YAKEEN NEET 2.0

2026

Circular Motion

PHYSICS | **Lecture** 03

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Todays goal

Questions practice on angular velocity, angular acceleration

- Circular motion θ, ω, α,
- centripital acc, tangential acc.

Circular Motion

- $\theta \longrightarrow$ Angular displacement
- $\omega = \dfrac{d\theta}{dt}$ = Rate of change of θ
- $\alpha = \dfrac{d\omega}{dt}$ = Rate of change of angular velocity.

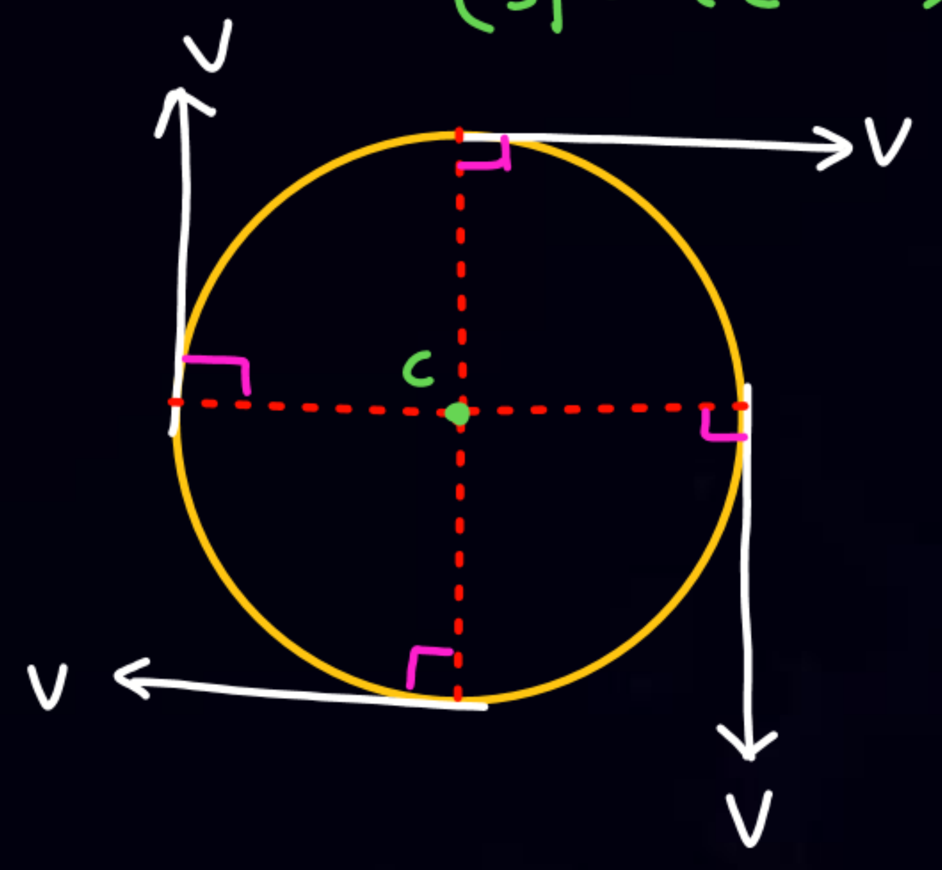
Q $\theta = 2t^3$

find ω & α at $t = 2$ sec.

$\omega = \dfrac{d\theta}{dt} = 6t^2 = 24$ rad/sec.

$\alpha = \dfrac{d\omega}{dt} = 12t = 24$ rad/sec^2

(speed const)



$$V = R\omega$$

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

Q A particle is moving in a circular path of radius $R = 8\,m$ such that $\theta = t^3$. Find

① Angular velocity at $t = 2$

$\omega = 12$

② Angular acc. at $t = 2$ sec.

$\alpha = 12$

③ Speed of particle at $t = 2$ sec.

$v = R\omega = 8 \times 12 = 96$

Sol:

$\theta = t^3$

$\omega = \frac{d\theta}{dt} = 3t^2$

$\alpha = \frac{d\omega}{dt} = 6t$

* $$a_t = \frac{d(\text{speed})}{dt}$$

* $$v = R\omega$$

speed

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

$$a_t = R\frac{d\omega}{dt}$$

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

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

Tangential acc.

* $$\boxed{\begin{aligned} v &= R\omega \\ a_t &= R\alpha \end{aligned}}$$

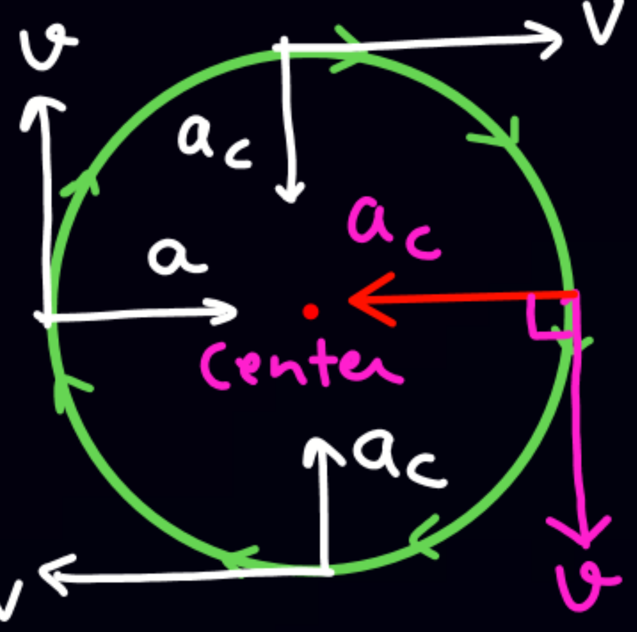
If speed $\longrightarrow$ const $\Longrightarrow a_t = 0$

$\omega \longrightarrow$ const $\Rightarrow \alpha = 0$

$a_t = R\alpha$

Uniform Circular motion

- $v = R\omega$ $(\omega \to \text{const})$
- speed const $\Rightarrow a_t = 0$
- $\vec{v}$ const ✗,
- $\vec{v} \to$ change (dir^n change)
- $\vec{a}_N \neq 0$

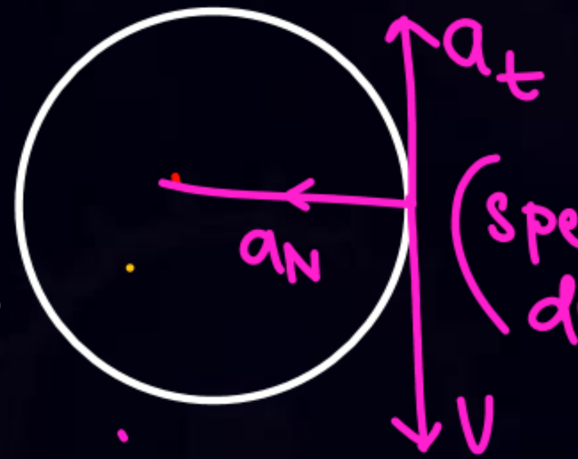


- Normal acc = Centripetal acc $= \dfrac{v^2}{R}$
- $\vec{a} = \underbrace{\vec{a}_t}_{0} + \vec{a}_N \Rightarrow \vec{a} = \vec{a}_N$
- magnitude of $a_c \to$ Const
  Dir^n of $a_c \to$ Change.

Non Uniform Circular motion

- speed $\to$ change, $a_t \neq 0$
- $v = R\omega$, $(\omega \to \text{change})$
- $\vec{v} \to$ change, (Dir^n change)
- $\vec{a}_N \neq 0$
- Normal acc = Centripetal acc $= \dfrac{v^2}{R}$ $\to$ change (Dir^n & magnitude)

(Speed up)



(speed down)

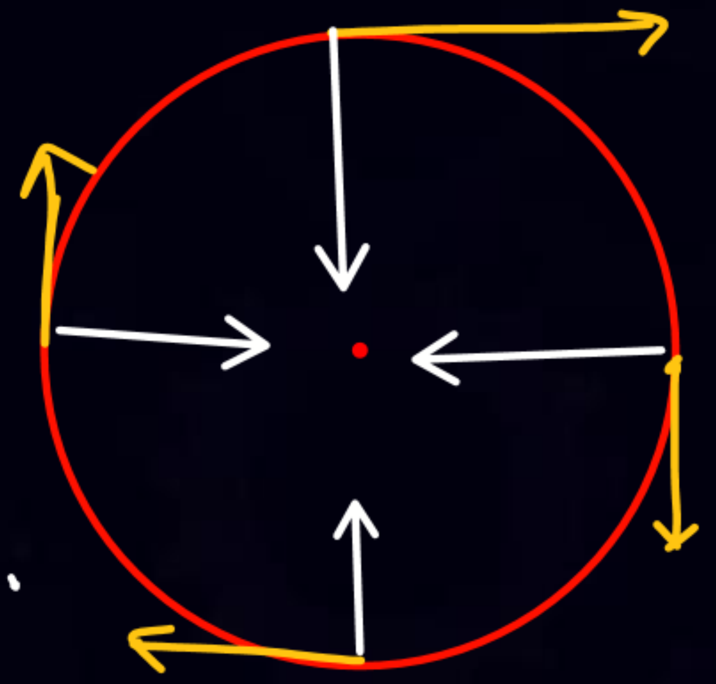
If Uniform Circular motion / Non. Uniform

$\vec{v} \longrightarrow$ change (dirⁿ change)

$\vec{a}_N = \vec{a}_c \longrightarrow$ change (")

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

change



$$x \xrightarrow{\text{Diff}} v \xrightarrow{\text{diff}} a$$

$$\theta \xrightarrow{\text{diff}} \omega \xrightarrow{\text{diff}} \alpha$$

$$x \longrightarrow \theta$$
$$v \longrightarrow \omega$$
$$a \longrightarrow \alpha$$

$$\left.\begin{aligned} v &= u + at \\ s &= ut + \tfrac{1}{2}at^2 \\ v^2 &= u^2 + 2as \end{aligned}\right\} \vec{a} \rightarrow \text{const} \implies \left.\begin{aligned} \omega &= \omega_0 + \alpha t \\ \theta &= \omega_0 t + \tfrac{1}{2}\alpha t^2 \\ \omega^2 &= \omega_0^2 + 2\alpha\theta \end{aligned}\right\} \alpha \rightarrow \text{const}$$

- $(x-t)$ slope $\Longrightarrow v$
- $(v-t)$ slope $\Longrightarrow a_{cc}$
- $(a-t)$ area $\Rightarrow \underline{\Delta \vec{v}}$
- $(v-t)$ area $\Rightarrow$ Displacement

* $(\theta-t)$ slope $\Rightarrow \omega$ देगा

* $(\omega-t)$ slope $\Rightarrow \alpha$ देगा

* $(\alpha-t)$ area $\Rightarrow \Delta\omega$

* $(\omega-t)$ area $\Rightarrow$ angular displacement

If a_{cc} = Const

$$\left.\begin{aligned} v &= u + at \\ s &= ut + \frac{1}{2}at^2 \\ v^2 &= u^2 + 2as \end{aligned}\right\}$$

$x \longrightarrow \theta$

$v \longrightarrow \omega$

$a \longrightarrow \alpha$

$$v = \frac{dx}{dt}$$

$$a = \frac{dv}{dt}$$

If $\alpha \rightarrow$ const

$$\omega = \omega_0 + \alpha t$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega_f^2 = \omega_i^2 + 2\alpha\theta$$

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

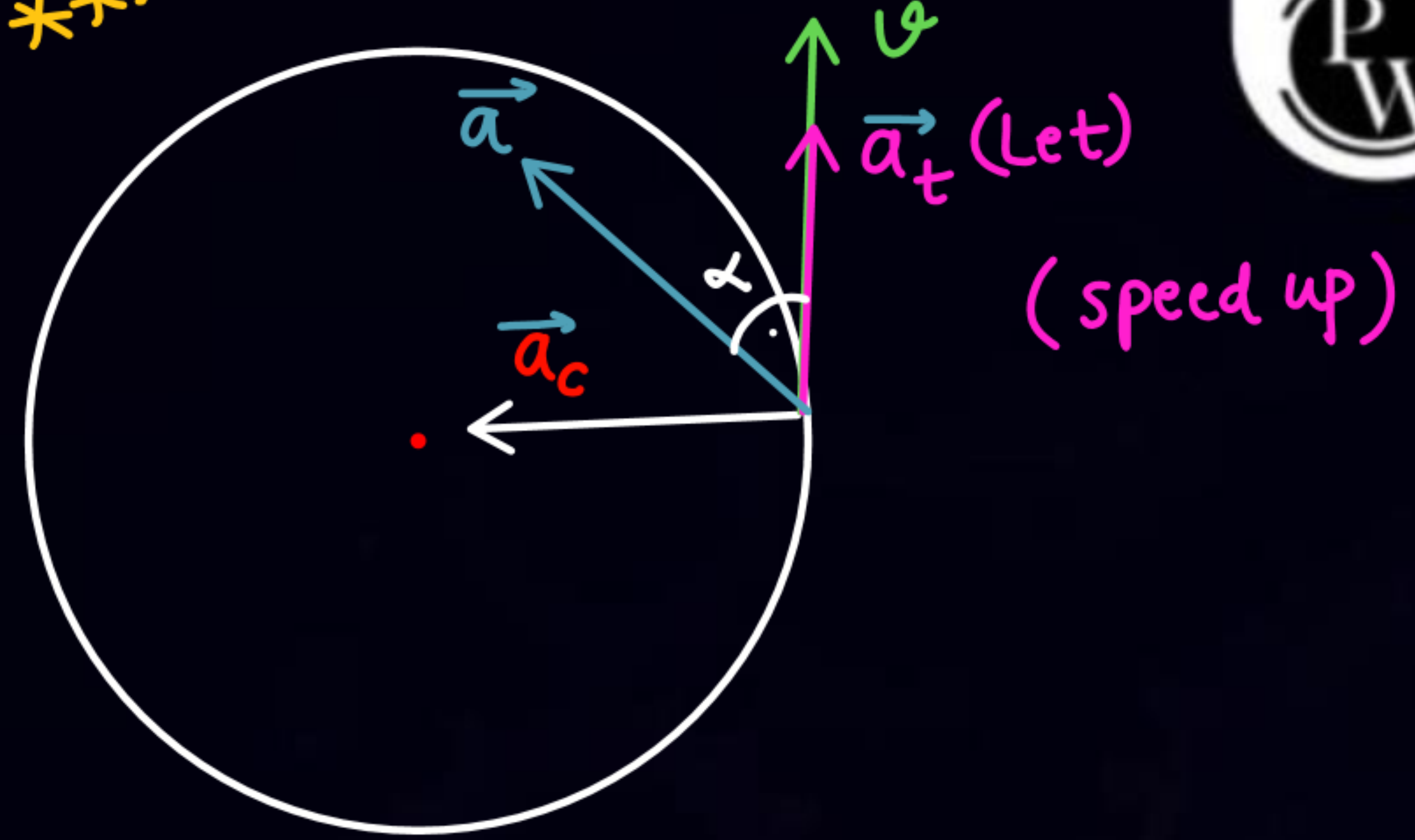
$$\alpha = \frac{d\omega}{dt}$$

- $v = R\omega$ $\xrightarrow{}$ speed
- $a_t = R\alpha$
- $\underbrace{a_c = \frac{v^2}{R}} = R\omega^2 = v\omega$ (towards center)

• Centripital acc $= a_c = \frac{v^2}{R}$ (Towards the center)
  (a_N)

• $\vec{a} = \vec{a}_t + \vec{a}_c = \vec{a}_{net}$

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



Angle b/w $\vec{a}$ & $\vec{v}$ $= \alpha$

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

*** Q A particle start moving in a circular path of radius 8 m. such that its speed $V = 2t^2$. Find

$v = 2t^2$

$t\uparrow, v\uparrow$

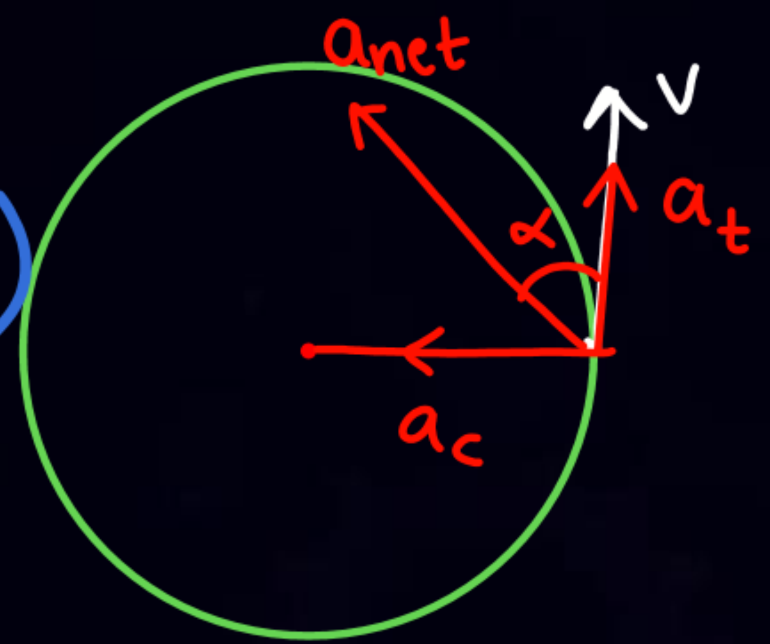
① speed at $t = 2$, $v = 2 \times 2^2 = 8\ m/s$

② Tangential acc. at $t = 2$

(Non Uniform)

$$a_t = \frac{d}{dt}(\text{speed}) = 4t$$

$t = 2$, $a_t = 4 \times 2 = 8$



③ Centripital acc at $t = 2$

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

④ Net acc at $t = 2$ sec.

$$a = \sqrt{a_c^2 + a_t^2} = \sqrt{8^2 + 8^2} = 8\sqrt{2}$$

⑤ Find angle b/w $\vec{v}$ & $\vec{a}$ at $t = 2$ sec.

$$\tan\alpha = \frac{a_c}{a_t} = \frac{8}{8} \Rightarrow \boxed{\alpha = 45^\circ}$$

⑥ ω at $t = 2$ sec

$v = R\omega$

$8 = 8\omega$ $\quad \omega = 1$ rad/se

⑦ α at $t = 2$ sec

$a_t = R\alpha$

$8 = 8 \cdot \alpha$

$\alpha = 1$

***

Q A particle start moving in a circular path of radius 2m such that its speed $v = 4t$ Find

(1) speed at $t = 2$, $v = 4 \times 2 = 8$

(2) Tangential acc. at $t = 2$

$a_t = 4$

(3) Centripital acc at $t = 2$

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

(4) Net acc at $t = 2$ sec.

$a = \sqrt{a_c^2 + a_t^2} = \sqrt{(32)^2 + 4^2} = 4\sqrt{65}$

(5) Find angle b/w $\vec{v}$ & $\vec{a}$ at $t = 2$ sec.

$\tan\alpha = \frac{a_c}{a_t} = \frac{32}{4} = 8$

(6) ω at $t = 2$ sec

$v = R\omega$

$8 = 2\omega$, $\omega = 4$

(7) α at $t = 2$ sec

$a_t = R\alpha$

$4 = 2\alpha$

$\alpha = 2$

Short Q $v = 3t^2$, $R = 4m$

Sol^n

$t = 2 \Rightarrow$ (1) $v = 12$

(2) $a_t = 6t \Rightarrow 12$

(3) $a_c = \frac{v^2}{R} = \frac{(12)^2}{4} = 36$

(4) $a_{net} = \sqrt{36^2 + 12^2} = 12\sqrt{10}$

(5) $\tan\alpha = \frac{a_c}{a_t} = \frac{36}{12} = 3$

$V = R\omega$, $a_t = R\alpha$

(6) $\omega = \frac{V}{R} = \frac{12}{4} = 3$

(7) $\alpha = \frac{a_t}{R} = \frac{12}{4} = 3$

(8) $\omega = f(t)$

$\omega = \frac{V}{R} = \frac{3t^2}{4}$

Q A particle is moving in a circular path of radius 2m such that $\theta = t^3$. find everything.

① ω at $t = 2$

$$\omega = \frac{d\theta}{dt} = 3t^2$$

put $t = 2$, $\omega = 12$

② ~~ω~~ speed $= f(t)$

$$v = R\omega$$

$$v = 2 \times 3t^2 = 6t^2$$

③ α at $t = 2$ sec.

$$\omega = 3t^2$$

$$\alpha = 6t \quad , \; t = 2, \; \alpha = 12$$

④ a_t at $t = 2$ sec

$$a_t = R\alpha = 2 \times 12 = 24$$

⑤ a_c at $t = 2$ sec

$$a_c = R\omega^2 = 2 \times (12)^2 = 288$$

M-2

$\theta = t^3$, $R = 2m$

find everything at $t = 2$

(1) $\omega = \frac{d\theta}{dt} = 3t^2$

(2) $v = R\omega = 2 \times 3t^2 = 6t^2$

$v = 6t^2 \Rightarrow a_t = 12t$

$t = 2$, $v = 24$

$a_t = 12 \times 2 = 24$

$a_c = \frac{v^2}{R} = \frac{(24)^2}{2} = 288$

$$\theta = f(t) \xrightarrow{\text{diff}} \omega = f(t) \xrightarrow{\text{diff}} \alpha$$

$a_c = R\omega^2$

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

$a_t = R\alpha$

$$\omega = f(t) \xrightarrow{v = R\omega} v = R\omega \Rightarrow v = f(t)$$

$v = f(t) \xrightarrow{\text{Diff}} a_t$

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

$\sqrt{a_c^2 + a_t^2}$

Q $\theta = 2t^2$

$R = 2m$

Find $a_t, a_c, \dot{\alpha}, \dot{\omega}, a_{net}$ at $t = 2$ sec

Sol: $\omega = 4t$, $v = R\omega = 8t$

$\alpha = 4$ $\quad$ $a_t = 8$

$t = 2$, $\omega = 8$

$v = 16$

$$a_c = \frac{v^2}{R} = \frac{(16)^2}{2} = 128$$

$$a_t = 8 = R\alpha = 2\alpha$$

$$2\alpha = 8 \Rightarrow \alpha = 4$$

$$a_{net} = \sqrt{(128)^2 + 8^2}$$

Q If a particle start motion in a circular path with initial angular velocity 10 rad/sec (C.W) such that its angular acc is +5 rad/sec² (C.W). find

$\omega_0 = 10$

$\alpha = 5$

① Angular velocity at $t = 4$ sec.

$$\omega = \omega_0 + \alpha t$$

$$= 10 + 5 \times 4 = 30$$

② Angle rotated in four second.

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$= 10 \times 4 + \frac{1}{2} \times 5 \times 4^2 = \underline{80}$$

Home work

- Complete (PYQ JM+ NEET) of NLM till Sunday 17 Aug 2025 Any how.

- HCV → page 72 ⇒ (1 − 10) Dont see sol^n
  - → (Ex. complete NLM) if you have not.

HCV friction → 10, 11, 13, 14, 15, 19, 20

THANK

YOU