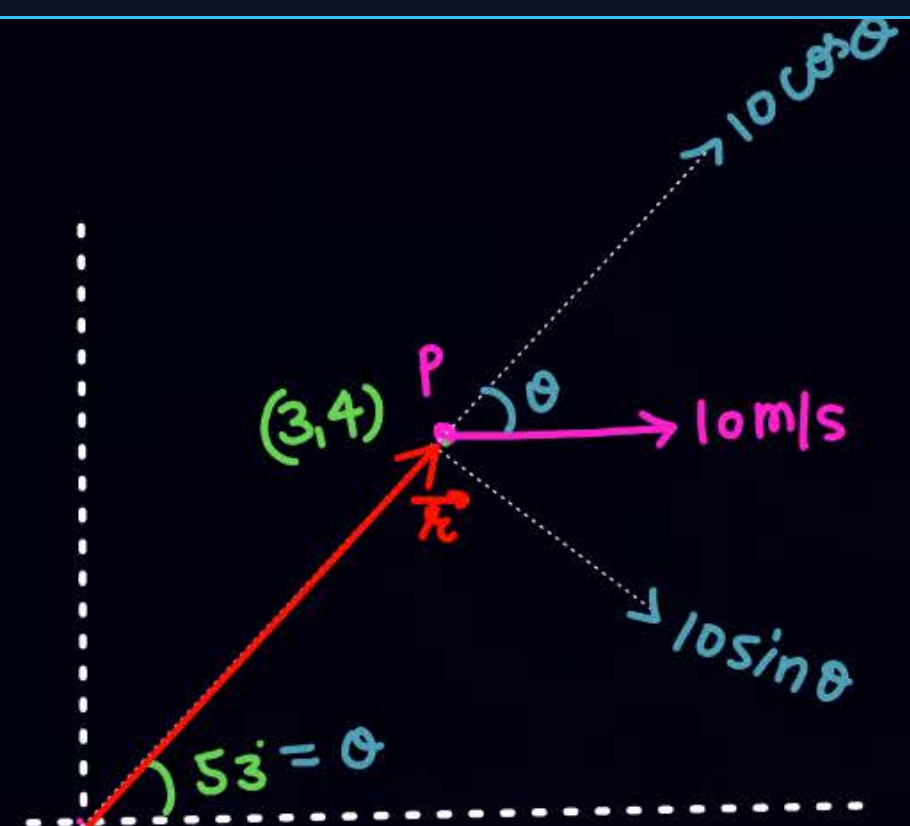
$\vec{r} \rightarrow$ dirⁿ change

$|\vec{r}| \rightarrow$ change

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Q

Solⁿ

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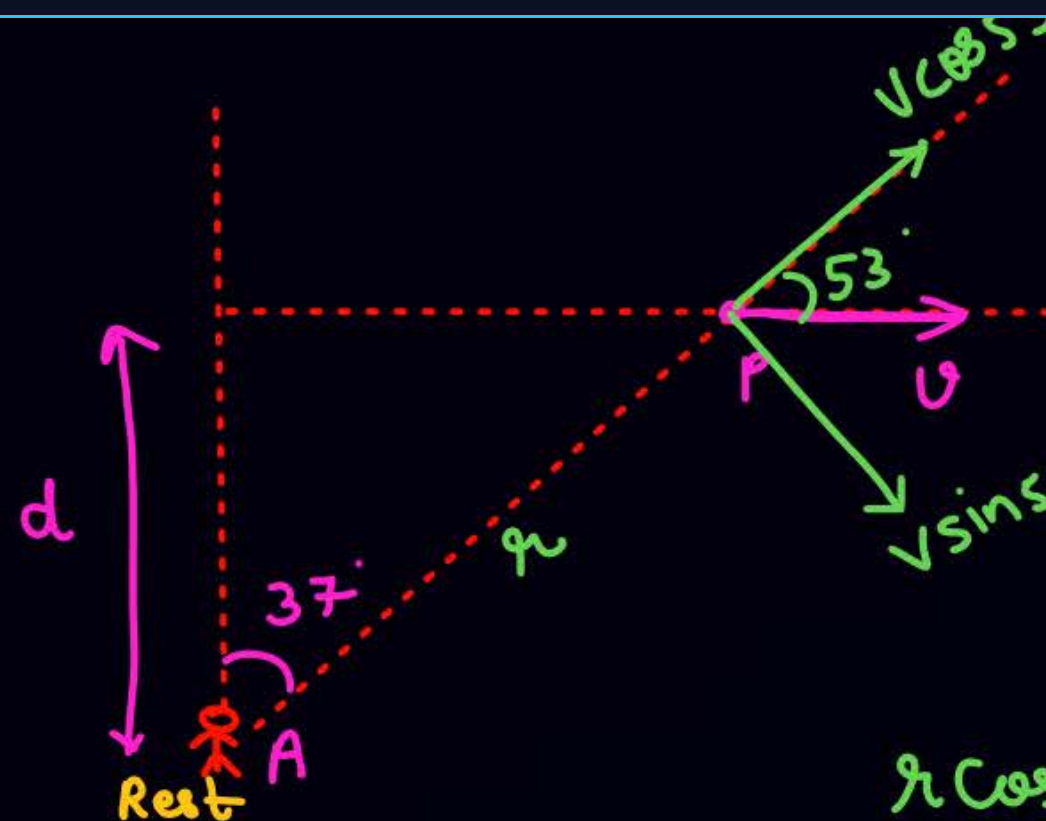
$$w_{P/O} = ?$$

$$\therefore w_{P/O} = \frac{10 \sin \theta}{r} = \frac{10 \sin 53}{5} = \frac{8}{5}$$

Rate of change of separation of particle from origin =
 $= 10 \cos \theta$



Q



Rate of change of separation
= $v \cos 53^\circ$

$$r \cos 37^\circ = d$$

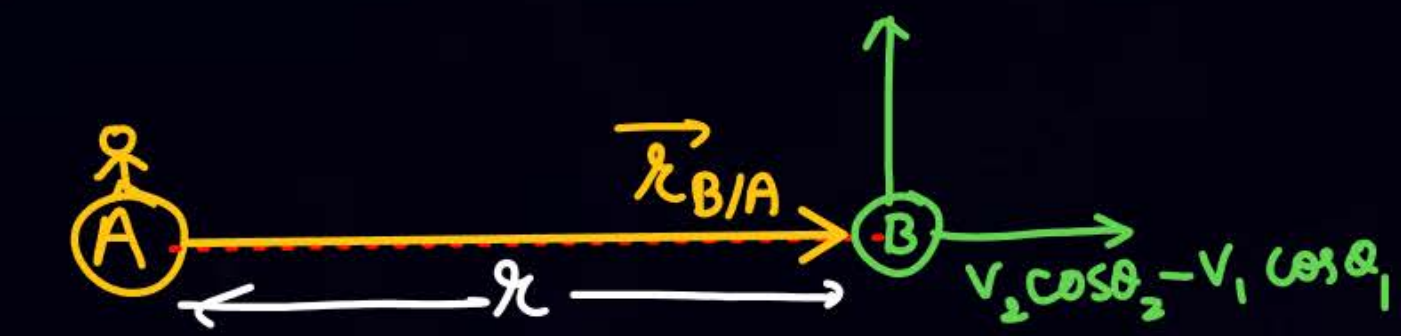
$$r = \frac{d}{\cos 37^\circ} = \frac{5d}{4}$$

$$\omega_{P/A} = \frac{v \sin 53^\circ}{r}$$

$$\omega_{P/A} = v \times \frac{4}{5} \times \frac{5d}{4} = \frac{16}{25} \frac{v}{d} \quad (\text{cw}), \hat{-k}$$



$w_{B/A}$, $w_{A/B}$ when both particles are moving



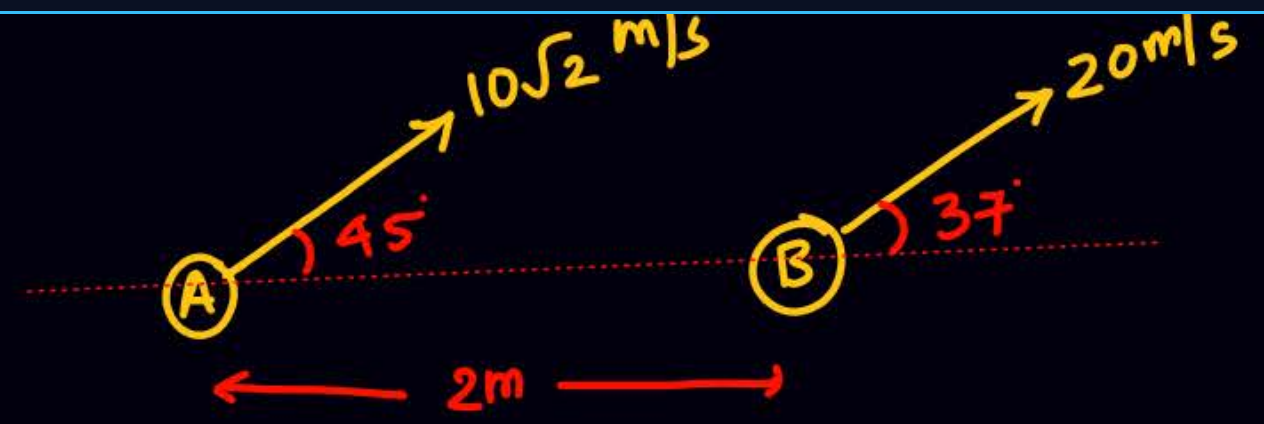
$$w_{B/A} = \frac{v_2 \sin \theta_2 - v_1 \sin \theta_1}{r}$$

Rate of change of separation
 $= v_2 \cos \theta_2 - v_1 \cos \theta_1$

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$$\left| \frac{d}{dt} (\vec{r}_{B/A}) \right| = \sqrt{6^2 + 2^2}$$

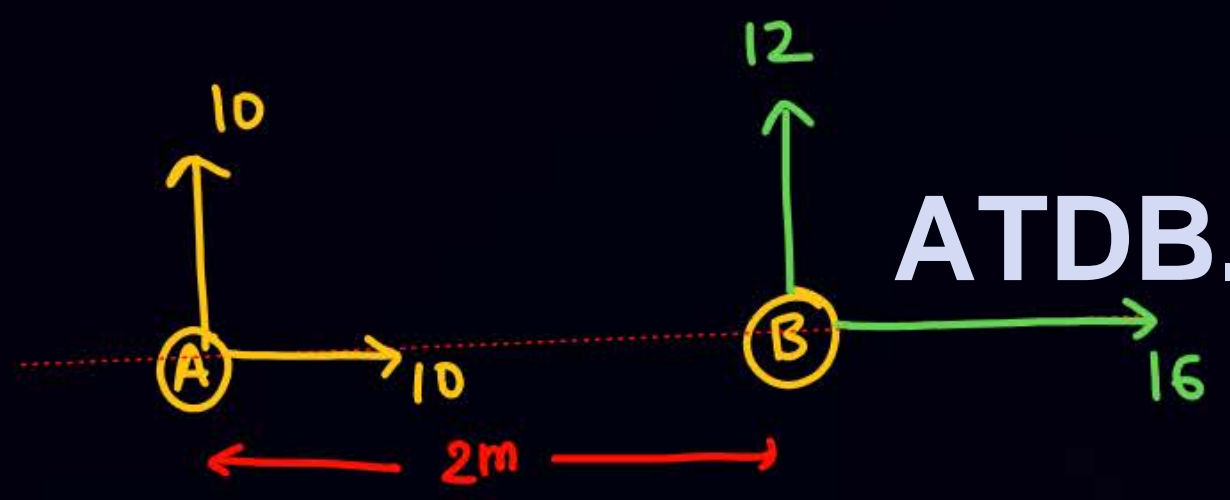
SKC



- line
- Component
- वेकॉम्पोनेन्ट

find $\omega_{B/A}$ & rate of change of separation

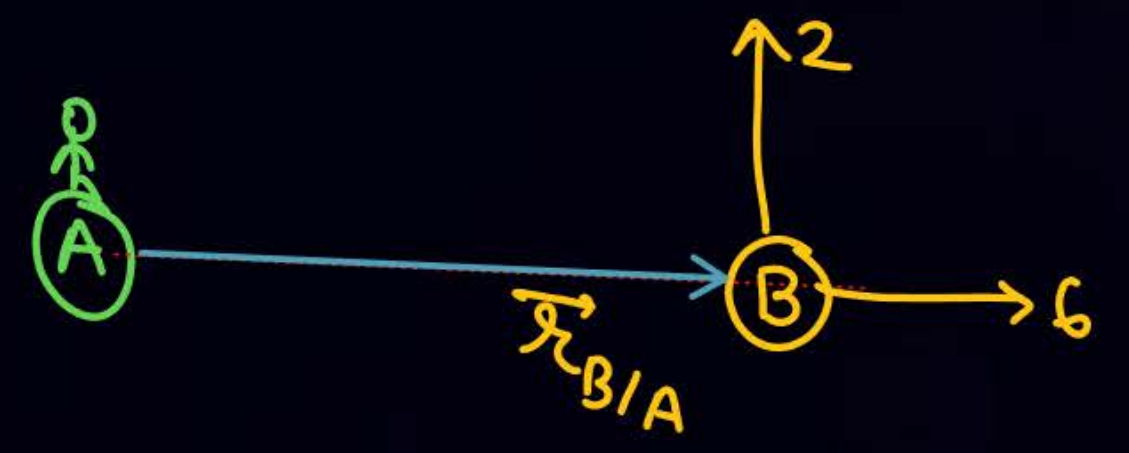
Solⁿ



$$\omega_{B/A} = \frac{2}{r} = \frac{2}{2} = 1 \text{ rad/sec (ACW)}$$

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Rate of change of separation = 6

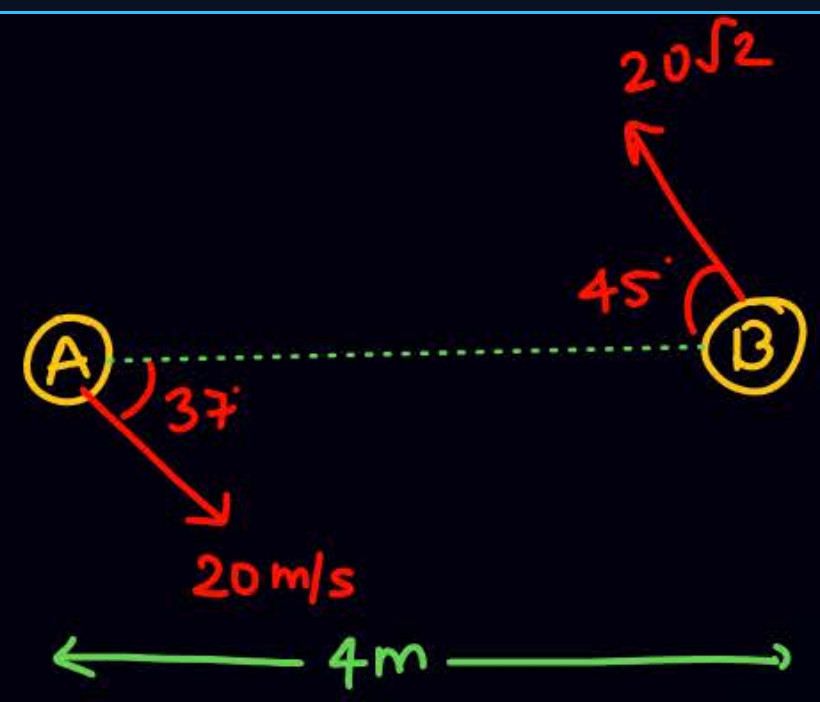


$$\frac{d}{dt} |\vec{r}_{B/A}| = 6$$

$$\frac{d}{dt} (\vec{r}_{B/A}) = \vec{v}_{B/A} = 6\hat{i} + 2\hat{j}$$



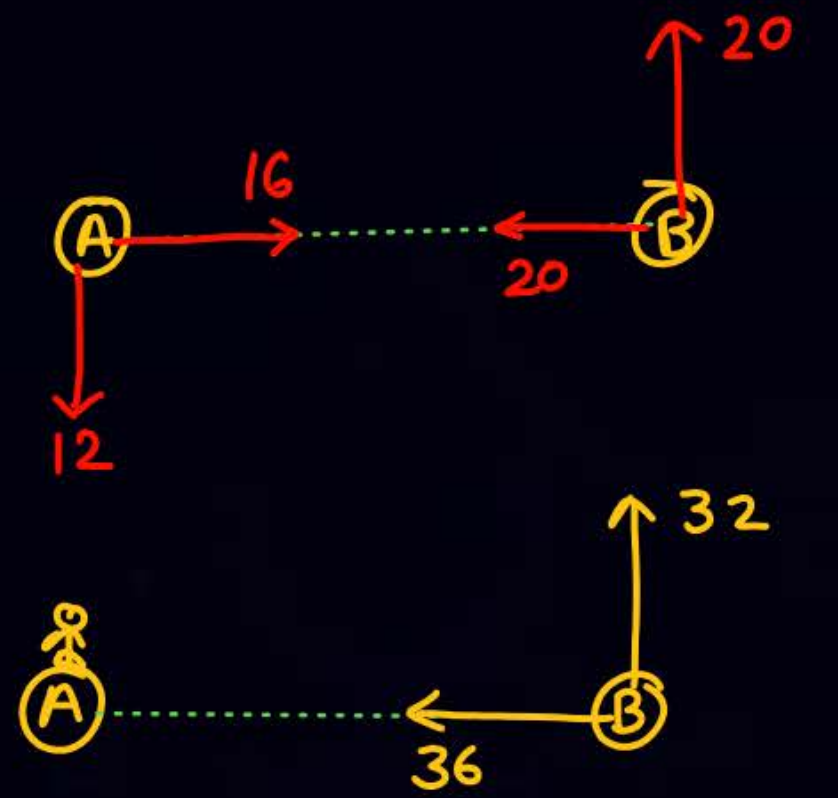
Q



solⁿ

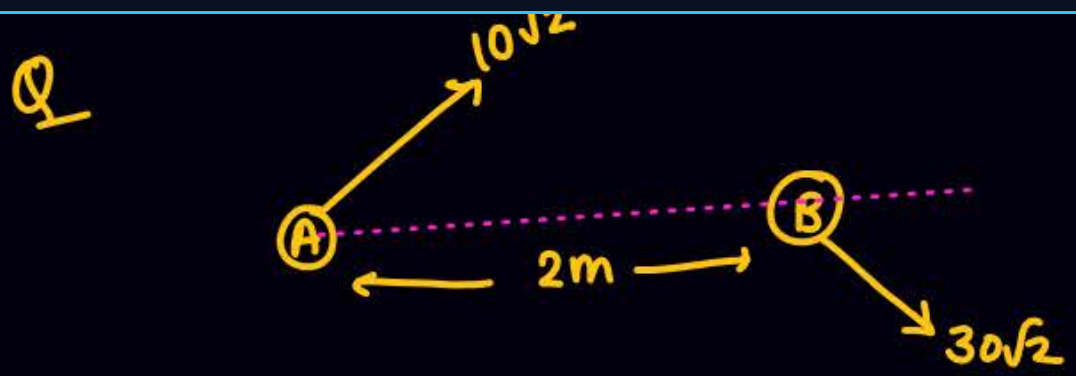
- ① $\omega_{B/A}$
- ② Rate of change of sep^y

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$$\omega_{B/A} = \frac{32}{r} = \frac{32}{4} = 8 \text{ rad/sec (A cw)}$$

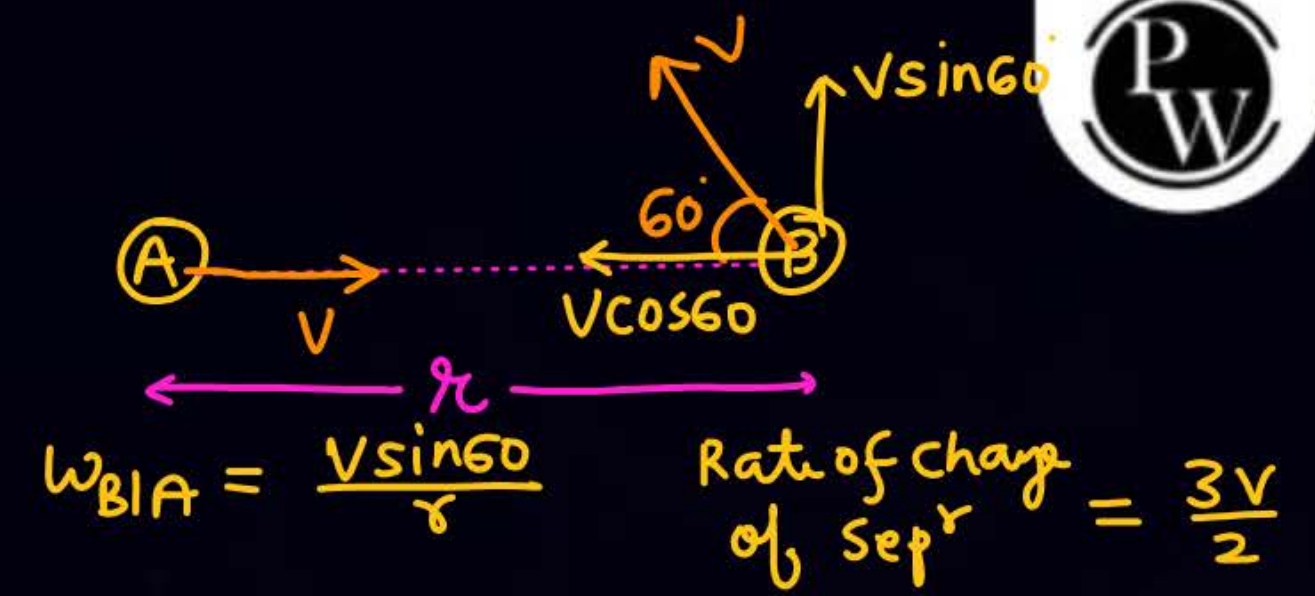
$$\text{Rate of change of separation} = 36$$



(*)
(3)

$$w_{B/A} = \frac{40}{2} \text{ (cw)}$$

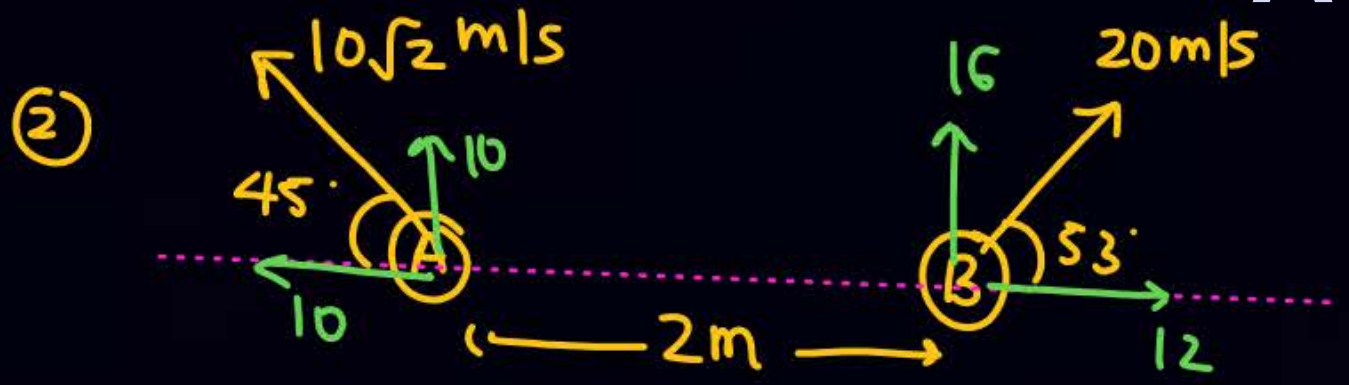
rate of change of separation = 20



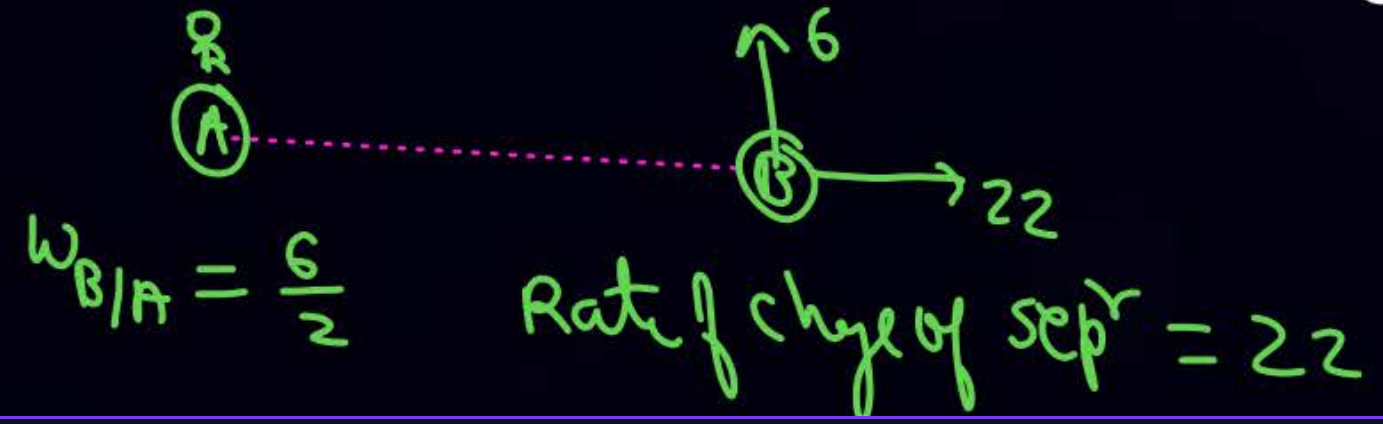
$$w_{B/A} = \frac{V \sin 60}{1}$$

Rate of change of sep^r = $\frac{3V}{2}$

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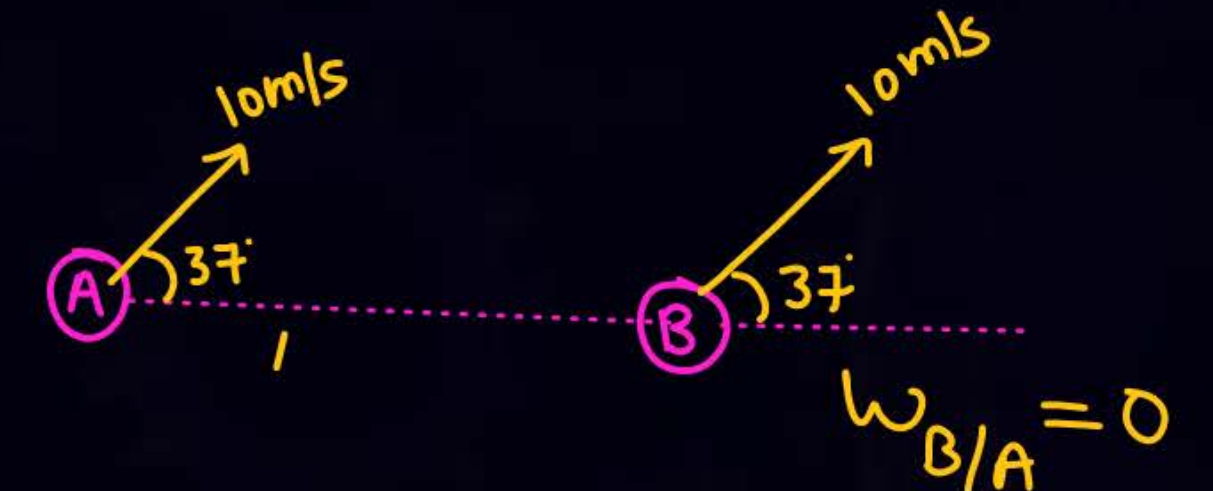


(5)



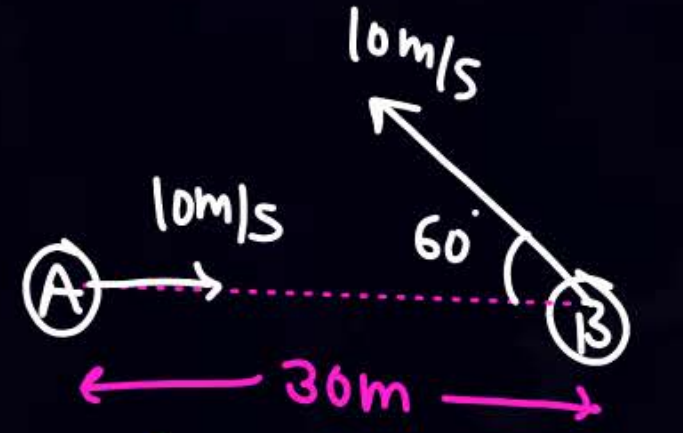
$$w_{B/A} = \frac{6}{2}$$

Rate of change of sep^r = 22



$$w_{B/A} = 0$$

$$\frac{d|\vec{r}|}{dt} = 0$$



$$w = \frac{5\sqrt{3}}{30}$$

rate of change of sep^r = 15

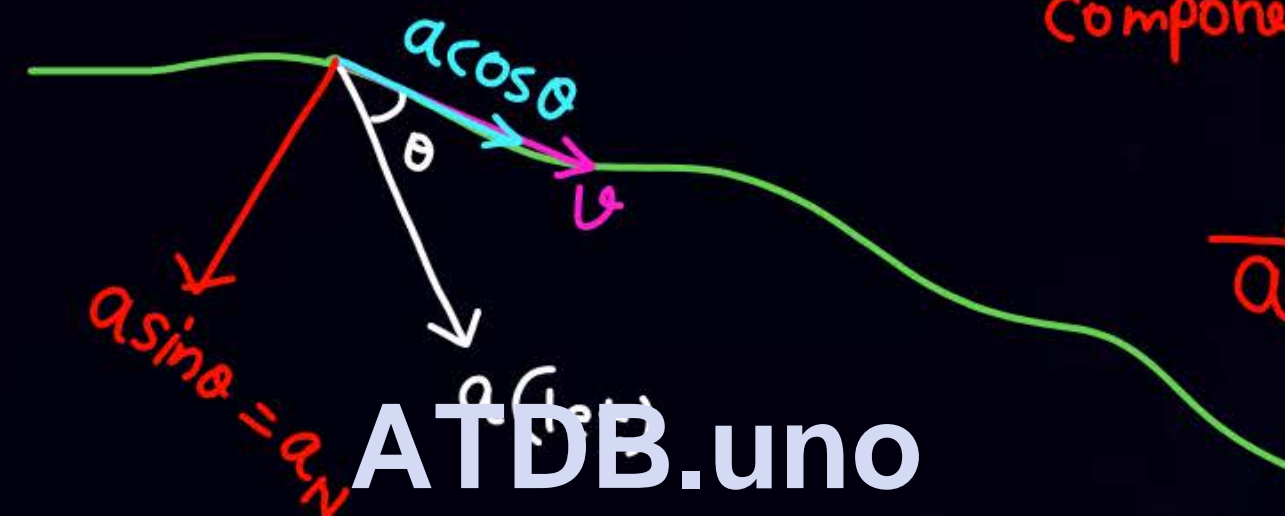


tangential & Normal acc

(कसम रवाई थी)

$$\vec{a} = \vec{a}_t + \vec{a}_N$$

$$a = \sqrt{a_t^2 + a_N^2}$$



Component of a_{acc} normal to velocity
 $= a \sin \theta = a_N$

$$\vec{a}_N = \vec{a} - \vec{a}_t$$

Component of a_{acc} along velocity $= a \cos \theta = \frac{\vec{a} \cdot \vec{v}}{v} =$ tangential acc

$$a_t = a \cos \theta = \frac{\vec{a} \cdot \vec{v}}{v} \text{ (magnitude)}$$

$$\vec{a}_t = (a \cos \theta) \hat{v} = \frac{\vec{a} \cdot \vec{v}}{v} \hat{v}$$

|||
 Responsible to
 change magnitude
 of velocity



Homework

- Revise today Lecture 2-3 times. (Very imp)
& revise vector (a_t, a_N)
- Solve PYQ attached Im of NUM & friction

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THANK YOU

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