YAKEEN NEET 2.0

2026

Motion in a Plane

Physics | Lecture - 12

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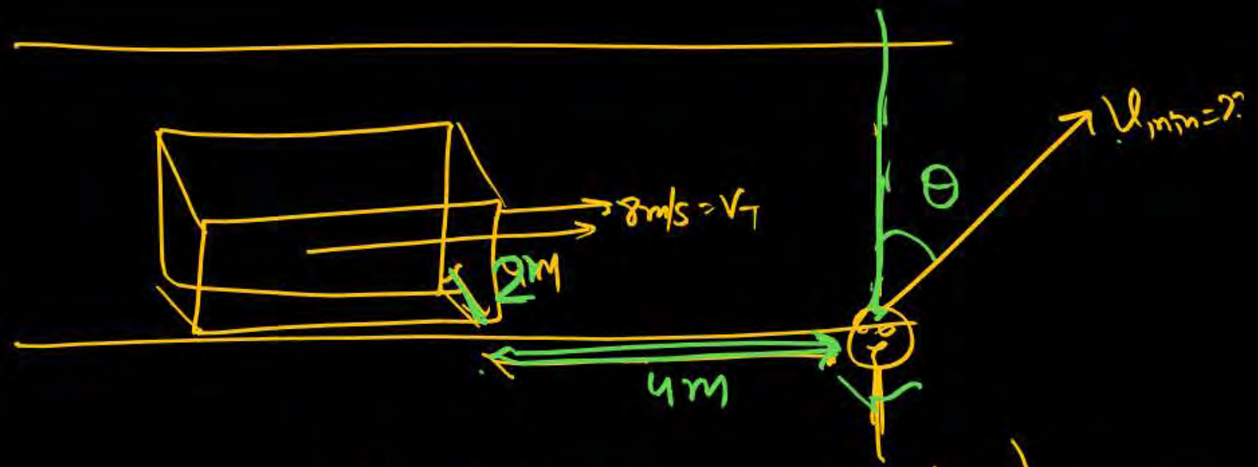
Topics to be covered

1. # Kinematics of circular motion
2.
3.
4.



last lecture ka (11/w) →
last lecture ke slide par hoga ||

Circular Motion

- Kinematics of circular Motion
  - * Angular disp^{n}
  - * Angular velocity
    - " Accn
  - Uniform & Non Uniform
    - Circular moth

- Dynamics of circular motion
  - In laws of moth
    - Cause of circular motion
    - Bending of cyclist
      - CAR on Curved Road.

- *Vertical circular motion.
  - In work energy & power

Circular motion → When Point object moving on circular Path of constant radius is called circular motion.

* All observation taken from centre of circular Path.

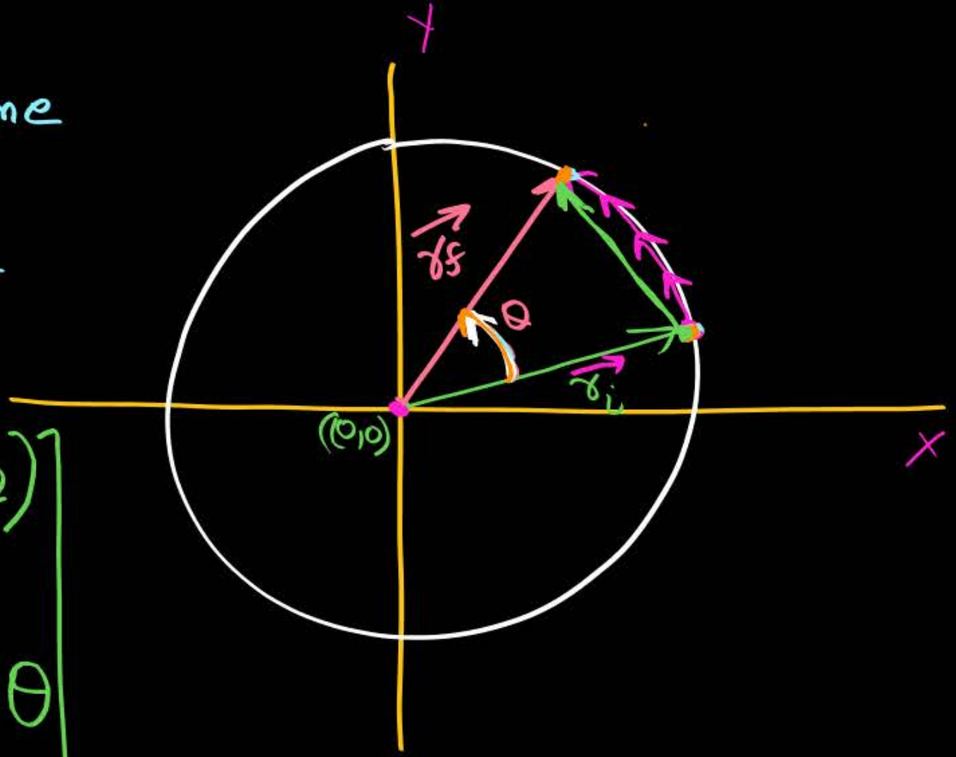
Angular Displacement θ = Angle Rotated by Position vector.

Rotation is A.C.W, then $\theta \rightarrow \odot$ outward to plane

Rot^n is clock-wise then $\theta \rightarrow \otimes$ Inward to Plane

(Axial vector)

- Displacement in θ Angle $= 2R\sin(\theta/2)$
- Distance (total Path length) $=$ Arc $= R\theta$



(Q) Find **Angular displ^{m}** in one - comp^{t} rotation on circular path.

→ Angle Rotated by Post^{n} vector in one Rot^{n}.

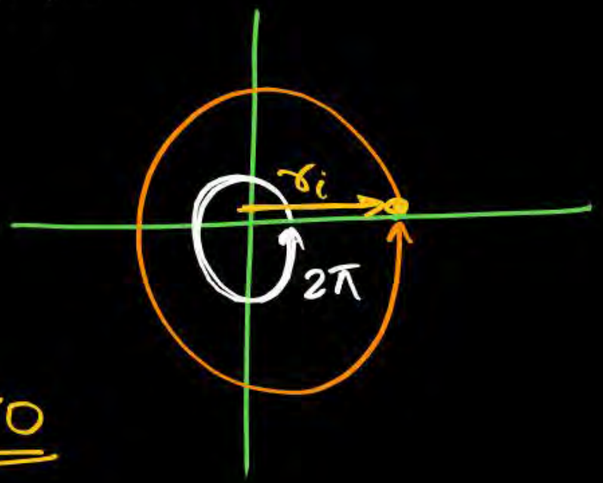
X (a) $2\pi R$

✓ (b) 2π rad

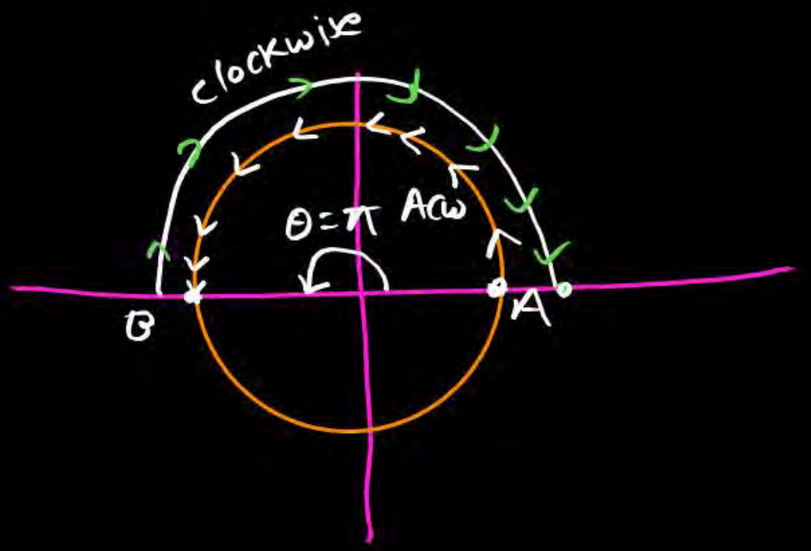
X (c) 0

X (d) zero

Jn same case displacement in one Rot^{n} is zero



MR* Box
Circular motion me Jabtak Angular mention no ho Angular Parameter nahi discuss Karenge



Angular distance $= \pi + \pi = 2\pi$
(disp^m Consider Nahi Karna.)
→ Scalar!

total Angular disp^m from A to A $= \theta_{AB} + \theta_{BA}$

$= \pi\odot + \pi\otimes$

$=$ zero

disp^m from A to A $= 0$

MR* Box

fixed plane ke circular motion me $[\theta, \omega, \alpha]$ → Axial vector

ka do hi direction Possible hai outward (A-C-W) & Inward (clock-wise) motion

(Q) find Angular displacement in n- Rotation.

Ans $\theta_{Total} = n(2\pi)$ rad

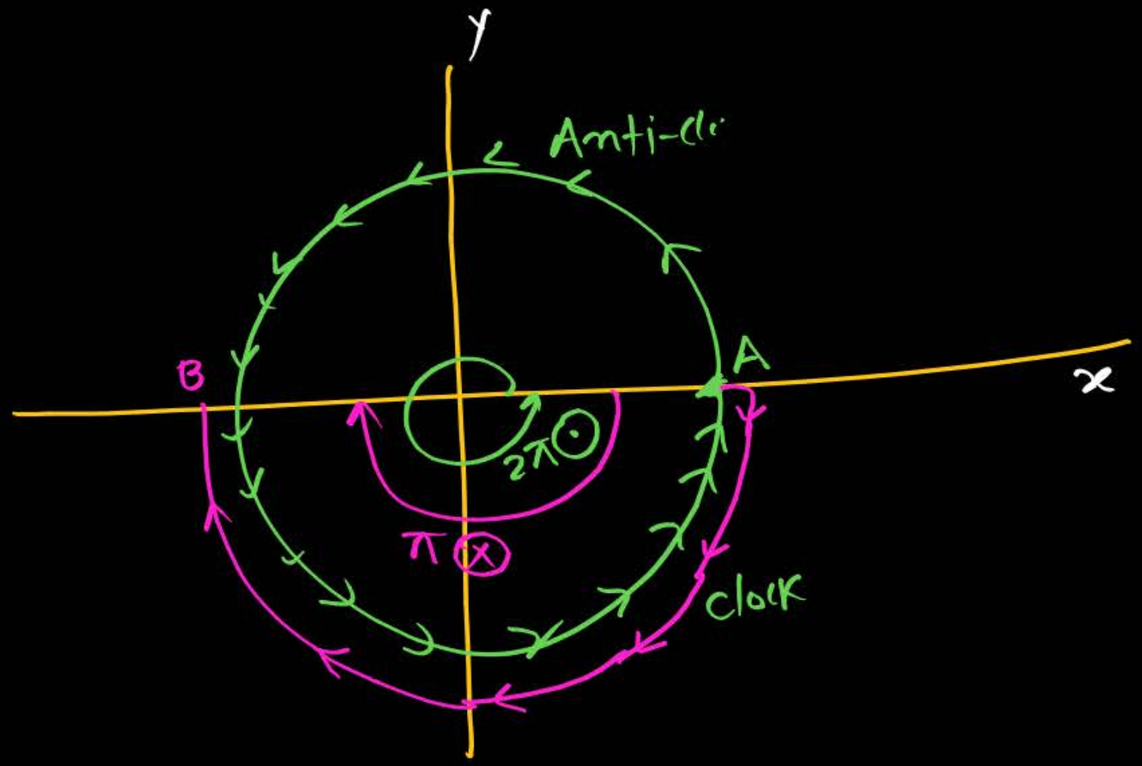
(Q) find Angular displacement in 2π rotation ??

$n = 2\pi$ (no. of rotation)

Soln

$\theta = n(2\pi)$ rad

$\theta_{total} = 2\pi(2\pi) = 4\pi^2$ rad

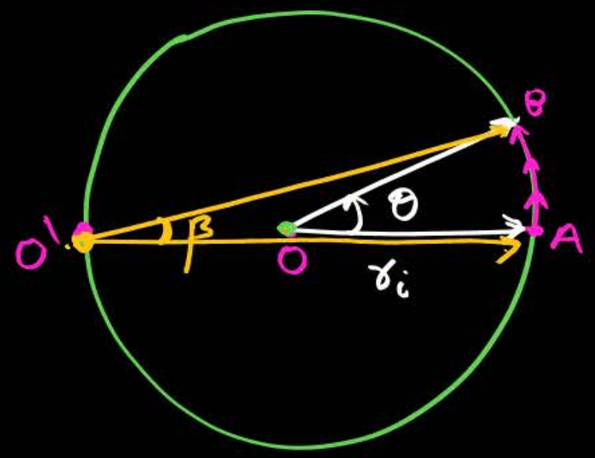


Angular displacement (vector) $= 2\pi\odot - \pi\otimes$

$= \pi$ rad $\odot$

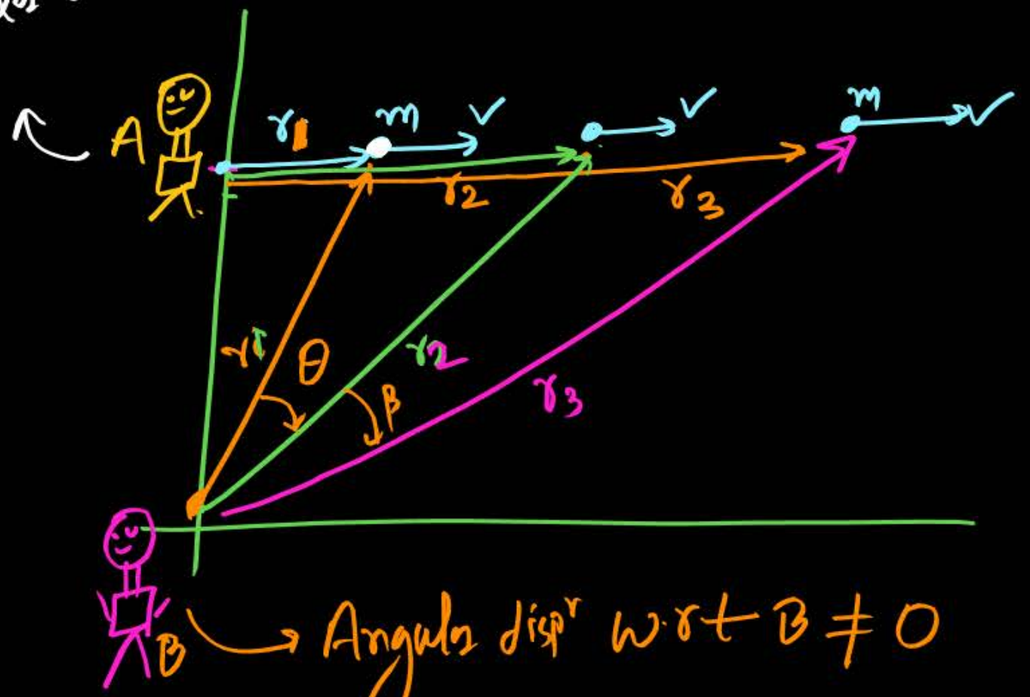
Angular dist^{n} $= 2\pi + \pi = 3\pi$ rad

(dir^{n} Not Consid



$\text{Arc} = R\theta\perp$
(same)

Angular disp^m w.r.t A $= 0$



Angular disp^r w.r.t B $\neq 0$

Angular disp^m w.r.t 'O' $= \theta$

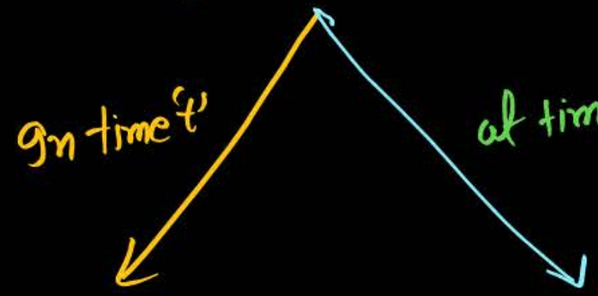
(θ) Angular disp^m depends on frame of reference.

$\beta < \theta$

Angular disp^m from O

Angular (disp^m from O')

Angular velocity. ⟶ How fast Angle is changing (In which direction)



$$\vec{\omega}_{Avg} = \frac{(\text{total Angle})}{\text{total time}}$$

$$= \frac{\vec{\theta}_f - \vec{\theta}_i}{\Delta t}$$

$$\langle \omega_{Avg} \rangle = \frac{\int \omega dt}{\int dt}$$

Instantaneous Angular velocity = The Rate of change in Angular displ^n.

$$\vec{\omega} = \frac{d\theta}{dt}$$

- → vector
- → dir^ (ACW) → $\omega \odot$
  (CW) → $\omega \otimes$
- → unit → rad/sec.
- → slope of θ/t graph is $\vec{\omega}$.

for $\omega = \text{cost}^n$

→ Rate of change in Angle is constant.

$$\vec{\omega}_{Avg} = \vec{\omega}_{Inst} = \frac{d\theta}{dt} = \frac{\theta_{total}}{T}$$

T = time taken to comp^t one rotation.

$$\omega = \frac{2\pi}{T} = 2\pi f$$

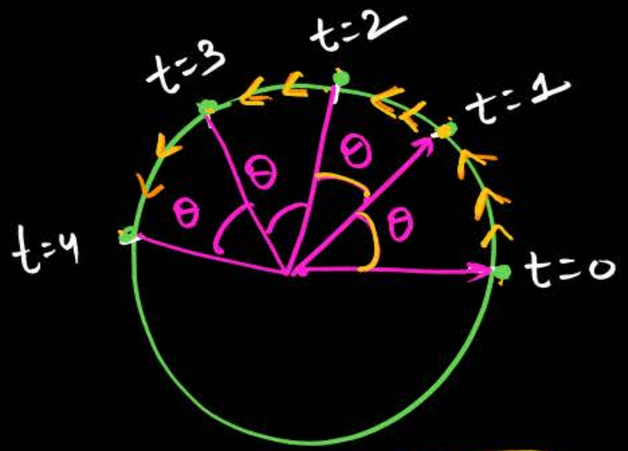
f → frequency of rot^n (Hz) → revolution per-sec (rps)

→ rad/sec.

→ Angular velocity (Angular frequency → unit (rad/sec))

$$f = \frac{1}{T}$$ *

$\omega = \text{Const}^n$ → equal angle in equal time (In same sence of Rot^n)



$\omega = \frac{\theta}{T}$

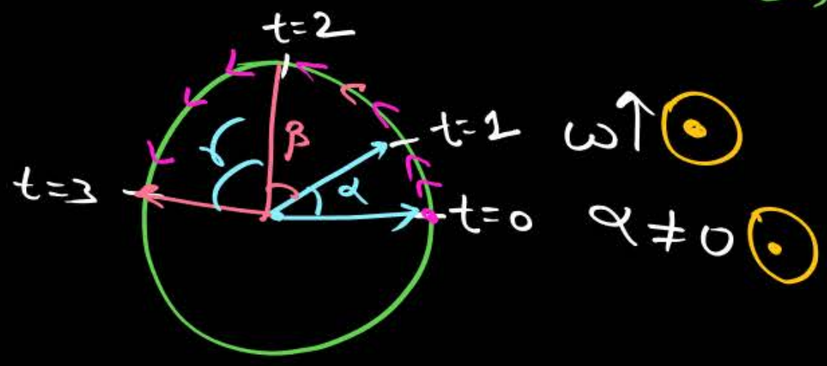
→ Same.

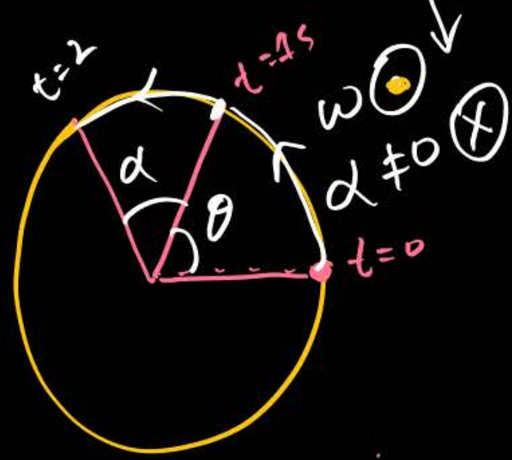
Rate of change in $\omega = 0$

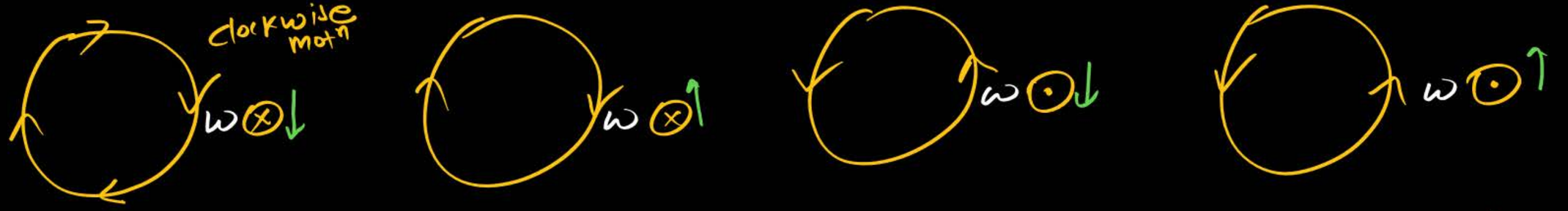
(#) **Angular acc^n** = The rate of change in Angular Velocity is called Angular acc^n

$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$ ($\omega = \text{Const}^n$, $\alpha = 0$)

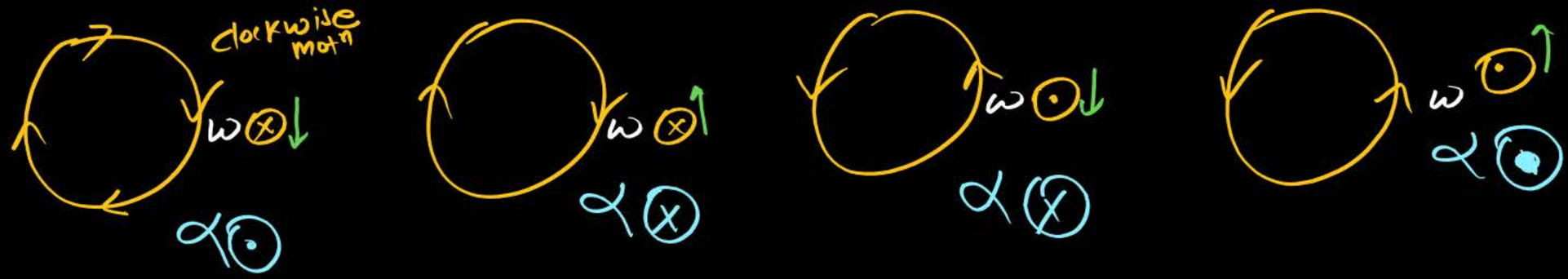
↳ vector dir^n along change in (ω)







(Q) for given above diagram find direction of Angular acc^{n} (α).



MR$^{\alpha}$ Box
- If $\omega\uparrow$ then ω & α Parallel
- If $\omega\downarrow$ then ω & α Anti-parallel.

MR$^{\alpha}$ Box
ω(dir^{n}) → Rot^{n} Ke sense में
- ⊗ AC·W Rot^{n} ⊙
- ⊙ C·W ⊗

Angular Acceleration

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

↳ unit rad/sec^2

$$\alpha = \frac{d}{dt}\left(\frac{d\theta}{dt}\right)$$

$$\alpha = \frac{d^2\theta}{dt^2}$$

\# $$\alpha = \frac{d\omega}{dt} \times \frac{d\theta}{d\theta}$$

$$\boxed{\alpha = \omega \frac{d\omega}{d\theta}}$$

$$\boxed{\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2} = \omega \frac{d\omega}{d\theta}}$$

Angular acc

$$\boxed{\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2x}{dt} = v\frac{dv}{dx}}$$

↳ Acc

Question

Angular displacement of object $\theta = t^2 + 2t + 5$ then, find angular speed.

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

$$\omega = 2t + 2 \times \frac{dt}{dt} + 0$$

$$\boxed{\omega = 2t + 2}$$

$$\alpha = \frac{d\omega}{dt} = 2 + 0$$

$$\boxed{\alpha = 2 \text{ rad/s}^2}$$

Nali Concept:-

Angular disp. $= \Delta\theta = \int_{t_1}^{t_2} \omega\, dt$ = Area of ω/t graph.

Change in Angular velocity $= \Delta\omega = \int_{t_1}^{t_2} \alpha\, dt$ = Area of α/t graph

θ (Angular disp^m) ⇄ Angular velocity (ω) ⇄ Angular acc^n (α)

$\theta = \int \omega\, dt$ = निकालो

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

Angular velocity = slope of θ/t graph

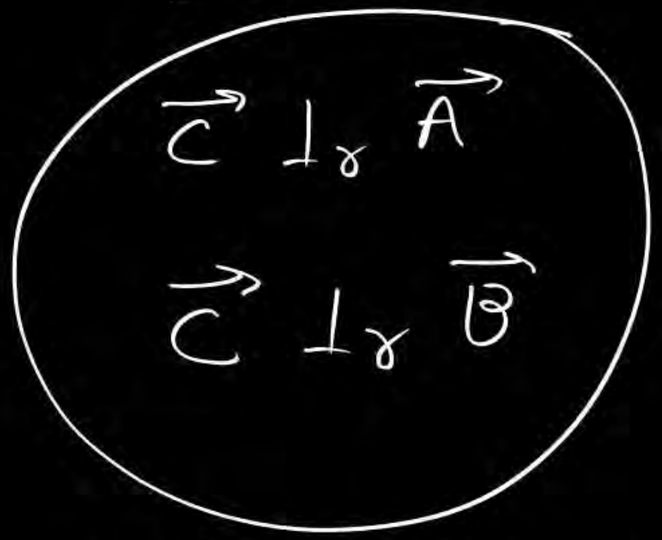
$\alpha = \frac{d\omega}{dt}$ = slope of ω/t graph

$\alpha = \omega \frac{d\omega}{d\theta}$

$\frac{d\alpha}{dt}$ = निकालो

slope of α/t = निकालो graph

$\vec{C} = \vec{A} \times \vec{B}$

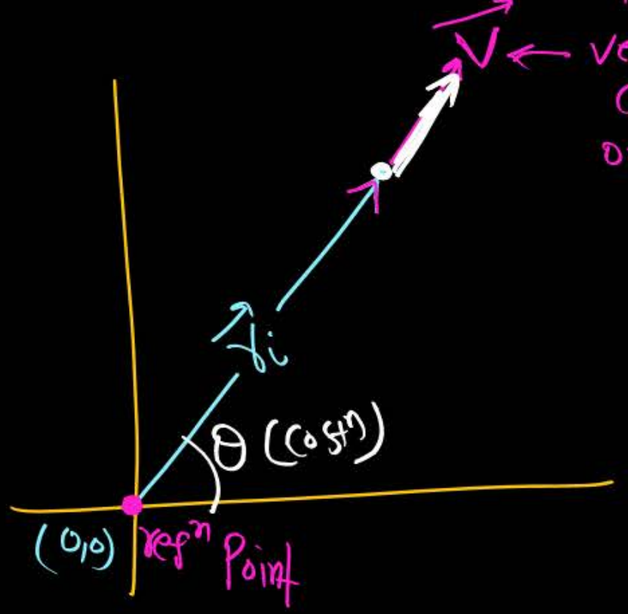


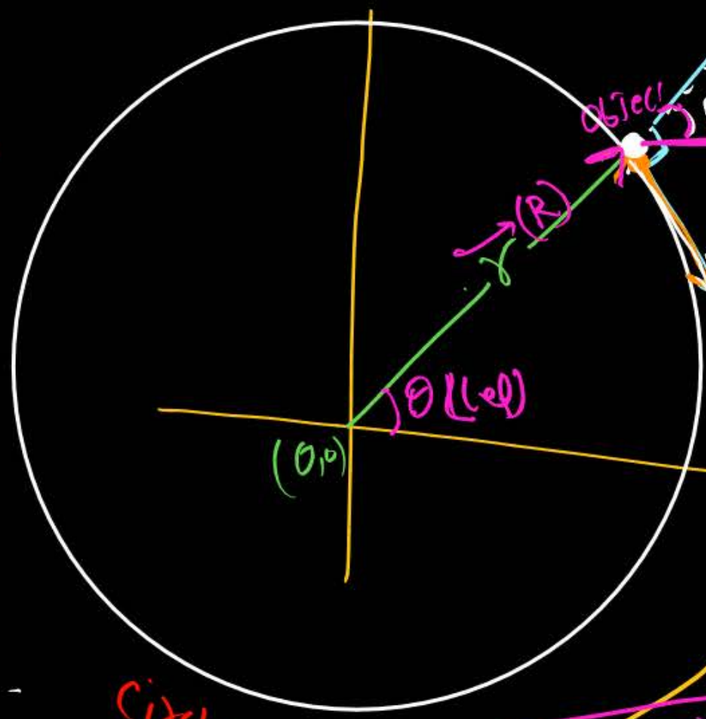
Result of $\vec{A} \times \vec{B}$ vector is $\vec{C}$ must be $\perp_r$ to $\vec{A}$ & $\vec{B}$

Relation B/w velocity($\vec{v}$) & Angular velocity(ω)

If object is moving with velocity V & it's radius is R at that instant.

$\vec{V} = R\vec{\omega}$ ✗ Wrong.





$V = R\omega$

↑ velocity ⊥r to Radius vector

$\omega = \frac{V\sin\theta}{R}$

$\vec{V} = \vec{\omega} \times \vec{R}$

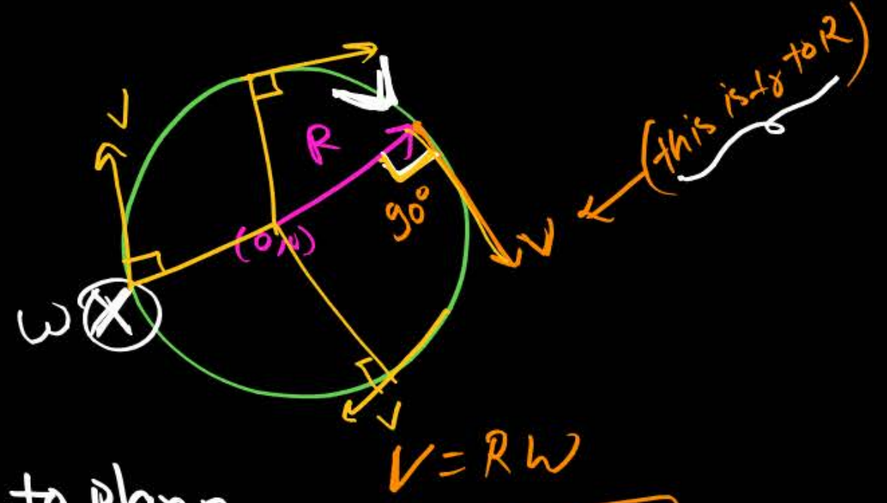
Rotation में पड़ेगा

radius

$(\text{velocity } \perp \text{r to } \vec{R})\ V = R\omega$

$\omega = \dfrac{V_{\perp r \text{ to } \vec{R}}}{R\ (\text{Radius})}$

+) gn circular motion



$\omega \otimes$ ⊥r to plane

$\omega \otimes$ ⊥r to $\vec{R}$ & $\vec{V}$.

$\vec{\omega} \cdot \vec{V} = 0$

$\vec{\omega} \cdot \vec{R} = 0$

$\vec{V} \cdot \vec{R} = 0$

$\omega = \dfrac{V}{R}$

(Q) Object is moving with speed V on a straight line along x-axis. then find its Angular velocity when it is at Point $P(a,b)$ w.r.t origin.

Soln

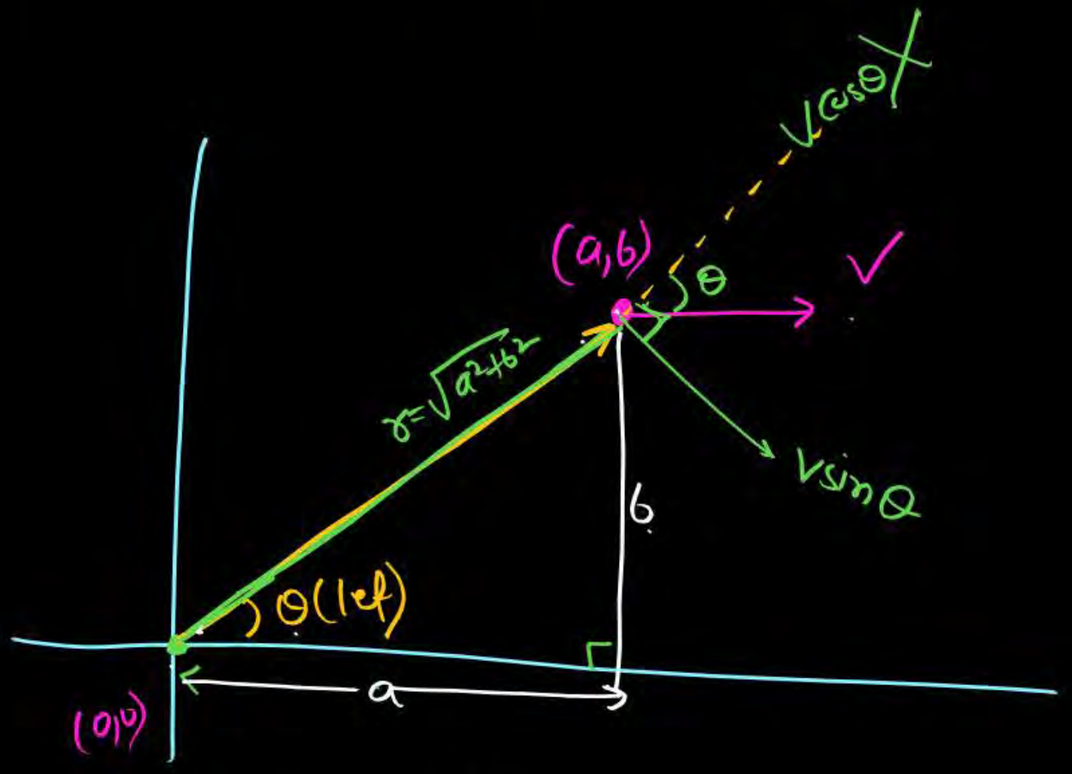
Zero ✗

$$\omega = \frac{(\text{velocity } \perp^r \text{ to } \vec{R})}{\text{Radius}}$$

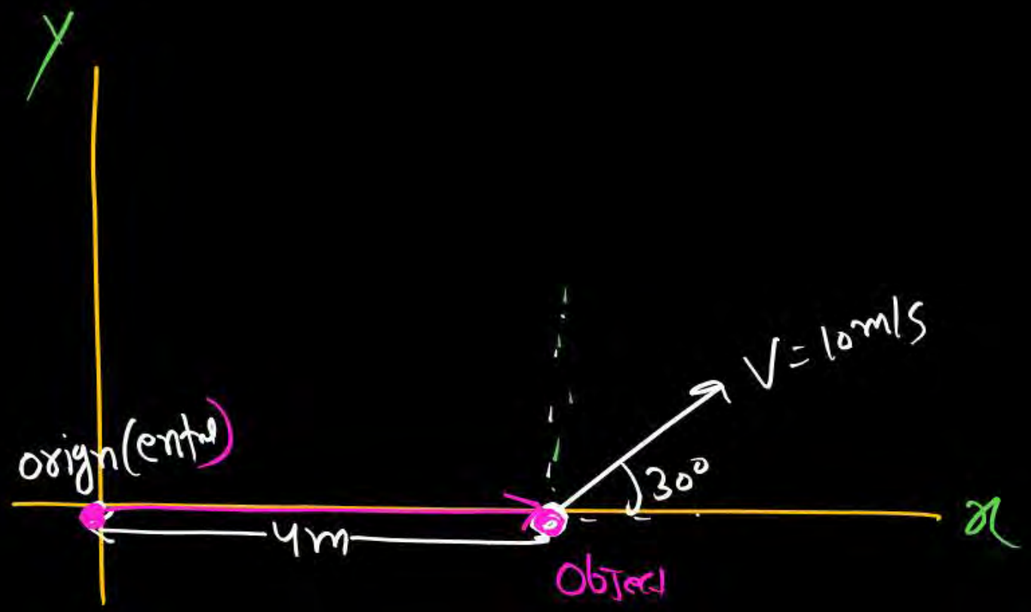
$$\omega = \frac{V\sin\theta}{\sqrt{a^2+b^2}}$$

$$\omega = \frac{V}{\sqrt{a^2+b^2}} \times \frac{b}{\sqrt{a^2+b^2}}$$

Ans $\boxed{\omega = \frac{Vb}{(a^2+b^2)}}$



$$\sin\theta = \frac{b}{\sqrt{a^2+b^2}}$$



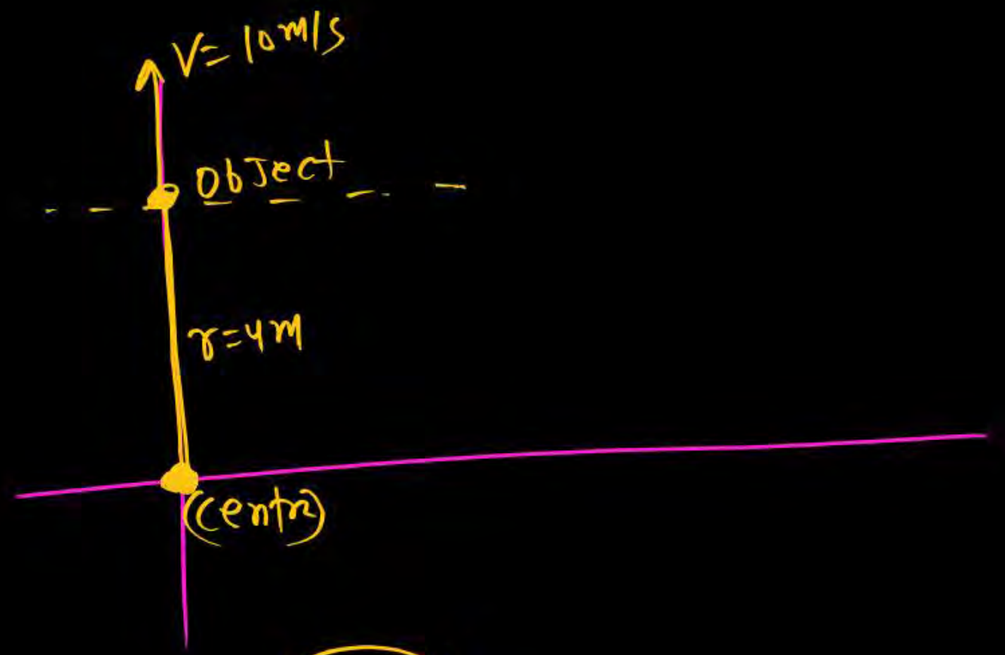
find ω = ??

$$\omega = \frac{V_{\perp \text{ to radius}}}{\text{radius}}$$

$$= \frac{V \sin 30^\circ}{4}$$

$$\omega = \frac{V}{4 \times 2} = \frac{10}{4 \times 2}^{5}$$

$$\omega = \frac{5}{4} \text{ rad/s}$$



$\omega = 0$

Question

Angular velocity $\omega = 6t - t^2 + 6$. Find time when angular acceleration will be zero?

Question

Object completes 7 rotation in 22 sec on circular path of radius 1 m then find angular speed.

$\rightarrow 7(2\pi) = \theta$

Soln

$$\omega = \frac{\theta_{total}}{Time} = \frac{7(2\pi)}{22\ sec}$$

$$= \frac{7 \times 2 \times 22}{22 \times 7}$$

$$= 2\ rad/sec$$

Question

H/w

A body performing uniform circular motion completed 140 revolution in a second. Its angular speed is

1. 88 rad/s
2. 440 rad/s
3. 220 rad/s
4. 240 rad/s

THANK YOU