YAKEEN NEET 2.0

2026

Motion in a Plane

Physics | **Lecture - 13**

***
x marks + 30 marks

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Topics to be covered

1 # Uniform & Non-uniform circular motion

2

3

4

N.U.C.M. → Not in syllabus given by NTA for NEET.

(Q) Object is Projected from Ground at angle 15° & 45° from Horizontal then its Range R_1 & R_2 respectively

MR Scam.

~~(a) $R_1 > R_2$~~

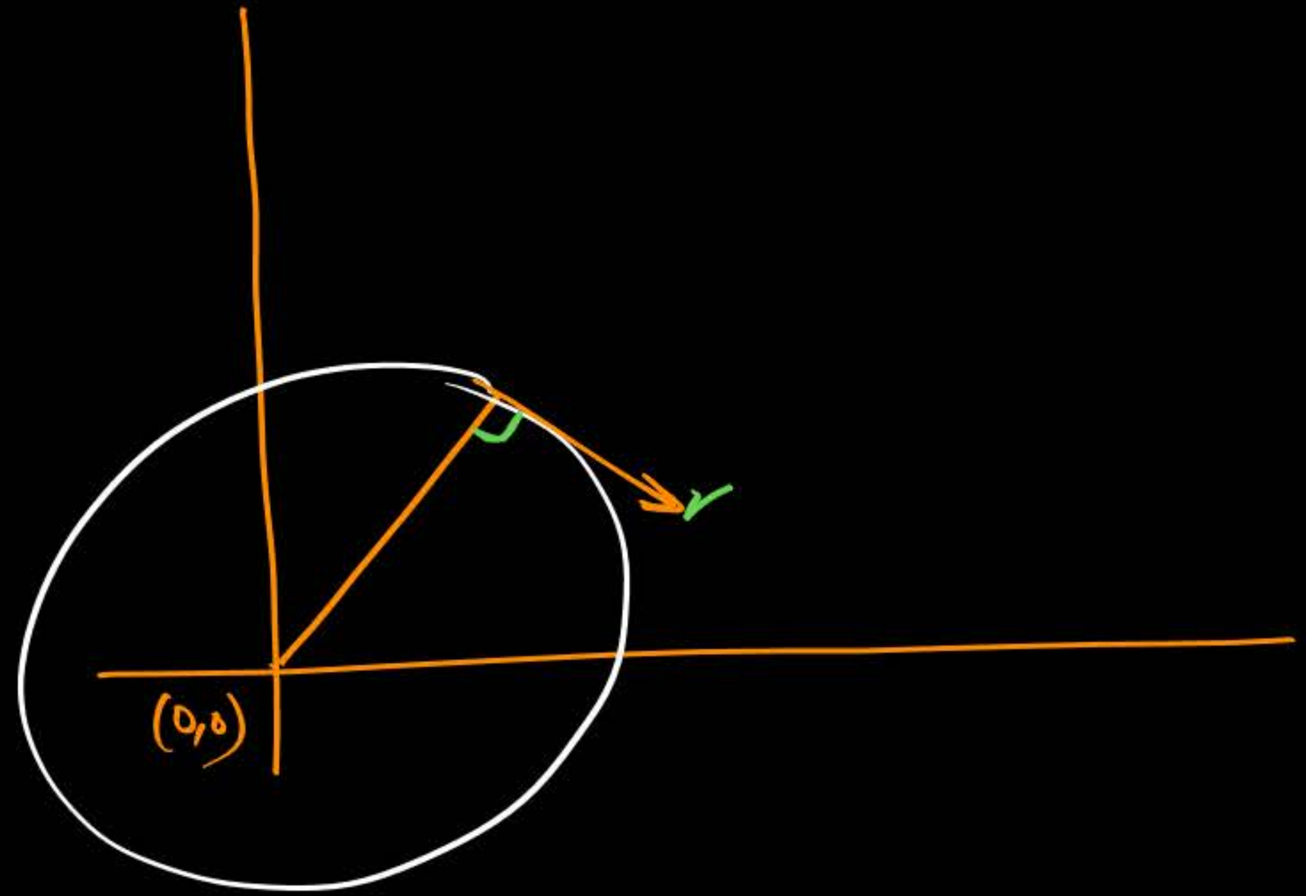
~~(b) $R_1 < R_2$ (71%)~~

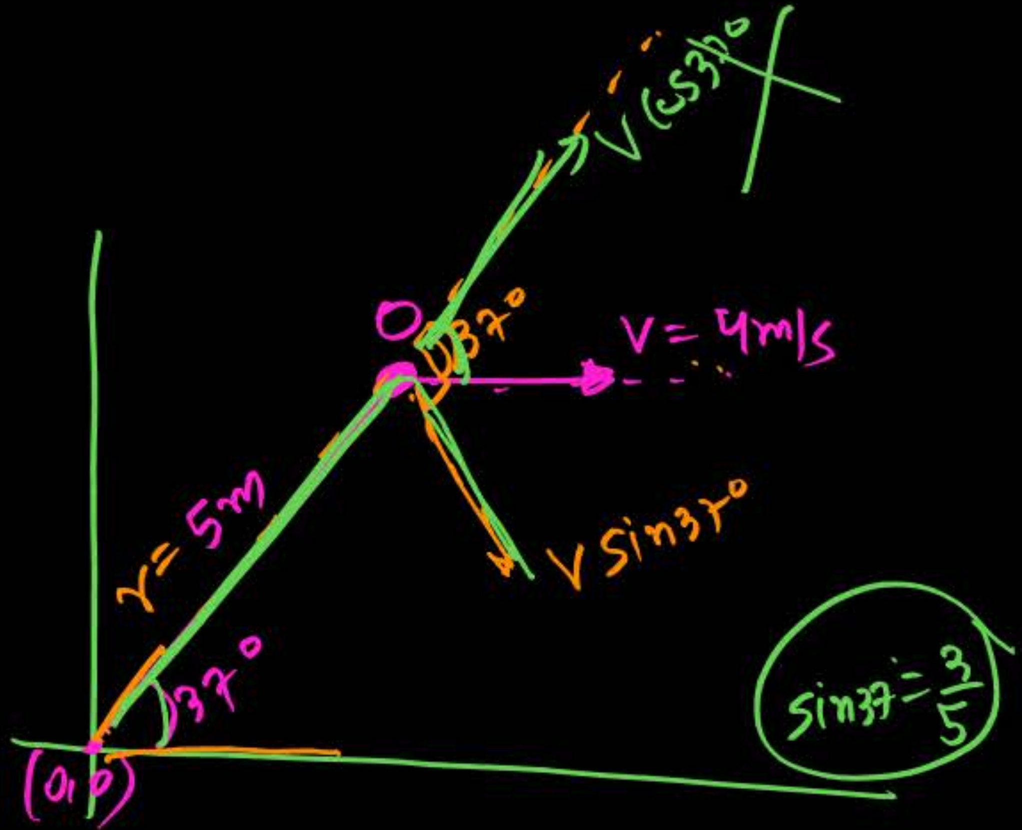
(c) can't say

* Speed is not given.

(Q) Object is Project at angle 60° & 30° from Horizontal from ground.

then Range may be equal





$v = r\omega \rightarrow \omega = \frac{v}{r}$

↑

Correct for circular motⁿ

but for general m.

$$\omega = \frac{V_{\perp r} \text{ to } r}{r\,(\text{radius})}$$

↳ distⁿ b/w reference & object.

Angular speed ??

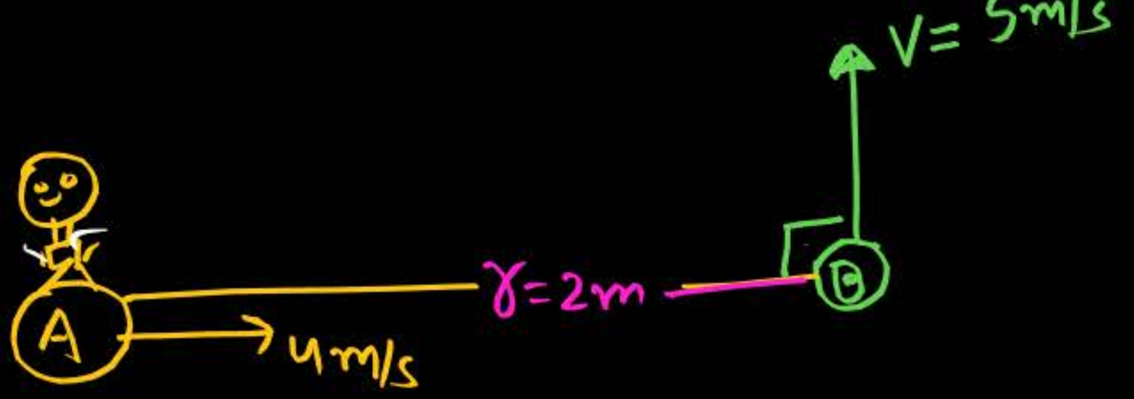
$$\omega = \frac{v\sin 37^\circ}{5}$$

$$= \frac{4\times 3}{5\times 5}$$

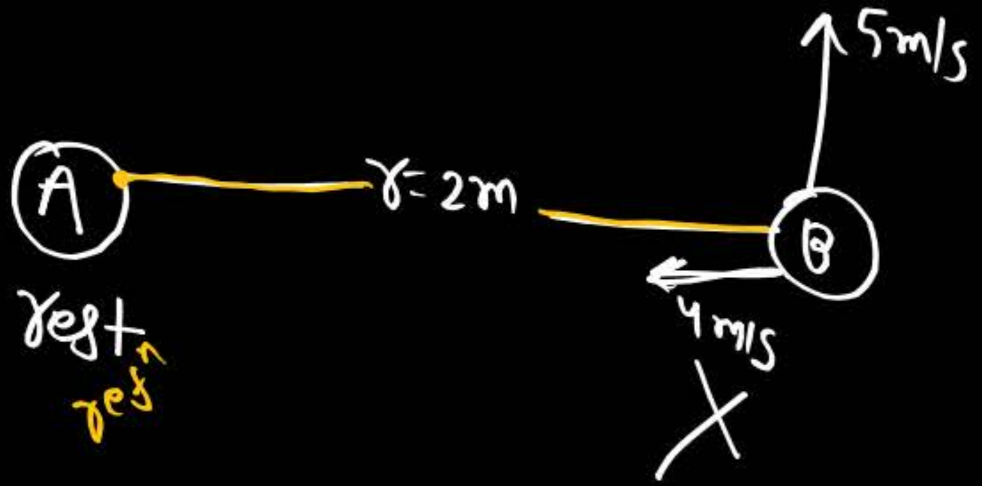
$$= \frac{12}{25} \text{ rad/s}$$

Angular velocity with moving frame :-

1

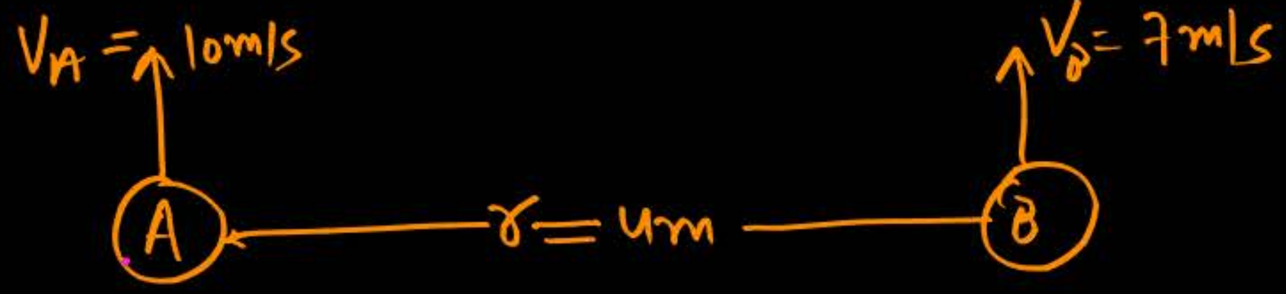


Angular speed (ω) of B w.r.t A

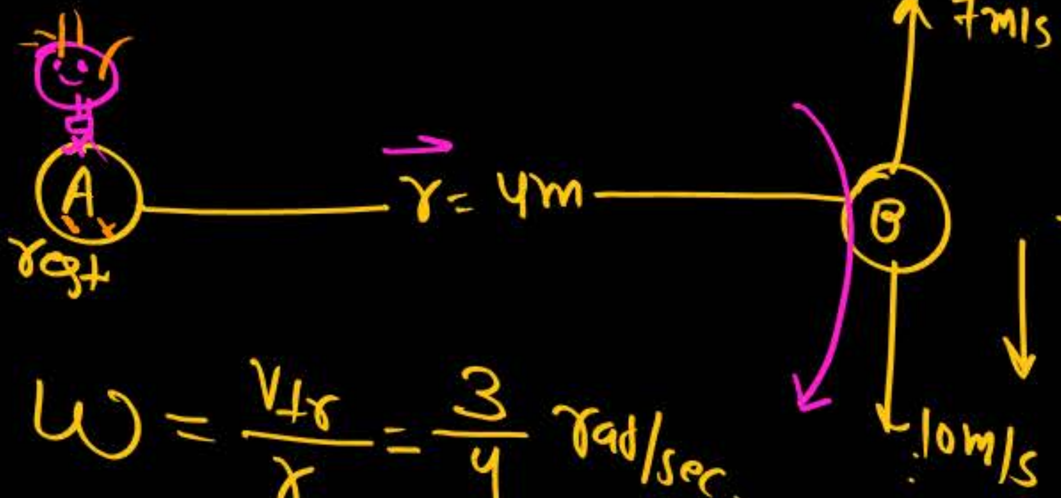


$$\omega = \frac{V_{\perp r\ to\ r}}{r} = \frac{5}{2}\ \text{rad/sec.}$$

(2)



$\omega_{BA} = ??$

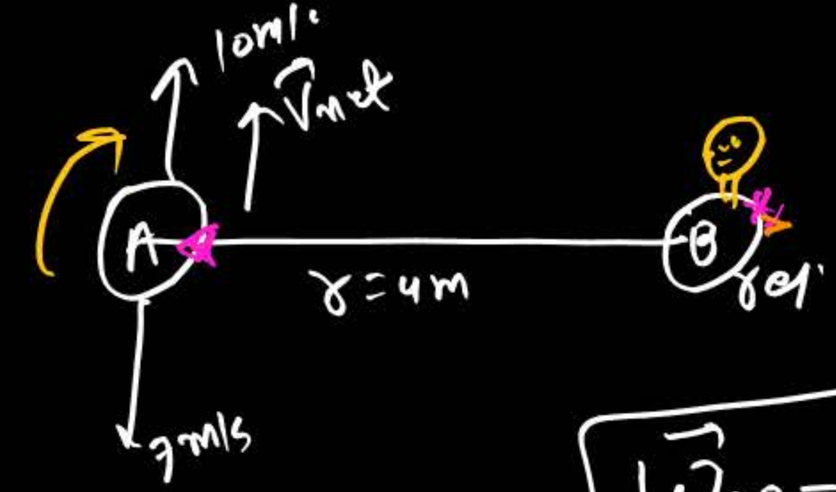


$\vec{v}_{BA} = -3 m/s$

$$\omega = \frac{v_{\perp r}}{r} = \frac{3}{4} \text{ rad/sec.}$$

Clockwis

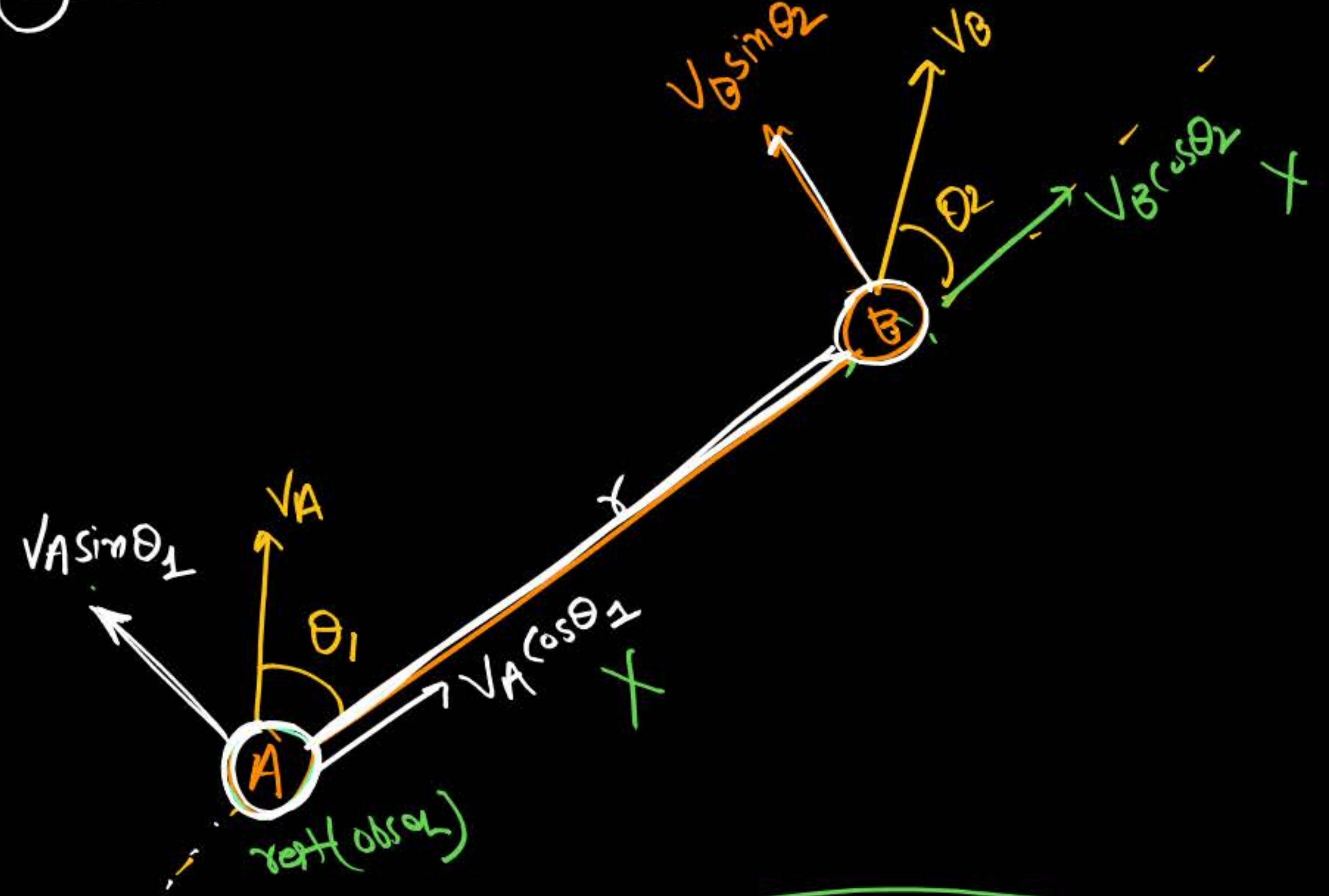
ω_{AB} = ? → observer



$$\boxed{\vec{\omega}_{AB} = \frac{3}{4}}$$

clockw

find Angular velocity of B w.r.t A



$\omega_{BA} = ??$

$$\omega_{BA} = \frac{(\vec{V}_{BA})_{\perp r}}{r}$$

$$\boxed{\omega_{BA} = \frac{V_B \sin\theta_2 - V_A \sin\theta_1}{r}}$$

Ans

* Angular velocity ke liye radius ke along velocity Nahi lete hai

u, a (Tangential)

speed ↑

1-D mot^n without change in dir^n

(straight line Path)

Angle b/w $\vec{u}$ & $\vec{a}$ is $0°$

u, a (Tangential)

speed ↓ and

(1-D) object will take U-turn after some time. (Straight line with U-turn)

Angle b/w $\vec{u}$ & $\vec{a}$ $180°$

u, $90°$, a

a_c = normal or centripetal acc (radial acc^n)

at this inst^n a will change velocity in (2-D) Path

Next chapter

$a_T = a\cos\theta$ (Tangential)

$a_c = a\sin\theta$

Path

$\frac{d\vec{v}}{dt}$ = Rate of change in velocity w.r.t. time = acc^n (Likhna hai)

$\frac{d|\vec{v}|}{dt}$ = Rate of change in (magnitude of velocity) = The rate of change in speed = Tangential acc^n

$\left|\frac{d\vec{v}}{dt}\right|$ = Magnitude of the rate of change in velocity = magnitude of acc^n

$\left|\frac{d\vec{v}}{dt}\right| = |\vec{a}|$ = magnitude of acc^n

~~The rate of change in speed = magnitude of acc~~

For 1-D motion: $\vec{a} = a_T$, $a_c = 0$

component of acc^n along velocity (Tangential acc^n)

Velocity = speed × dir^n

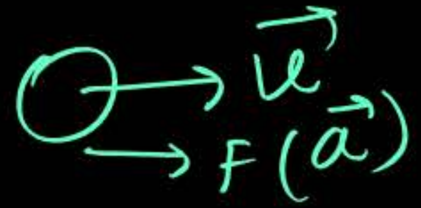
$\frac{d\vec{v}}{dt}$ = acc^n ; $\left|\frac{d\vec{v}}{dt}\right| = |\vec{a}|$ = acc^n ka magnitude

$\frac{d|\vec{v}|}{dt} = a_T$

How many ways to change velocity ??

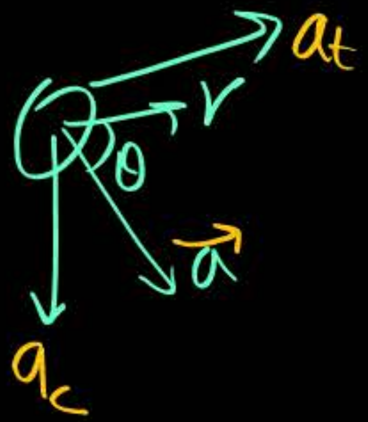
→ Ans ⇒ 3 - ways

\# ① By changiy speed only.



\# ② By changiy dir^n only.

\# ③ By changiy both magnitud & diretin.



Tangential acceleration

→ component of acceleration along line of motion (along velocity or, exactly opposite to velocity)

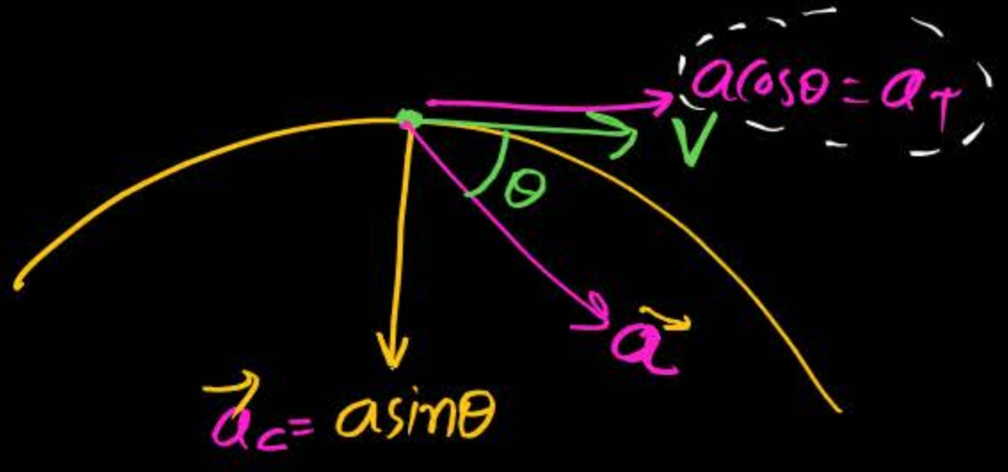
→ Rate of change in speed

$$\vec{a}_t = \frac{d|\vec{V}|}{dt}$$

$$\vec{a}\cdot\vec{v} = va\cos\theta$$

$$a_t = \frac{\vec{a}\cdot\vec{v}}{V}$$

$$\vec{a}_t = a_t\,\hat{a}_t = a_t\,\hat{V} = a_t\,\frac{\vec{V}}{|\vec{V}|}$$



$$\boxed{\vec{a} = \vec{a}_t + \vec{a}_c}$$

$\vec{a}_t \perp r\ \vec{a}_c$

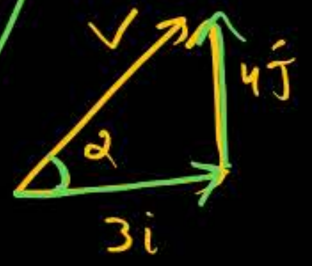
$\vec{a}_c$ (Normal acc^n) = Component of acc^n $\perp r$ to $\vec{V}$.

$$\boxed{\vec{a}_t\cdot\vec{a}_c = \text{zero}}$$

→ ⊥r vectr ka dot Product zero hota hai

Q. Velocity of object at any instant $\boxed{\vec{V} = 3\hat{i} + 4\hat{j}}$ and its acceleration $a = 10\hat{j}$. then find tangential and normal acc^n.

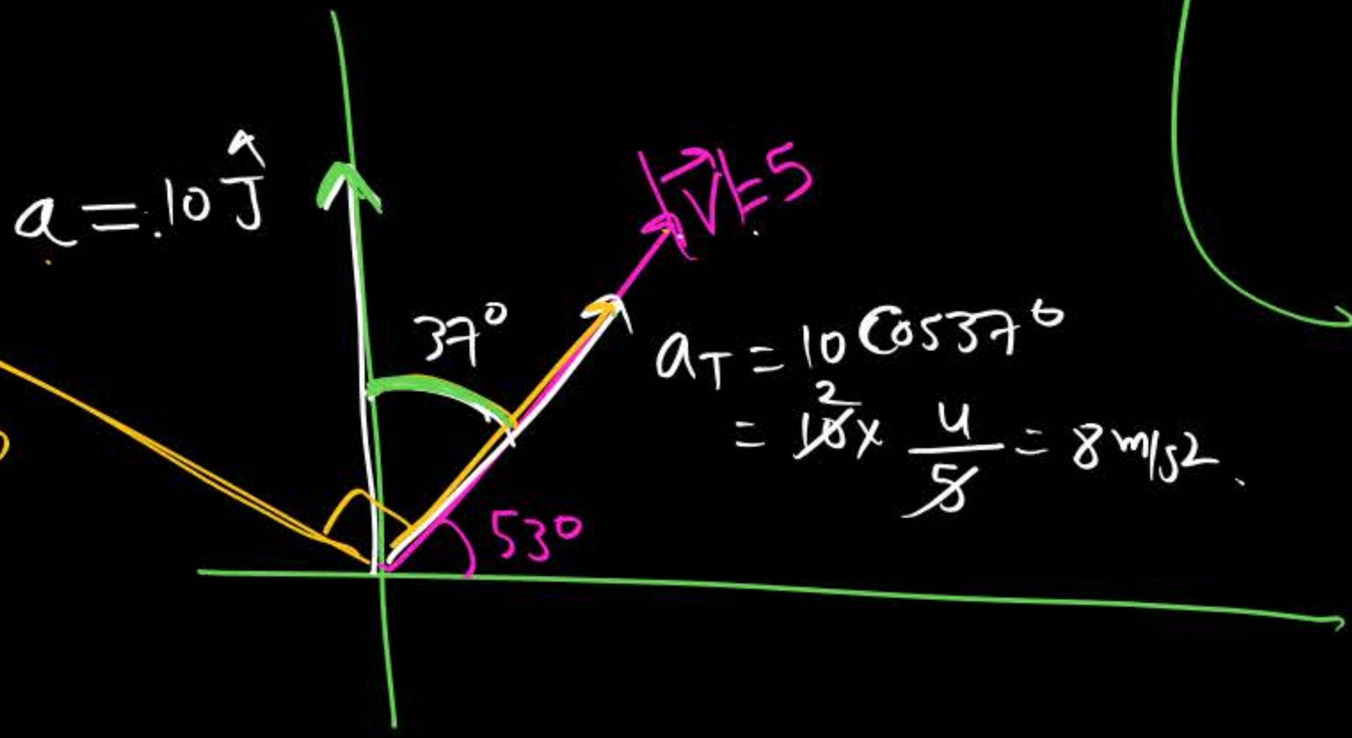
Sol^n 1st method



$\tan\alpha = \frac{4}{3}$ ✓

$\alpha = 53^\circ$

$|\vec{V}| = 5$



$a_T = 10\cos 37^\circ$

$= \cancel{10}^{2} \times \frac{4}{\cancel{5}} = 8\ m/s^2$

$a_c = a\sin 37$

$= \cancel{10}^{2} \times \frac{3}{\cancel{5}}$

$= 6\ m/s^2$

Q. Velocity of object at any instant $\boxed{\vec{v} = 3\hat{i} + 4\hat{j}}$ and its acceleration $a = 10\hat{j}$ then find tangential and Normal acc^n.

2nd method

Sol^n $\vec{a} \cdot \vec{v} = v\,a\cos\theta$

$$a_t = \frac{\vec{a} \cdot \vec{v}}{v}$$

$$= \frac{(10\hat{j}) \cdot (3\hat{i} + 4\hat{j})}{5}$$

dot Product.

$a_t = \frac{0 + 4\cancel{0}}{\cancel{5}} = 8\,m/s^2$

$|\vec{v}| = \sqrt{3^2 + 4^2} = \sqrt{25} = 5$

$\boxed{\vec{a}_c = \vec{a} - \vec{a}_t}$

* $\vec{a} = \vec{a}_t + \vec{a}_c$

$$|a| = \sqrt{a_t^2 + a_c^2 + 2a_t a_c \cancel{\cos 90}}$$

0

$$10 = \sqrt{(8)^2 + a_c^2}$$

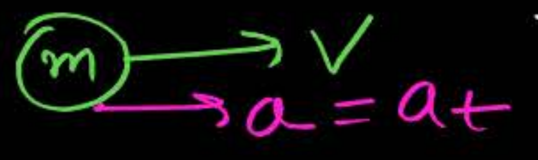
$$(10)^2 = (8)^2 + a_c^2$$

$\rightarrow a_c^2 = 100 - 64$

$a_c^2 = 36$

$a_c = 6\,m/s^2$

1-D motion.

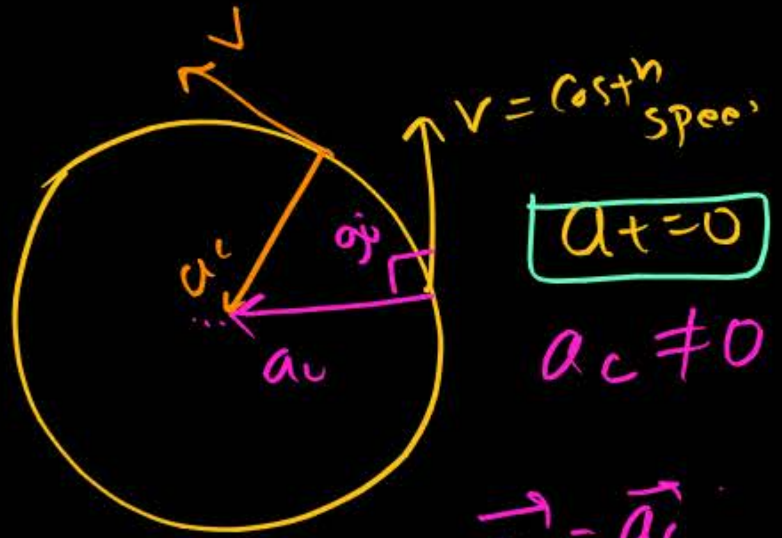


$\boxed{a_c = 0}$

Plane me No change in dirⁿ.

Uniform circular motion.

speed = constⁿ

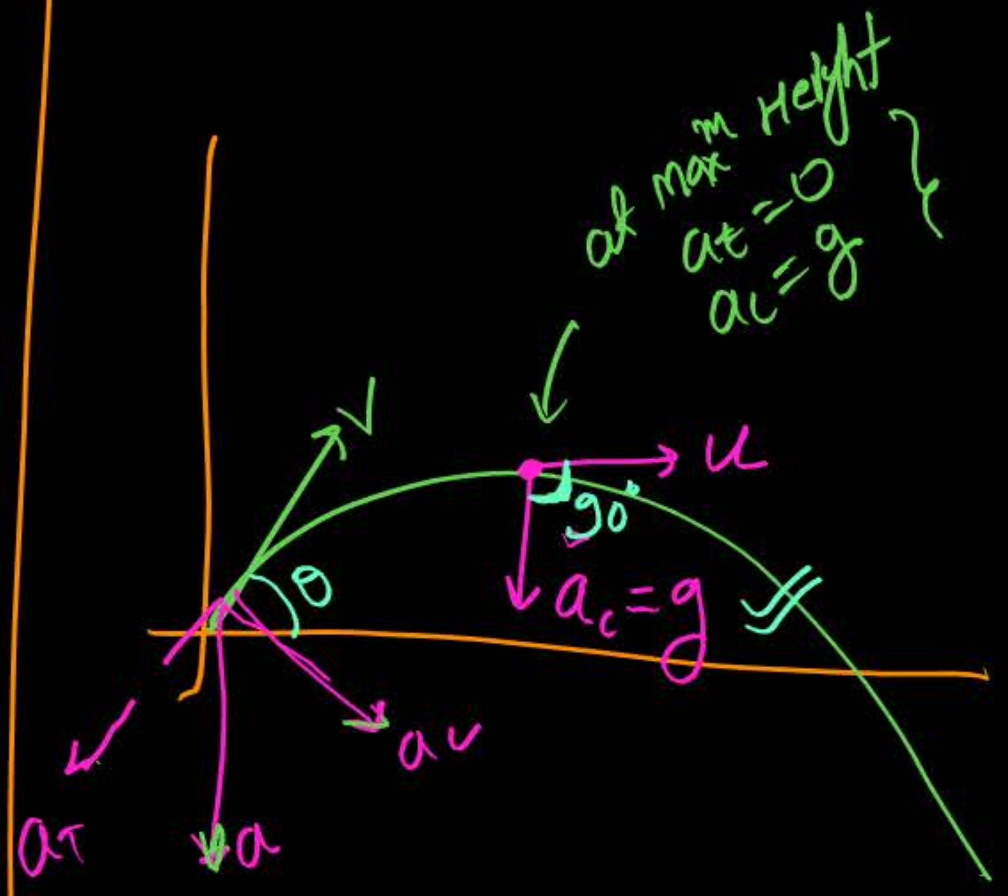


$\boxed{a_t = 0}$

$a_c \neq 0$

$\vec{a} = \vec{a_c}$

Projectile motion

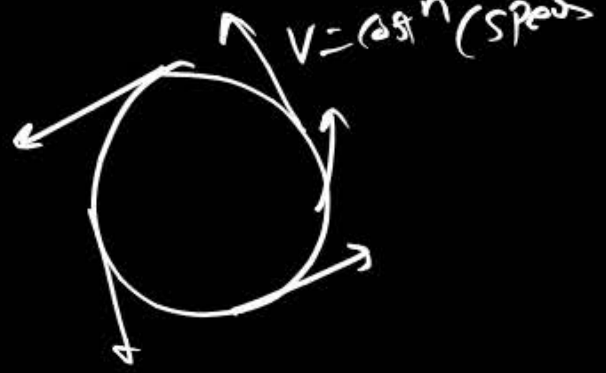


$a_t \neq 0$

$a_c \neq 0$

Angular velocity = cst^n

Uniform circular motion is an example of



~~(a) Uniform Motion~~

(b) Non-uniform motion.

* Uniform Motion

$\hookrightarrow \boxed{\vec{v} = Cost^n}$

Velocity constant.

* Non uniform → Variable velocity

Uniform circular motion. → Non-uniform motion

- Angular velocity = cost^n. ✓
  - → Angular speed = cost^n
    sence of Rot^n is fixed.
- ω = cost^n → $\alpha = 0$ (Angula acc^n)
- liner speed = cost^n → $a_t = 0$ (tangential acc^n)
- Kinentic enegy
  K.E = $\frac{1}{2}$ m (speed)^2 = cot^n.
  → sclar
  $\boxed{\text{Work} = \Delta K.E = 0}$
- direction = Variable $\vec{a}_c \neq 0$
  $\boxed{\text{Power} = \frac{\text{work}}{\text{time}} = 0}$
- $\vec{P}$ (momentum) = $m\vec{v}$ → varible.

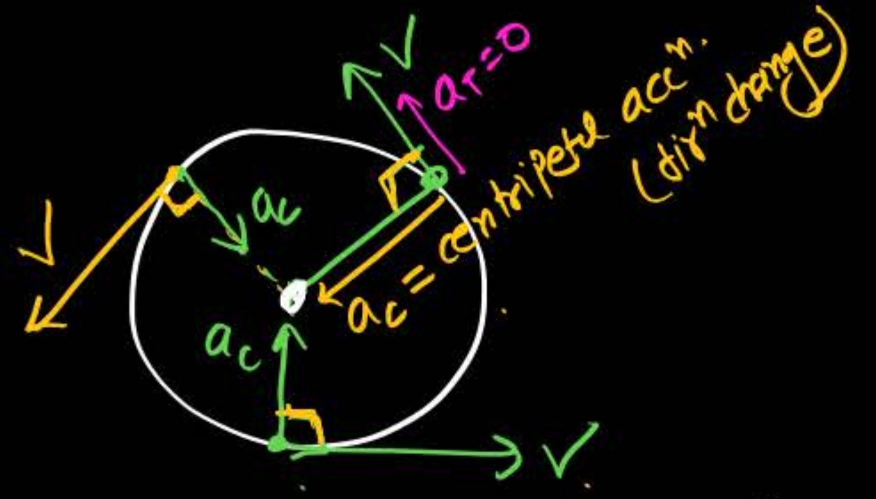
$V = r\omega$

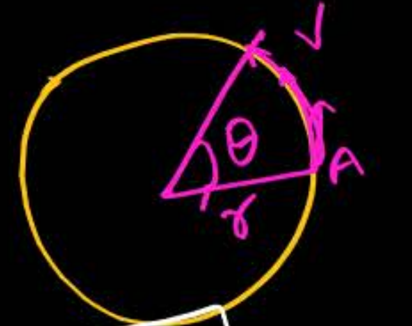
speed $\vec{V}$ cot^n

$$\underbrace{\vec{V} = \vec{\omega} \times \vec{r}}$$

$$\vec{a} = \cancel{\vec{a}_t}^{\,0} + \vec{a}_c$$

\# $\boxed{\vec{a} = \vec{a}_c}$





\# $\boxed{\text{dist}^n = \text{Arc} = r\theta}$

diff^n w.r.t. time

$$\frac{d(\text{dist}^n)}{dt} = r\frac{d\theta}{dt}$$ for circular mot^n

$\boxed{\text{speed} = r\omega}$

diff^n w.r.t time

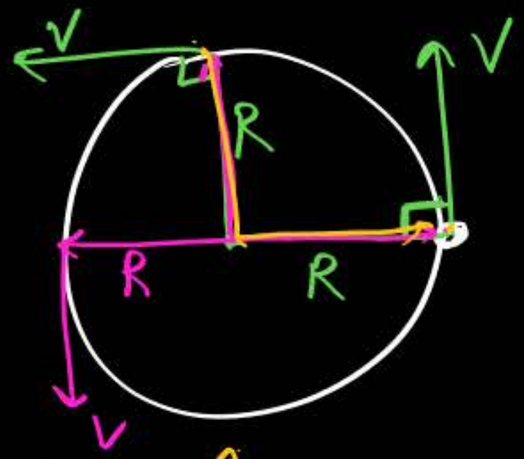
$$\frac{d(\text{speed})}{dt} = r\frac{d\omega}{dt}$$

\# $\boxed{a_t = r\alpha}$ ✓

Wrong ~~$\boxed{\text{acc}^n = r\alpha}$~~

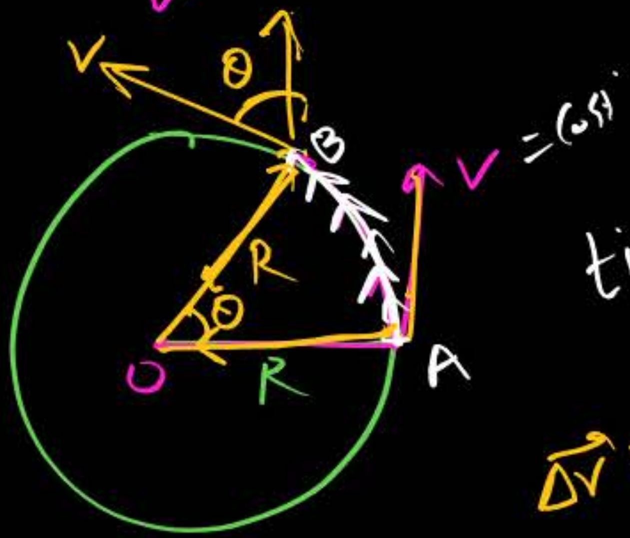
Acceleration in uniform circular motion

$$\text{Avg acc}^n = \frac{\vec{v_f} - \vec{v_i}}{\Delta t}$$



$$\text{Avg acc}^n = \frac{2v\sin(\theta/2)}{R\cancel{\theta}/v}$$

$$= \frac{v^2 \sin(\theta/2)}{R\,\theta/2}$$



$$\text{time}_{AB} = \frac{R\theta}{V}$$

$\vec{\Delta v} = \vec{v_f} - \vec{v_i}$ (magnitude of velocity is same)

$= 2v\sin(\theta/2)$ vector subtraction of two vector of same magnitude.

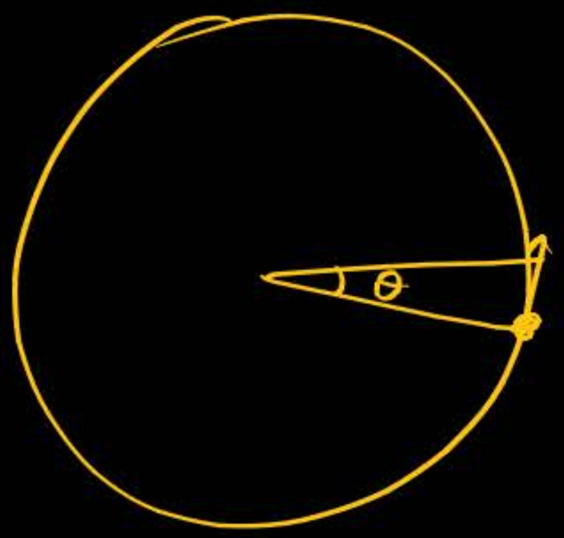
*

$$\boxed{\text{Avg acc}^n = \left(\frac{v^2}{R}\right) \times \frac{\sin(\theta/2)}{\theta/2}}$$

Uniform circula mot^n $\boxed{a_t = 0}$ ✓

$$\vec{a}_{Avg} = \vec{a}_{c(Avg)}.$$

If $\theta \rightarrow$ small. Angle



$$\vec{a}_{c\,Avg} = \frac{v^2}{R}\,\frac{\sin\theta/2}{\theta/2}$$

$$\lim_{\theta \to 0} \vec{a}_{c\,Avg} = \frac{v^2}{R}\left(\frac{\sin\theta/2}{\theta/2}\right) \rightarrow 1$$

small

$$\boxed{\vec{a}_{c\,instan} = \frac{v^2}{R}}$$

$$\boxed{\begin{array}{c} \sin\theta = \theta \\ \theta \rightarrow \text{small} \\ \lim_{\theta \to \text{small}} \frac{\sin\theta}{\theta} = \frac{\cancel{\theta}}{\cancel{\theta}} = 1 \end{array}}$$

Instantaneous centripetal acc^n

$$\vec{a}_{c\,inst} = \frac{v^2}{R} \leftarrow \text{Radial}$$

$$\boxed{\vec{a}_{cent} = \omega^2 R}$$

$V = R\omega$

Non-uniform circular motion.

Angular Speed varible. $\longrightarrow \alpha \neq 0$

lineaR speed = varible $\longrightarrow \underbrace{a_t \neq 0}$

$\boxed{V = R\omega}$

Variable, Cst^n, Varible

dir^n → changing $\longrightarrow \vec{a}_c \neq 0$

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

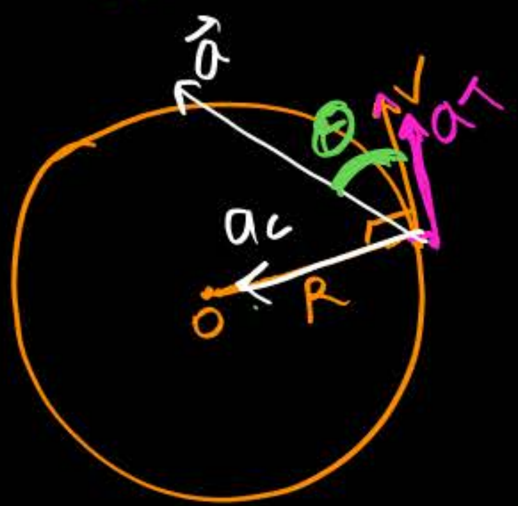
K.E → varible

Work $\neq 0$

PoweR $\neq 0$

Moment → varible

Speed ↑



θ (Angle B/w $\vec{V}$ & $\vec{a}$) $< 90°$

$$\vec{a} = \vec{a}_T + \vec{a}_c$$

$\boxed{\vec{a} \cdot \vec{V} = +ve}$ ← Nature

speed ↑

$$|a| = \sqrt{a_c^2 + a_T^2}$$

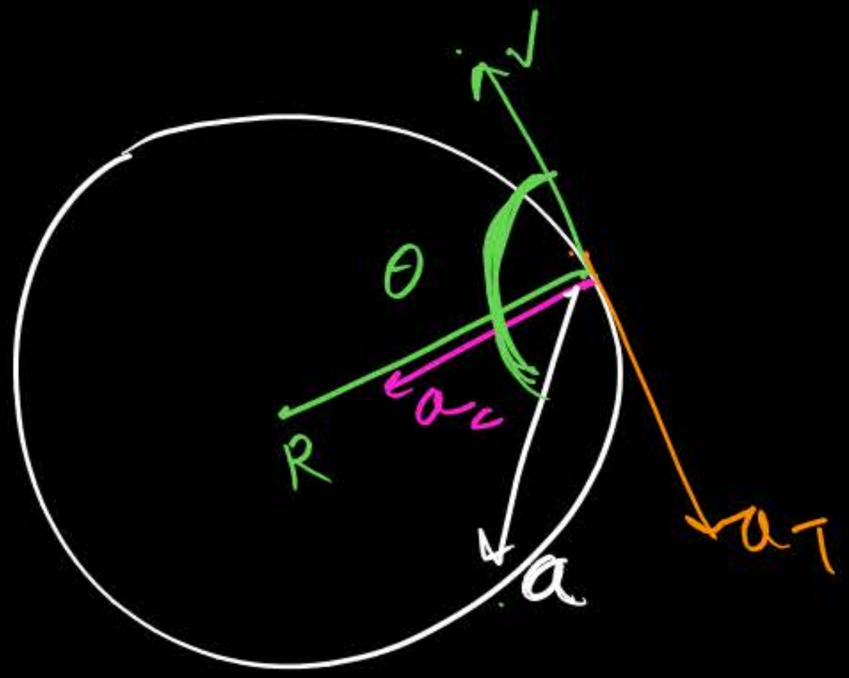
$$|\vec{a}_T| = r\alpha \quad \text{— (I)}$$

$$|\vec{a}_c| = V^2/R \quad \text{— (II)}$$

$\boxed{\vec{a} \cdot \vec{V} = 0}$ speed = Cst^n

uniform circular mot^n

$\vec{a} \perp r \vec{V}$



Speed ↓

θ (Angle b/w $\vec{v}$ & $\vec{a}$) > 90°

$\vec{v} \cdot \vec{a} = -ve$

Speed ↓

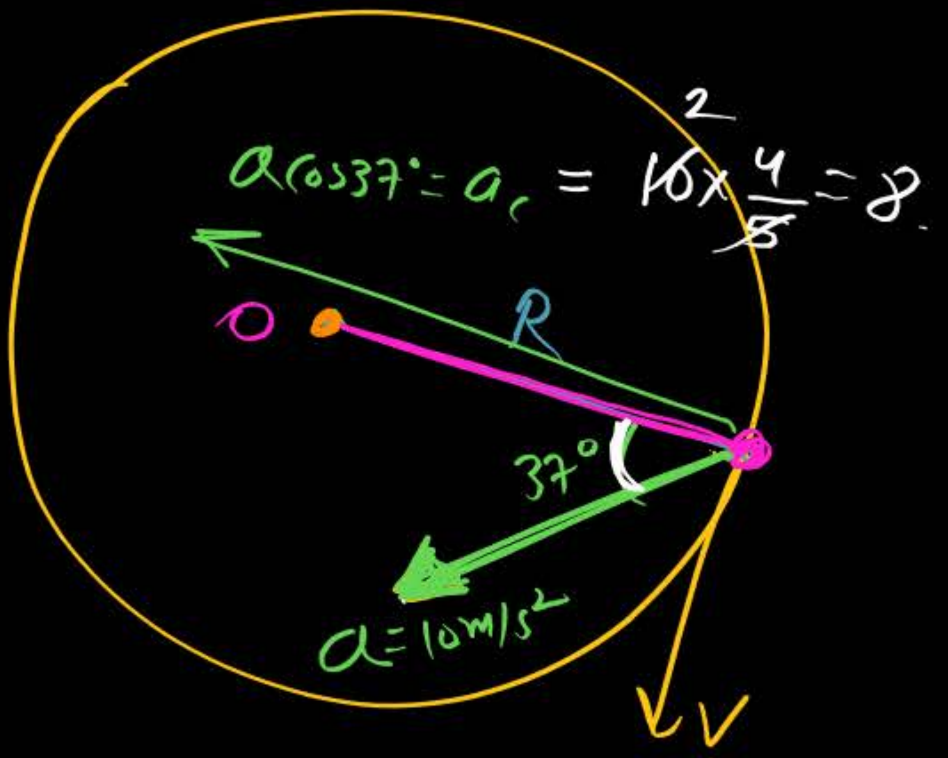
for circular motion a_c must be present

$a_T = r\alpha$

$a_c = v^2/R$

$\boxed{\vec{a} = \vec{a_T} + \vec{a_c}}$

Q find a_T and a_T for given circul motn



$a_T = a \sin 37°$

$= \cancel{10}^{2} \times \frac{3}{\cancel{5}}$

$\boxed{a_T = 6\,m/s^2}$

MR* Box

① question me given deta se find karo motion U.C.M ya N.U.C.M hai.

② If U.C.M.

then $a_t = 0$

$\vec{a} = \vec{a}_c = v^2/R$

* $\omega = \text{costn}$

③ NUCM.

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

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

$a_t = R\alpha$ $a_c = v^2/R$

u

Question

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

$$\frac{d\omega}{dt} = \alpha = 6 - 2t$$

$$\text{If } \alpha = 0 = 6 - 2t$$

$$6 = 2t$$

$$t = 3 \text{ sec}$$

Question

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

[redacted]

$$\omega = 2\pi f$$

$$= 2\pi \times 140$$

$$= 280\pi$$

$$\omega = \frac{n(2\pi)}{T} = \frac{140 \times (2\pi)}{}$$

$$= \frac{\overset{20}{\cancel{140}} \times 2 \times 22}{\cancel{7}}$$

$$= 40 \times 22$$

$$= 880 \text{ rad/s}$$

Question

A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is

1. 15 m/s^2
2. 25 m/s^2
3. 36 m/s^2
4. 5 m/s^2 ✓

U.C.M.

$a_t = 0$

$T = 0.2\pi$

$a = a_c = \omega^2 R$

$= \left(\frac{2\pi}{T}\right)^2 R$ ✓

Question

centripetal (Normal)

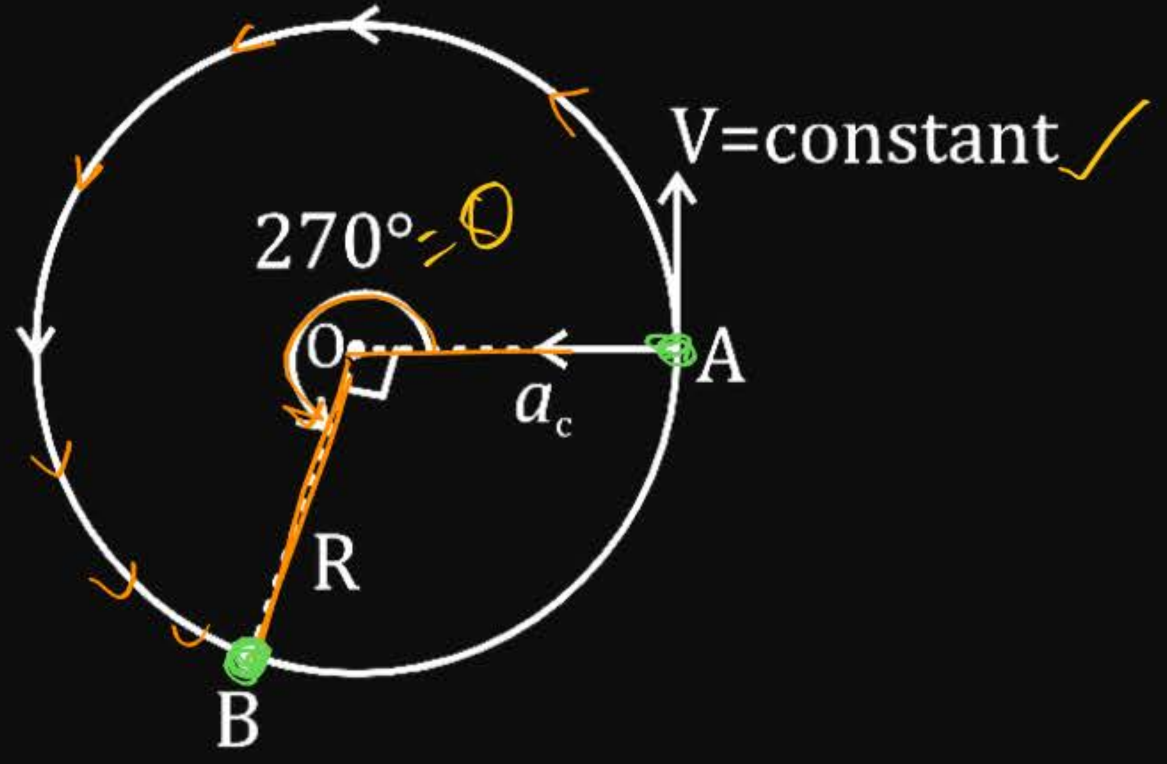
a_r and a_t represent radial and tangential acceleration. The motion of a particle will be uniform circular motion if:

1. $a_r = 0$ and $a_t = 0$
2. $a_r = 0$ but $a_t \neq 0$
3. $a_r \neq 0$ but $a_t = 0$ Ans
4. $a_r \neq 0$ and $a_t \neq 0$

Question

Find average acceleration between A and B. (UCM)

[AIPMT-2015]

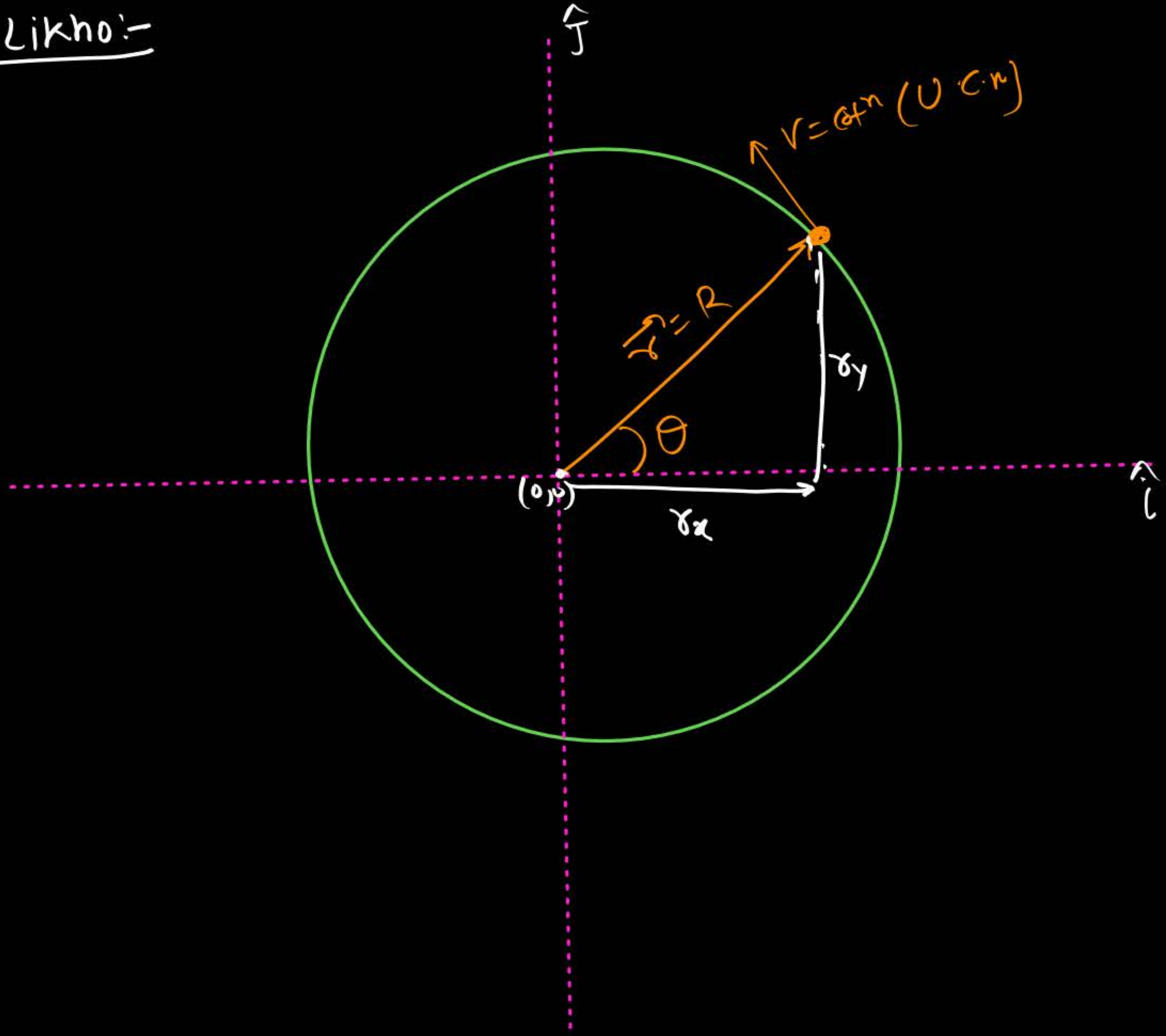


$a_t = 0$

$$\vec{a}_{c_{Avg}} = \frac{V^2}{R}\,\frac{\sin\theta/2}{\theta/2}$$

$$\theta = 270° = \cancel{270}^{3} \times \frac{\pi}{\cancel{180}_{2}} = \frac{3\pi}{2}\ \text{rad}$$

H/w Likho:-



write down Position, velocity in vector form)

$$\vec{r} = r_x\hat{i} + r_y\hat{j}$$

↳ diff^n (find $\vec{v}$)

Question Likho (u|ω)

Find angular speed of hr. hand.

Question

H/w Nahi likhna.

An object moving in a circular path at constant speed has constant

1. Energy
2. Velocity
3. Acceleration
4. Displacement

Question

H/W (Nahi likhna)

The angle between velocity vector and acceleration vector in uniform circular motion is:

1. $0°$
2. $180°$
3. $90°$
4. $45°$

Question Likha hai (H|w)

Two cyclists cycle along circular tracks of radii R_1 and R_2 at uniform rates. If both of them take same time to complete one revolution, then their angular speeds are in the ratio

1. $R_1 : R_2$
2. $R_2 : R$
3. $1 : 1$
4. $R_1R_2 : 1$

Question

H/w likha hai

Centripetal acceleration of a cyclist completing acceleration of a cyclist completing 7 rounds in a minute along a circular track of radius 5 m with a constant speed, is

UCM

$a_t = 0$

1. $2.7\ m/s^2$
2. $4\ m/s^2$
3. $3.78\ m/s^2$
4. $6\ m/s^2$

Question Likho HW

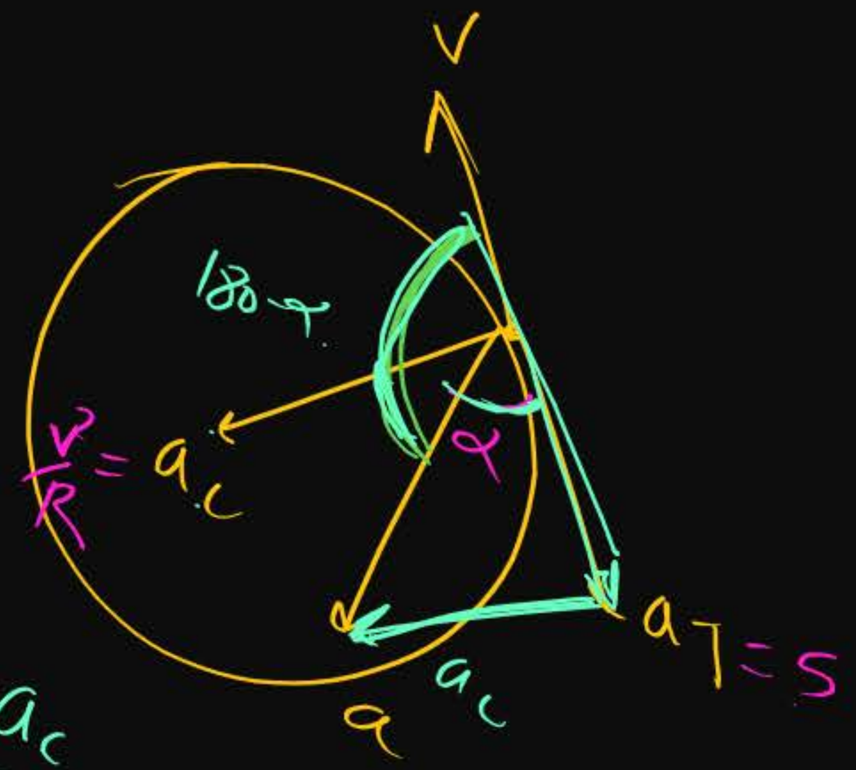
A body is moving on a circle of radius 80 m with a speed 20 m/s which is decreasing at the rate 5 m/s^2 at an instant. The angle made by its acceleration with its velocity is

1. 45°
2. 90°
3. 135°
4. 0°

Speed ↓

$\boxed{a_t = 5\ m/s^2}$

→ N.U.C.M



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

find α.

Question

A car is moving at a speed of 40 m/s on a circular track of radius 400 m. This speed is increasing at the rate of $3\ m/s^2$. The acceleration of car is

1. $4\ m/s^2$
2. $7\ m/s^2$
3. $5\ m/s^2$
4. $3\ m/s^2$

$a_t = 3\ m/s^2$ (NUC.M)

$a_c = v^2/R = \frac{40 \times 40}{400} = 4$

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

Question

H/w (Nahi likna hai)

A car is going round a circle of radius R_1 with constant speed. Another car is going round a circle of radius R_2 with constant speed. If both of them take same time to complete the circles, the ratio of their angular speeds and linear speeds will be

1. $\sqrt{\frac{R_1}{R_2}}, \frac{R_1}{R_2}$

2. $1, 1$

3. $1, \frac{R_1}{R_2}$

4. $\frac{R_1}{R_2}$

Question H|w (Nahi likhna)

If θ is angle between the velocity and acceleration of a particle moving on a circular path with decreasing speed, then

1. $\theta = 90^\circ$
2. $0^\circ < \theta < 90^\circ$
3. $90^\circ < \theta < 180^\circ$
4. $0^\circ \leq \theta \leq 180^\circ$

Question

Likho H/W

The distance of a particle moving on a circle of radius 12 m measured from a fixed point on the circle and measured along the circle is given by $s = 2t^3$ (in meters). The ratio of its tangential to centripetal acceleration at

1. $4 : 1$
2. $1 : 2$
3. $2 : 1$
4. $3 : 1$

Question H/w (Likno)

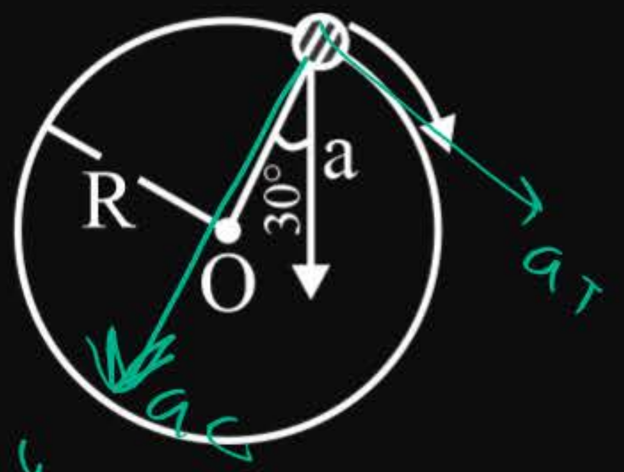
A motor car is travelling at 30 m/sec on a circular road of radius 500 m. It is increasing its speed at the rate of 2.0 ms^{-2}. The total acceleration is:

1. 1.8 ms^{-2}
2. 2 ms^{-2}
3. 3.8 ms^{-2}
4. 2.7 ms^{-2}

Question

In the given figure, $a = 15\ \mathrm{m\ s^{-2}}$ represents the total acceleration of a particle moving in the clockwise direction in a circle of radius $R = 2.5$ m at a given instant of time. The speed of the particle is

N.U.C.M



$a\cos 30 = \frac{v^2}{R}$

hint

1. $4.5\ \mathrm{m\ s^{-1}}$
2. $5.0\ \mathrm{m\ s^{-1}}$
3. $5.7\ \mathrm{m\ s^{-1}}$
4. $6.2\ \mathrm{m\ s^{-1}}$

Question H/w (Likho)

A car moves on a circular path such that its speed is given by $v = Kt$, where K = constant and t is time. Also given: radius of the circular path is r. The net acceleration of the car at time twill be

1. $\sqrt{K^2 + \left(\frac{K^2t^2}{r}\right)^2}$
2. $2K$
3. K
4. $\sqrt{K^2 + K^2t^2}$

Question

Likho (H/w)

If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where θ is in radians and t in seconds, then the angular velocity of the particle after 2s from its start is:-

1. 8 rad/s
2. 12 rad/s
3. 24 rad/s
4. 36 rad/s

Question

Likho (H/w)

A particle starting from rest, moves in a circle of radius 'r'. It attains a velocity of V_0 m/s in the n^{th} round. Its angular acceleration will be

1. $\frac{V_0}{n}$ rad/s^2

2. $\frac{V_0}{2\pi n r^2}$ rad/s^2

3. $\frac{V_0^2}{4\pi n r^2}$ rad/s^2

4. $\frac{V_0^2}{4\pi n r}$ rad/s^2

Question

Likho (H/W)

A particle moves along a circle of radius $(20/\pi)$ m with constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

1. $40\ m/s^2$
2. $640\pi\ m/s^2$
3. $160\pi\ m/s^2$
4. $40\pi\ m/s^2$

Must Try all HOME-WORK given in PPT.

Jisme likhne bola hai wahi Sirf Notes me add Karo

THANK YOU