PRAYAS

JEE 2025

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. ,

Angular displacement = θ (cw)

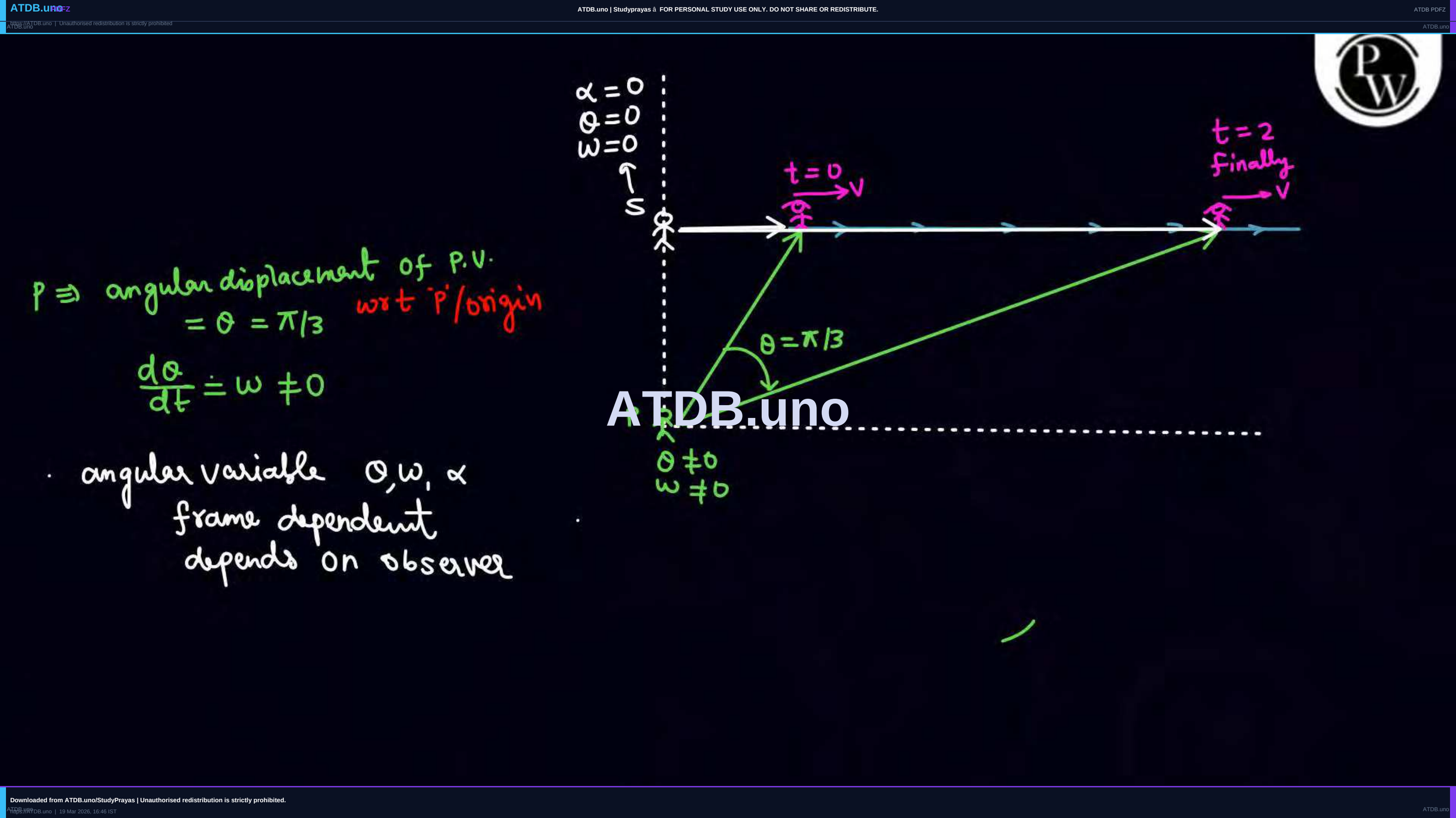
↓

angular displacement of position vector.

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

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

Circular motion X



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

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

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

Angular velocity ω

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

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

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

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

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

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

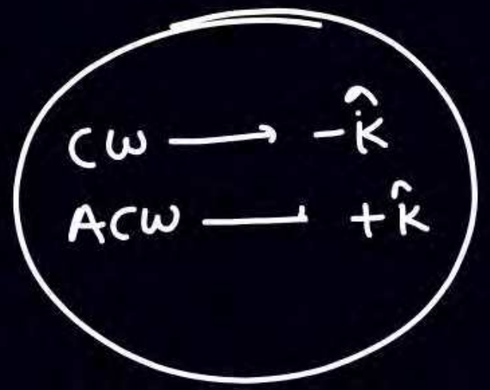
* $\vec{a}_{cc} = \frac{d\vec{v}}{dt}$

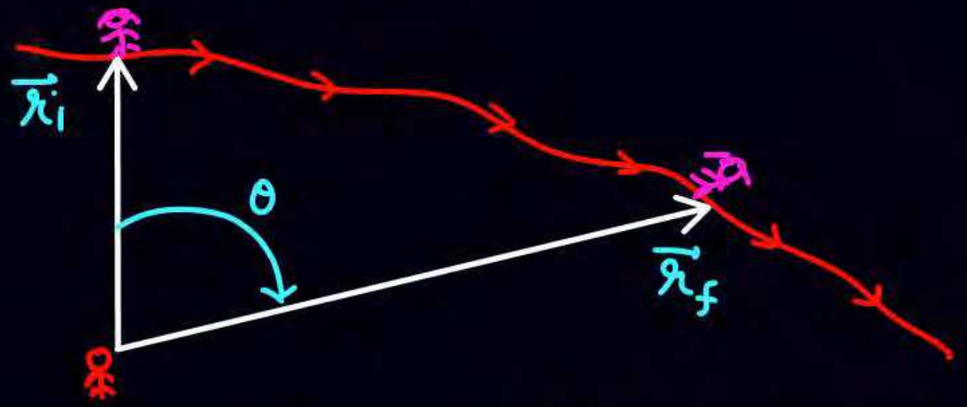
x $\langle \vec{a} \rangle = \frac{\vec{v}_f - \vec{v}_i}{t_2 - t_1}$

$x \longrightarrow \theta$

$v \longrightarrow \omega$

$a \longrightarrow \alpha$





θ ज्ञात ⟶ Clockwise, CW Sense

$\vec{\omega}$ ⟶ C.W

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

* $\vec{\alpha}, \vec{\omega}$ Same dirⁿ / Same Sign ≡ Speed up

* $\vec{\alpha}, \vec{\omega}$ direction opposite / " Sign Speed down

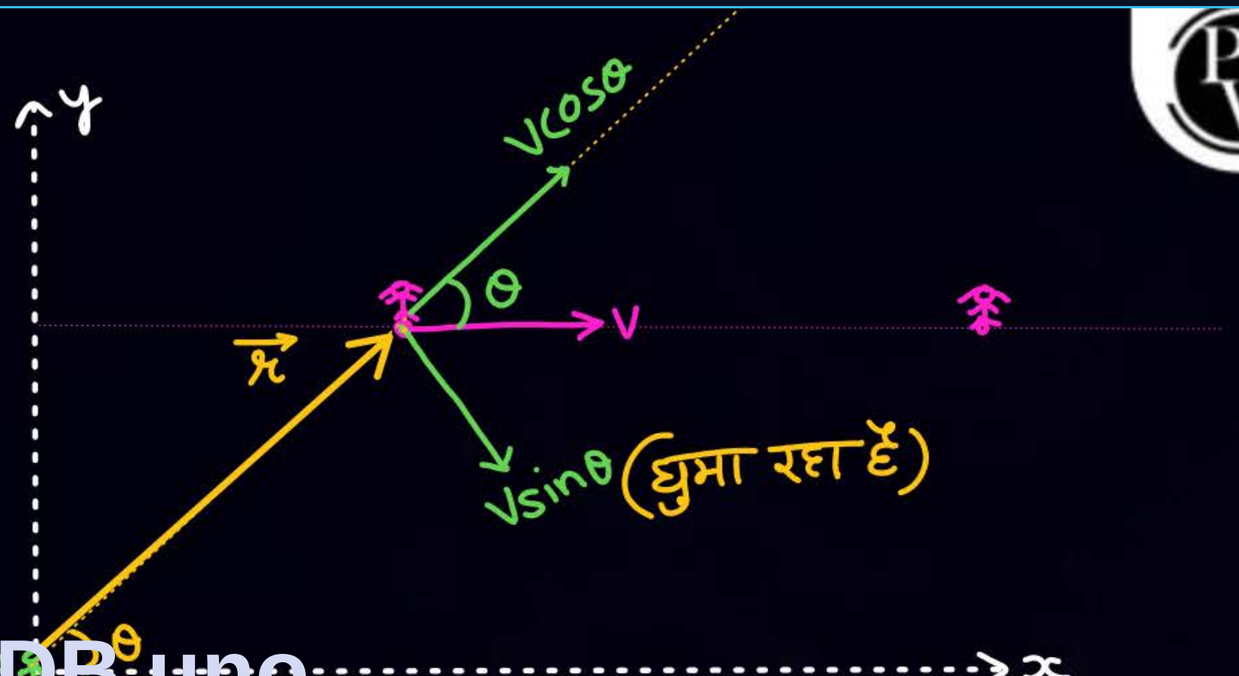
dirⁿ ≡ Right hand thumb rule ⇒ $-\hat{k} \equiv (CW)^{**}$

$V\cos\theta$ = 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 $= V\cos\theta = \frac{d|\vec{r}|}{dt}$

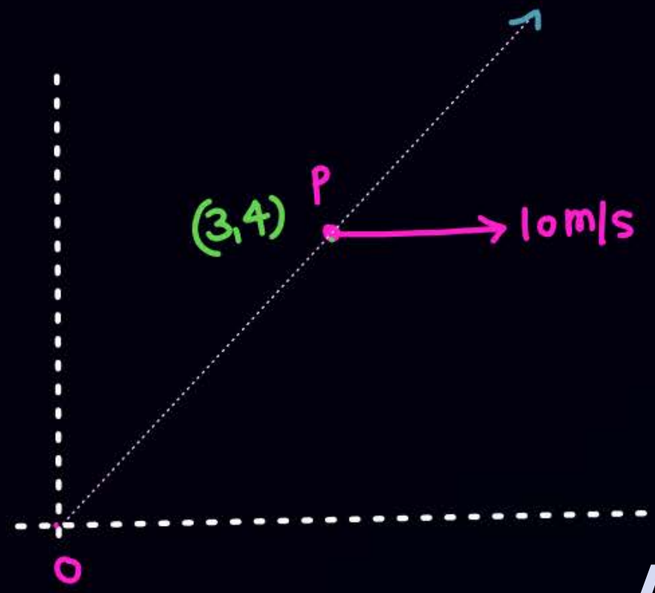


{If $V\cos\theta = 0$ circular motion}

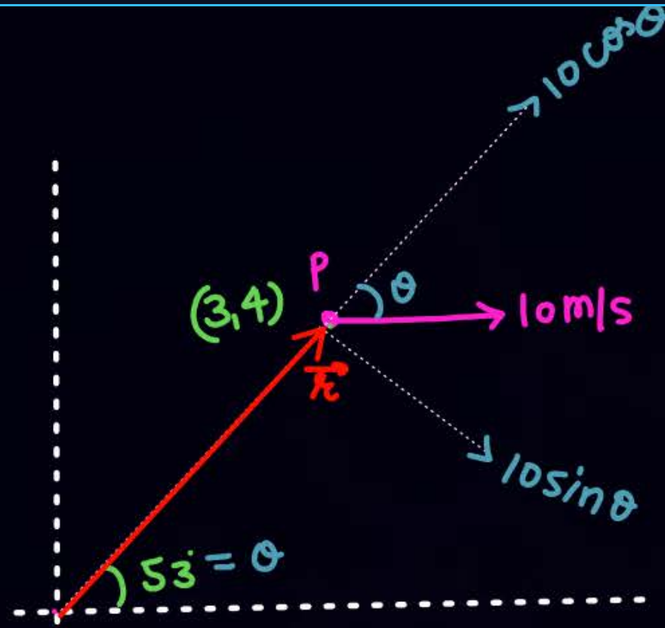
$\vec{r}$ → dir^n change

$|\vec{r}|$ → Change

Q



Soln



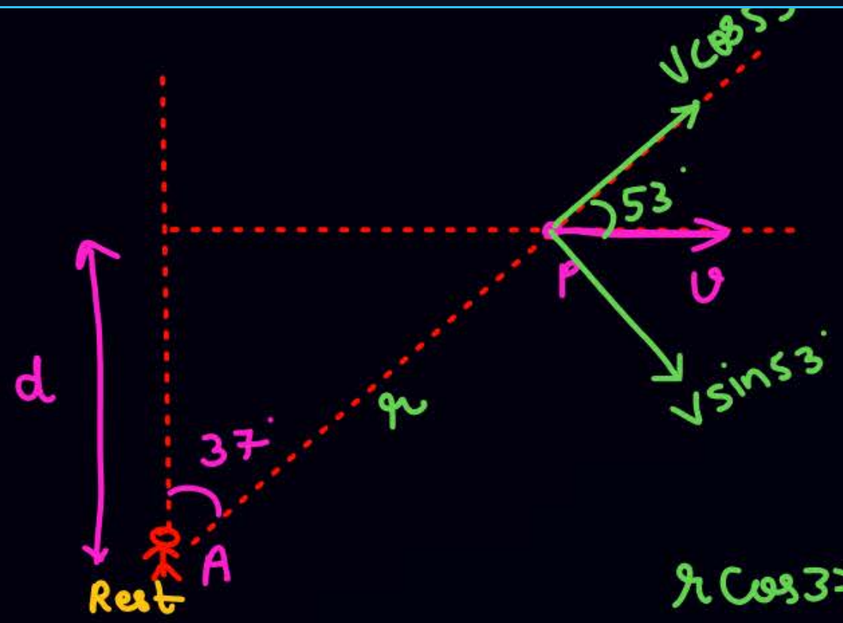
$w_{P/O} = ?$

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

Rate of change of Separation of particle from origin =

$= 10\cos\theta$

Q



Rate of change of separation
$= V\cos 53°$

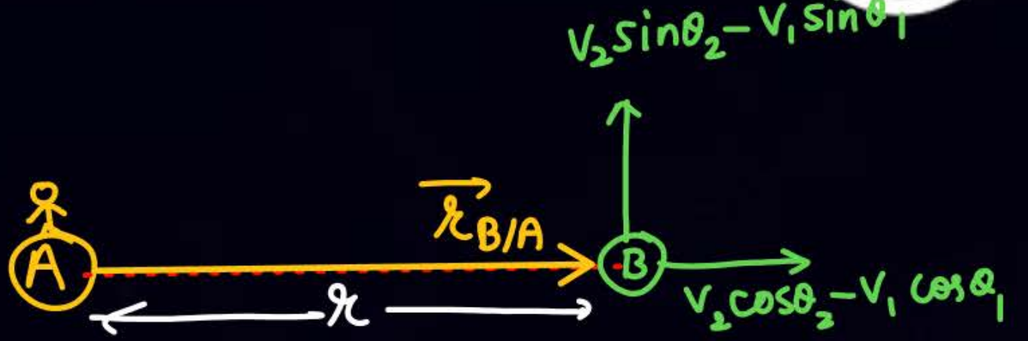
$r\cos 37 = d$

$\frac{d}{\cos 37} = \frac{5d}{4}$

$\omega_{P/A} = \frac{V\sin 53}{r}$

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

$W_{B/A}$, $W_{A/B}$ when both particle are moving

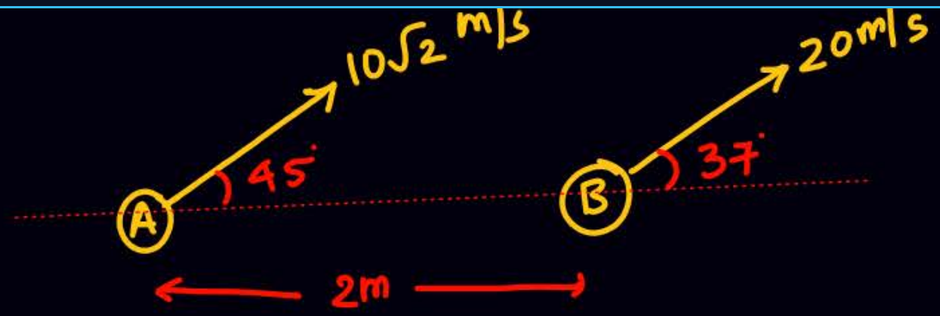


$$W_{B/A} = \frac{V_2\sin\theta_2 - V_1\sin\theta_1}{r}$$

Rate of change of separation

$$= V_2\cos\theta_2 - V_1\cos\theta_1$$

JA Q

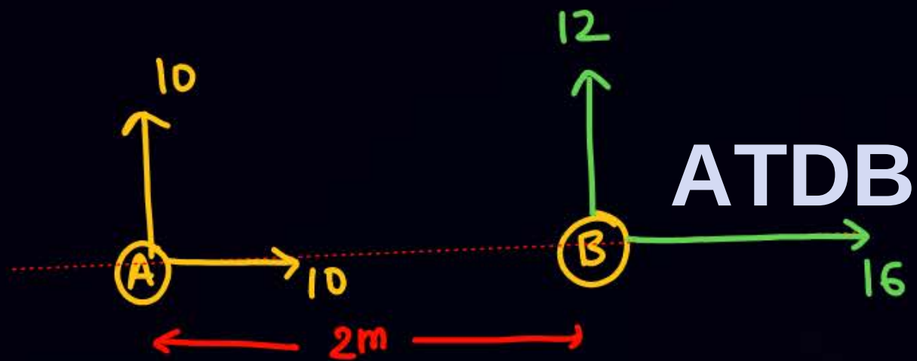


find $w_{B/A}$ & rate of change of separation

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

SKC
- line
- Component
- वेक्टर्स, त

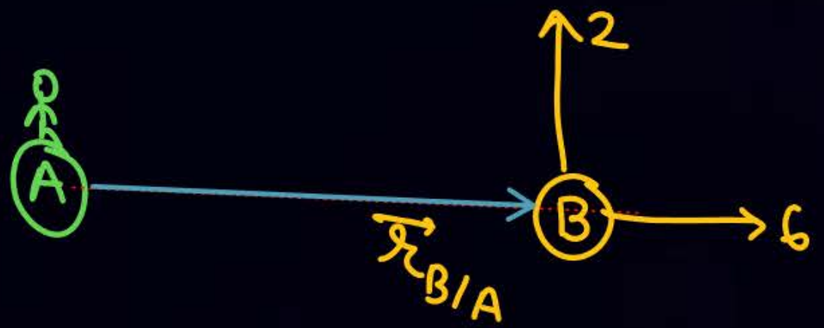
Sol"



$$w_{B/A} = \frac{2}{r} = \frac{2}{2} = 1 \text{ rad/sec} \quad (A\,c\,w)\ \hat{k}$$

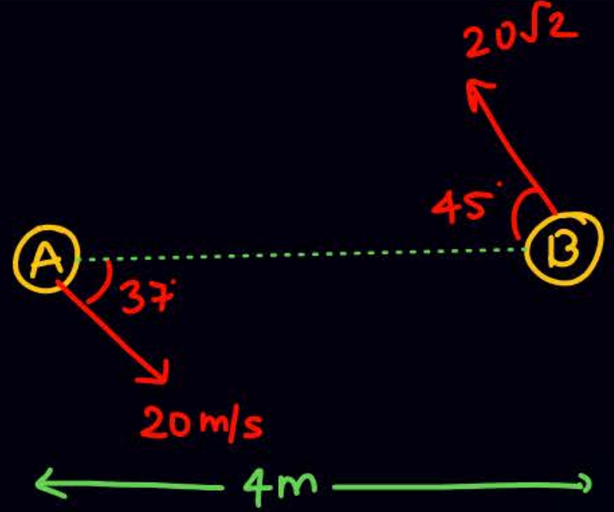
Rate of change of separation = 6

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

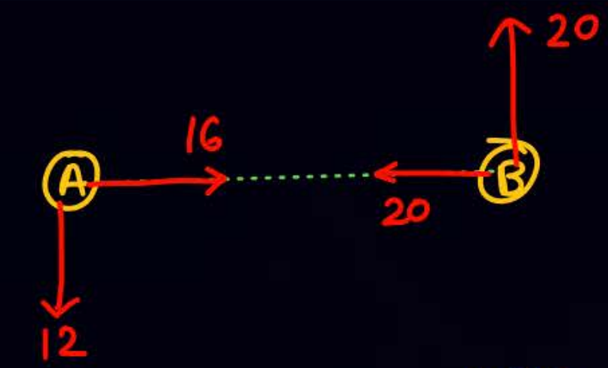


$$\frac{d}{dt}(\vec{r}_{B/A}) = \vec{v}_{B/A} = 6\hat{i}+2\hat{j}$$

Q



Sol^n



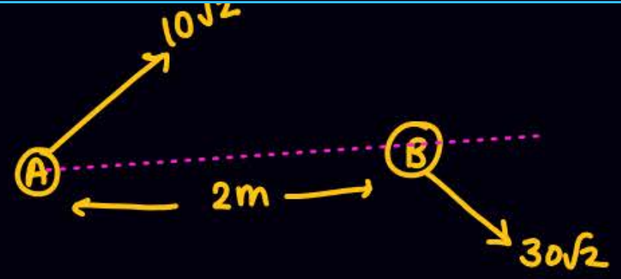
① $w_{B/A}$

② Rate of chaye of Sep^r

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

Rate of chaye of separation = 36

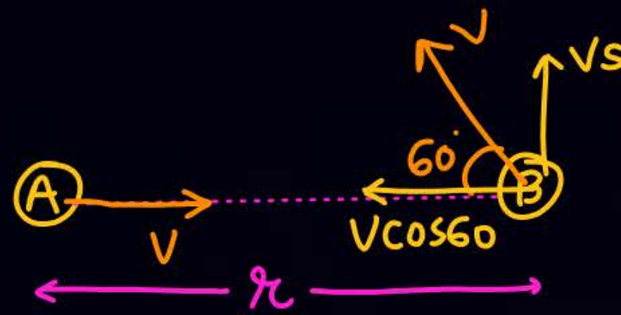
Q



$\omega_{B/A} = \frac{40}{2}$ (CW)

rate of change of separation = 20

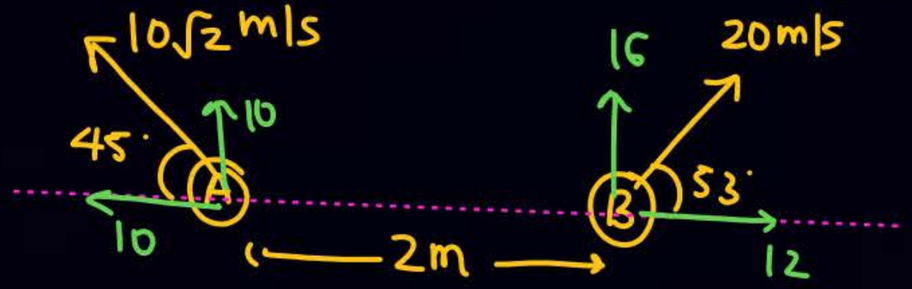
(3)



$\omega_{B/A} = \frac{V\sin 60}{r}$

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

(2)



(4)

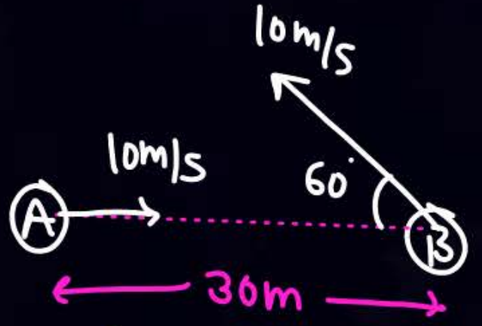
$\omega_{B/A} = 0$

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

(5)

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

Rate of change of sep^r $= 22$



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

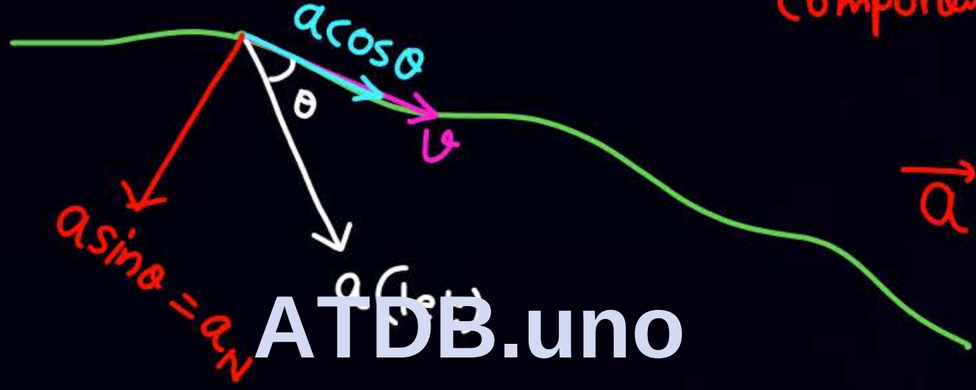
rate of change of sep^r $= 15$

tangential & Normal acc

(कसम खाई थी)

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

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



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

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

Component of acc along Velocity $= a\cos\theta = \dfrac{\vec{a}\cdot\vec{v}}{v}$ = 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
Chaye magnitude
of Velocity

Homework

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