Physics Notes

BY

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Class:10+1
Unit: 2
Topic: Kinematics

<u>SYLLABUS</u>: UNIT-II-D

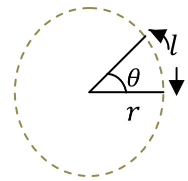
Frame of reference. Motion in a straight line: Position-time graph, speed and velocity, Uniform and non-uniform motion, average speed and instantaneous velocity.
Uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion (graphical treatment).
Elementary concept of differentiation and integration for describing motion.
Scalar and vector quantities: Position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors. Relative velocity.
Unit vector; Resolution of a vector in a plane – rectangular components, Motion in a plane, Cases of uniform velocity and uniform acceleration-projectile motion. Uniform circular motion.

Q.No.	Topic/Question	Page No.
1.	a) Define Angular Displacement? Units? Dimensions? b) Define Angular Velocity? Units? Dimensions? With examples.	
2.	Relationship between linear velocity v and angular velocity ω? (Scalar Relation).	
3.	a) Define “Angular Acc”? b) Relation between “Linear Acc” and “Angular Acc”?	
4.	Define T,f, Relation T→f, Relation ω→f	
5.	Prove centripetal acc $= \frac{v^2}{r}$	
6.	Derive and expression of $\vec{a}_c$ and $\vec{a}_r$ for “non uniform circular motion”.	

Q.1. a) Define Angular Displacement? Units? Dimensions?
b) Define Angular Velocity? Units? Dimensions? With examples.

Ans.a) **<u>Angular Displacement</u>**:- Angle traced by radius rector r.

Where $\theta = \frac{l}{r}$

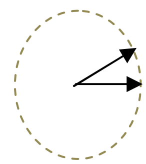


<u>Units</u>:- S.I. Unit → radians (rad)

<u>Dimensions</u>:- $[\theta\} = \frac{[l]}{[r]} = \frac{[L]}{[L]}$

$[\theta] = [M^0 L^0 T^0]$ Dimensionless

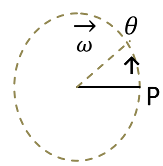
b) **<u>Angular Velocity</u>**:-



"Time rate of change of Angular displacement".

Angular Speed, $\omega = \frac{d\theta}{dt}$

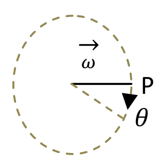
Angular velocity, $\vec{\omega} = \frac{d\vec{\theta}}{dt}$



<u>Direction</u>:- $\vec{\omega}$ Axial Vector

Towards the reader for Acw.

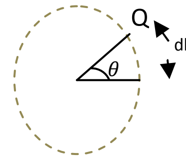
Away from the reader for cw.



<u>Units</u>:- S.I. Units $\rightarrow \frac{rad}{sec}$

<u>Dimensions</u>:- $[\omega] = [M^0\ L^0\ T^{-1}]$

Q.2. Relationship between linear velocity v and angular velocity ω? (Scalar Relation).

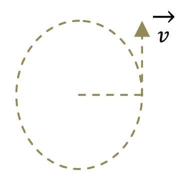


Ans. A particle moving from P to θ covering angle θ (intmi dt)

v= $\frac{dl}{dt}$ and ω = $\frac{d\theta}{dt}$ $\left\{d\theta = \frac{dl}{r}\right\}$

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

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



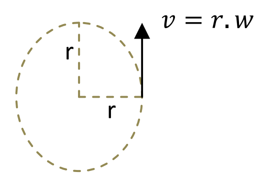
V= r.w

Direction of $\vec{v}$ is tangent to the circle

Q.3. a) Define "Angular Acc"?
b) Relation between "Linear Acc" and "Angular Acc"?

Ans.a) <u>**Angular Acc**</u>:-

Angular acc is defined as rate of change of angular velocity w.r.t time.



$\propto = \frac{dw}{dt}$

<u>**Relation between a and ∝**</u>

acc, a $= \frac{du}{dt}$ $\boxed{a = \propto .r}$

a $= \frac{d}{dt}$ (r.w)

a $= \left(\frac{dw}{dt}\right)$ r

<u>**Units**</u>:- rad/sec^2

<u>**Dimensions**</u>:- [∝] = $[M^0\ L^0\ T^{-2}]$

Q.4. Define T,f, Relation T→f, Relation ω→f.

Ans.

$T = 1/v$

$v = 1/T$

$v\,T = 1$

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

$\omega = 2\pi f$

Q.5. Prove centripetal acc $= \frac{v^2}{r}$.

Ans. "*Particle is moving in a circle with a uniform speed*".

Position vector triangle OAB is drawn as shown in fig. II velocity vector triangle PQR is drawn as shown in fig. III

In fig. II $\quad d\theta = \frac{dr}{r}$ —— (1)

In fig. III $\quad d\theta = \frac{dv}{v}$ —— (2)

From (1) & (2)

$$\frac{dv}{v} = \frac{dr}{r}$$

$$\boxed{dv = \frac{v}{r}.\,dr} \quad \text{—— (3)}$$

As per definition

$$\text{acc, a} = \frac{dv}{dt}$$

$$= \frac{v}{r}\left(\frac{dr}{dt}\right)$$

$$= \frac{v}{r}.\,v$$

$$a = \frac{v^2}{r}$$

$$\boxed{a_c = \frac{v^2}{r}}$$

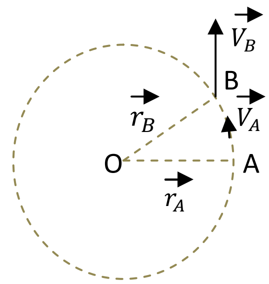
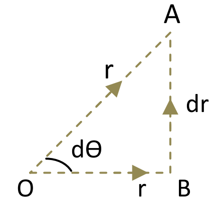
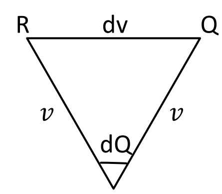


Fig.I



Position Vector Triangle
Fig.II



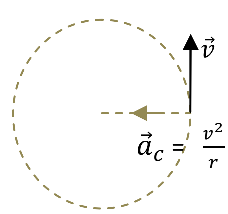
Velocity Triangle
Fig.III

<u>Direction</u>:- $\vec{a} = \frac{\vec{dv}}{dt}$

Direction of $\vec{a}$ is same as that of $\vec{d}_v$

Direction of $\vec{a}$ is opposite to $\vec{r}$

i.e. towards Centre.



<u>Conclusion</u>:-

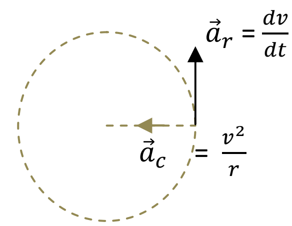
Q.6. **Derive an expression of $\vec{a}_c$ and $\vec{a}_r$ for "non uniform circular motion".**

Ans. **Centripetal Force,**

$$\vec{a}_c = \frac{v^2}{r}$$

Tangential force,

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



Ares $= \sqrt{ac^2 + aT^2}$

$$= \sqrt{\left(\frac{v^2}{r}\right)^2 + \left(\frac{dv}{dt}\right)^2}$$