MASTERJEE CLASSES

BRAIN MAP

CLASS XI

CIRCULAR MOTION

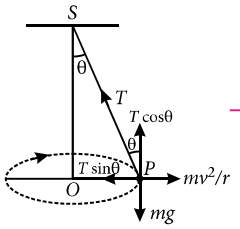
CIRCULAR MOTION

Dynamics of Circular Motion

Time period $T = 2\pi\sqrt{\dfrac{l\cos\theta}{g}}$

Linear velocity $v = \sqrt{gr\tan\theta}$

Angular velocity $\omega = \sqrt{\dfrac{g}{l\cos\theta}}$



Conical Pendulum : Tension in the string

$T = mg\sqrt{1+\left(\dfrac{v^2}{rg}\right)^2}$

- As $F = \dfrac{mv^2}{r} \neq 0$, Particle is not in equilibrium
- $\tau_{net} = 0$ as central force is involved. *i.e.*, $p \neq$ constant but L = constant

Forces

Centripetal force

$F_c = ma_c = \dfrac{mv^2}{r} = mr\omega^2$

Tangential force, $F_t = ma_t$

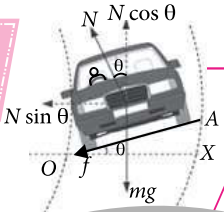
Net force, $F_{net} = m\sqrt{a_c^2 + a_t^2}$

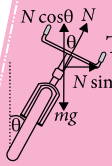
Maximum safe speed on a banked frictional road

$v = \sqrt{\dfrac{rg(\mu+\tan\theta)}{1-\mu\tan\theta}}$

Banking of a road : Optimum speed of a vehicle on a banked road.

$v = \sqrt{rg\tan\theta}$





Bending of a Cyclist : The cyclist should bend through an angle

$\theta = \tan^{-1}\left(\dfrac{v^2}{rg}\right)$

Tangential acceleration : $\vec{a}_t = \vec{\alpha}\times\vec{r}$

Centripetal acceleration : $\vec{a}_c = \vec{\omega}\times\vec{v}$

Kinematics of Uniform Circular Motion

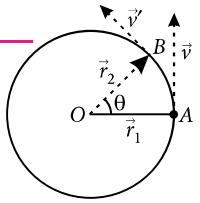
Uniform Circular Motion

A particle moves in a circle at a constant speed.

- **Angular displacement :** It is denoted by θ. SI unit : rad or degree
- **Angular velocity (ω) :** $\omega = \underset{\Delta t\to 0}{Lt}\dfrac{\Delta\theta}{\Delta t} = \dfrac{d\theta}{dt}$

Relations between :

- s and $\theta \Rightarrow s = r\,\theta$
- v and $\omega \Rightarrow \vec{v} = \vec{\omega}\times\vec{r}$



Kinematics of Non-uniform Circular Motion

Non-uniform Circular Motion

Speed of the particle in a horizontal circular motion changes with respect to time.

Motion in a Vertical Circle

Body is under the influence of gravity of earth and total mechanical energy is conserved.

Condition of Leaving the Circle

Tension in the string becomes zero before reaching the highest point if $\sqrt{2gL} < u < \sqrt{5gL}$

Tension at any point on vertical loop :

$T - mg\cos\theta = \dfrac{mv^2}{L}$

Condition of Oscillations

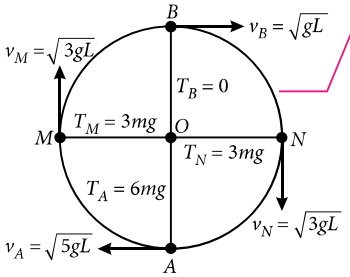
Particle will oscillate if velocity becomes zero the tension in the string is not zero.

$0 < u \leq \sqrt{2gL}$

Condition of Looping the Loop

The particle will complete the circle if

$u \geq \sqrt{5gL}$



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