LAKSHYA

MHTCET 2025

Physics

Lecture - 01

Rotational Dynamics

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Topics *to be covered*

1. Introduction ✓
2. Angular Displacement ✓
3. Angular Velocity ✓
4. Angular Acceleration ✓

Topics

to be covered

5 Uniform Circular Motion ✓

6 Non Uniform Circular Motion ✓

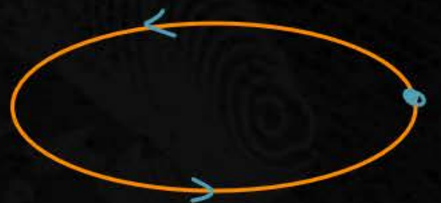
Introduction

For Board : 5-7. Marks

For MHTCET : 3-4 Que.

- Circular Motion.

When an object move along the circumference of circle it is c/a circular Motion.



Revolution :

When object moving around the axis.

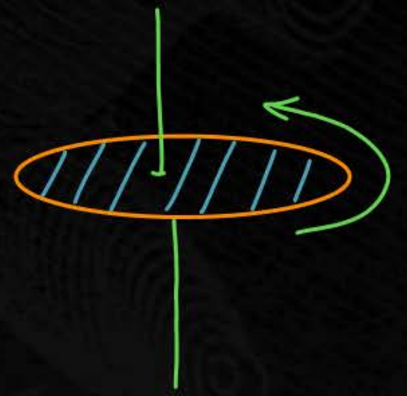
which is not passing through that object

Such a motion is c/a **Revolution**

e.g Motion of moon around earth.

Rotation :

When an object moves around an axis which pass through that object itself. Such a motion is c/a **Rotational Motion**.



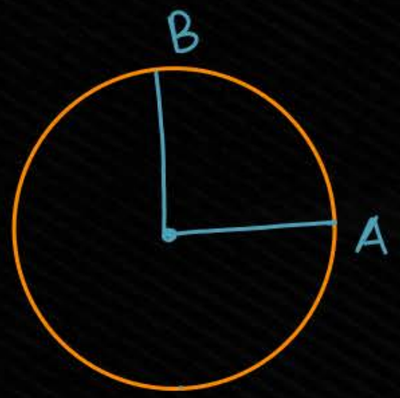
Angular Displacement

Angle traced by radius vector of a particle performing circular Motion at the center of circle is c/a **Angular Displacement** (θ).

It's unit is degree / radian.

eg :

1)



$\theta = l$.

a) 0° c) 180°

~~b)~~ 90° d) 360°

2)

$\theta = l$.

$\theta = 180^\circ$

$360^\circ = 2\pi^c$

$180^\circ = \pi^c$

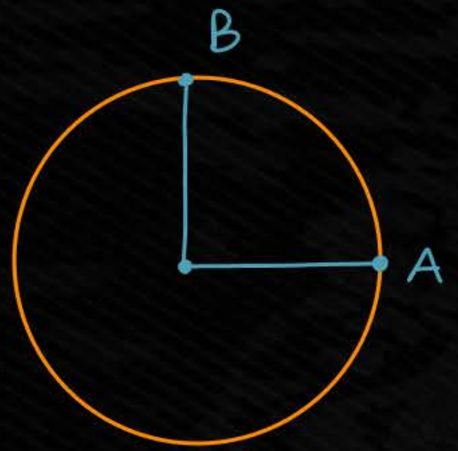
$90^\circ = \pi/2^c$

$60^\circ = \pi/3^c$

$45^\circ = \pi/4^c$

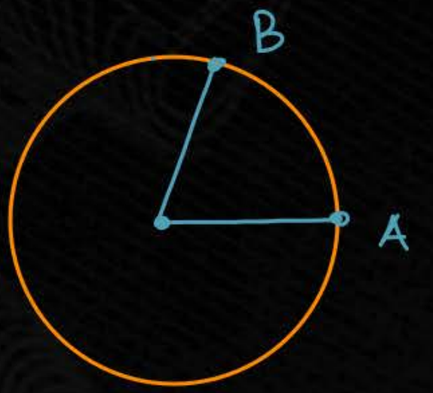
$30^\circ = \pi/6^c$

1)



$\theta = \pi/2^c$

2)



$\theta = \pi/3$

Conversion of Degree to Radian:

1) $270^\circ = \cancel{270}^{3} \times \frac{\pi}{\cancel{180}_{2}} = \frac{3\pi}{2}^{c}$

2) $60^\circ = \cancel{60} \times \frac{\pi}{\cancel{180}_{3}} = \pi/_{3}^{c}$

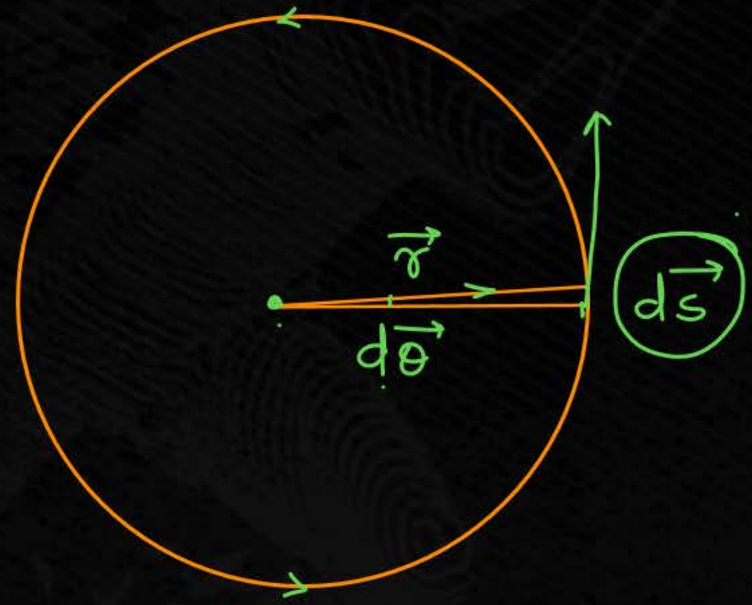
Conversion of Radian to Degree:

1) $\pi/_{2}^{c} = \frac{\cancel{180}^{90}}{\cancel{\pi}} \times \cancel{\pi}/_{2} = 90^\circ$

2) $\pi/_{3} = \cancel{\pi}/_{\cancel{3}} \times \frac{\overset{60}{\cancel{180}}}{\cancel{\pi}} = 60^\circ$

Relation Betⁿ Linear & Angular Displacement

$$\vec{ds} = \vec{d\theta} \times \vec{r}$$

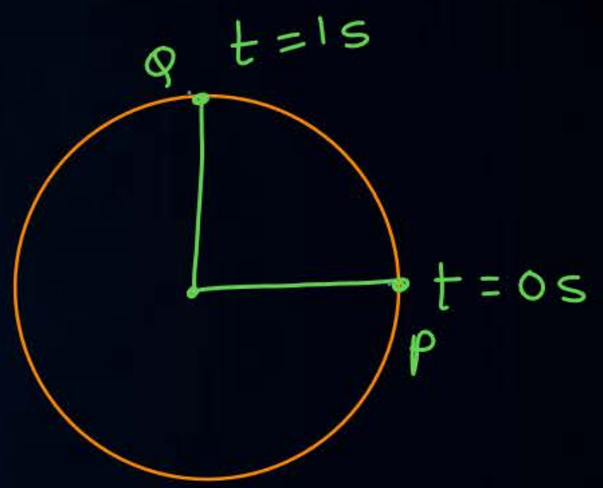


∴ Angular displacement is dimensionless.

Angular Velocity

It is defined time rate of change of angular displacement is c/a Angular Velocity (ω)

Unit : rad/s or degree/s.



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

1) if object completes 5 revolutions in 5 seconds then $\omega = ?$

$\Rightarrow$ 1 revoln $= 2\pi$ rad.

5 revoln $= 5 \times 2\pi = 10\pi$ rad.

$$\omega = \frac{\theta}{t} = \frac{10\pi}{5} = 2\pi \text{ rad/s} \;/\; 360^\circ/\text{s}.$$

Angular Acceleration

It is defined as time rate of change of angular velocity is c/a Angular Acc^{n} (α)

$$\vec{\alpha} = \frac{\vec{\omega}_2 - \vec{\omega}_1}{t} = \frac{\vec{d\omega}}{dt}.$$

e.g:

1) if $\omega_0 = \pi$ rad/s

$\alpha = \pi/2$ rad/s^2

$t = 2$ s

$\omega = ?$

a) 0 rad/s c) π rad/s

b) $\pi/2$ rad/s d) 2π rad/s

$$\alpha = \frac{\omega_2 - \omega_1}{t}$$

$$\omega_2 = \alpha t + \omega_1$$

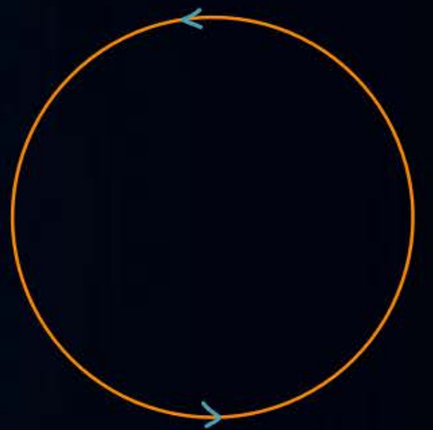
$$\omega = \omega_0 + \alpha t$$

$$\omega = \pi + \pi/2 \times 2$$

$$\boxed{\omega = 2\pi \text{ rad/s}}$$

Uniform Circular Motion

If an object moves along the circumference of circle with constant speed or angular velocity such motion is UCM.



QUESTION

Certain stars are believed to be rotating at about 1 rot/s. If such a star has a diameter of 40 km, what is the linear speed of a point on the equator of the star ?

A. 125.7 km/s

B. 120 km/s

C. 90 km/s

D. 12.57 km/s

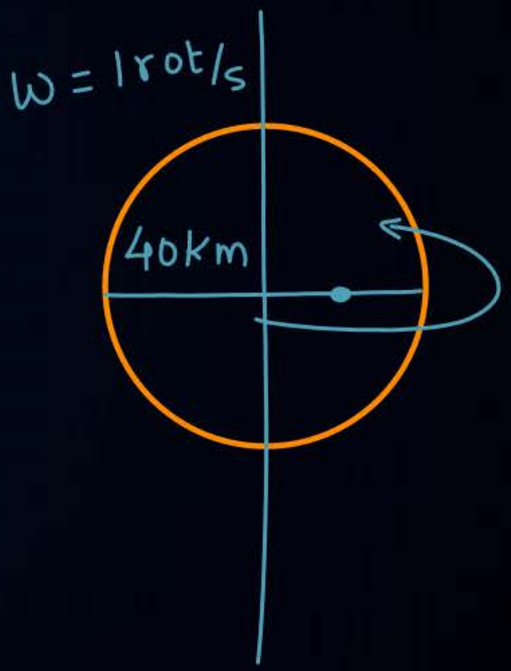
$\omega = 2\pi$ rad/s

$D = 40$ km

$R = 20$ km $= 2 \times 10^4$ m

$V = \omega r = 2\pi \times 2 \times 10^4$

$= 125.7$ km/s.



Summary

1) Revolution Vs Rotation

2) Angular displacement $\longrightarrow$ $\vec{ds} = \vec{d\theta} \times \vec{r}$

3) Angular velocity $\longrightarrow$ $\vec{\omega} = \frac{\theta}{t} = \frac{\vec{d\theta}}{dt}$, $\vec{V} = \vec{\omega} \times \vec{r}$

4) Angular Accln $\longrightarrow$ $\vec{\alpha} = \frac{\vec{\omega}_2 - \vec{\omega}_1}{t}$

Homework

1) Revise lecture

2) Practise questions.


धन्यवाद