A.A.V. PATEL JR. COLLEGE
EXCELLENCE PROGRAM S.Y.J.C PHYSICS

SYNOPSIS H.S.C Weightage (1)

TOPIC : CIRCULAR MOTION (4M)

Angular Displacement : Angular displacement is defined as the angle described by radius vector in a given time at the centre of circle.

Angular velocity : Angular velocity of a particle performing circular motion is defined as the time rate of change of limiting angular displacement.

Angular Acceleration (α) : The average angular acceleration is defined as the time rate of change of angular velocity.

Uniform Circular Motion (U.C.M):

Uniform Circular Motion is defined as the motion of particle along circumference of circle with constant speed.

or

Uniform Circular Motion can also be defined as periodic motion of a particle moving along circumference of a circle with constant angular speed.

Period (T)

The time taken by a particle performing uniform circular motion to complete one revolution is called as a periodic time or Period (T) OR

The time taken by a particle performing uniform circular motion to travel a distance equal to circumference of a circle is called as periodic time.

Frequency (n)

Frequency of revolution is defined as the number of revolutions performed by particle performing uniform circular motion in unit time.

Centripetal Force

Centripetal force is force acting on particle performing circular motion., which is along radius of circle and directed towards the centre of circle.

Centrifugal force:

Centrifugal force is a pseudo force in U.C.M which acts along radius and directed away from the centre of circle.

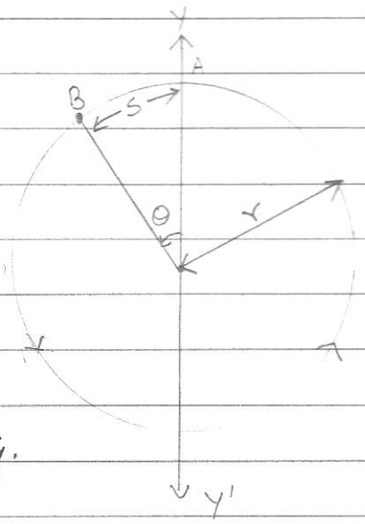
Banking of Roads

The process of raising outer edge of road over its inner edge through certain angle is known as banking of road. The angle made by the surface of road with horizontal surface of road is called angle of banking.

Conical Pendulum:

Conical pendulum is a simple pendulum which is given such a motion that bob describes a horizontal circle and the string describes a cone.

Formulae:



* $S = r\theta$

θ = angular displacement
r = Radius of circle
S = length of arc AB

* Instantaneous angular velocity.

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

→ finite angular velocity

$$\omega = \frac{\theta}{t}$$

* Angular acceleration

$$\vec{\alpha} = \frac{\vec{\delta\omega}}{\delta t}$$

* Relation between linear velocity and angular velocity

$$V = r\omega$$

In vector notation $\vec{v} = \vec{\omega} \times \vec{r}$

* $V = \frac{2\pi r}{T}$ $\quad T = \frac{2\pi}{\omega}$

* Acceleration in Uniform circular motion.

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

→ In vector form

$$\vec{a} = -\omega^2 \vec{r}$$

-ve sign shows that direction of acceleration is opposite to that of radius vector.

*. Relation between angular acceleration and linear acceleration:

$$\vec{a} = \vec{a_T} + \vec{a_r}$$

$\vec{a}$ = Linear acceleration
$\vec{a_T}$ = Tangential component of linear acceleration
$\vec{a_r}$ = Radial component of linear acceleration.

→ Magnitude of acceleration,

$$a = \sqrt{a_T^2 + a_r^2}$$

*. Centripetal force

$$F = mr\omega^2 = \frac{mv^2}{r}$$

* $V = \sqrt{\mu r g}$ (along horizontal road)

μ = coefficient of friction between tyres of car and road surface

* $V_{max} = \sqrt{rg\left[\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right]}$ (along curved horizontal road.

→ If $\mu_s = 0$

$$V_{max} = V_0 = \sqrt{rg\left[\frac{0 + \tan\theta}{1 - 0\tan\theta}\right]}$$

$$V_0 = \sqrt{rg\tan\theta}$$

V_0 = optimum speed.

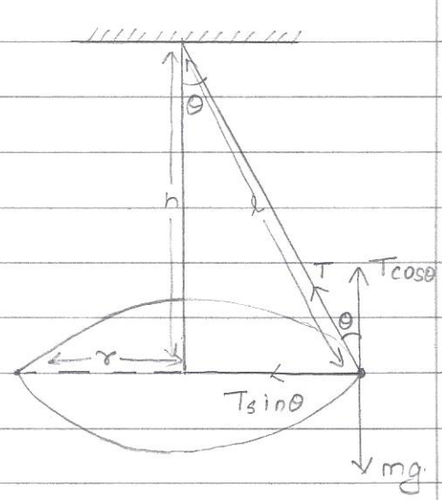
→ $\tan\theta = \frac{V_0^2}{rg}$

$$\theta = \tan^{-1}\left(\frac{V_0^2}{rg}\right)$$

* Periodic Time of conical pendulum

→ $T = 2\pi\sqrt{\frac{r}{g\tan\theta}}$

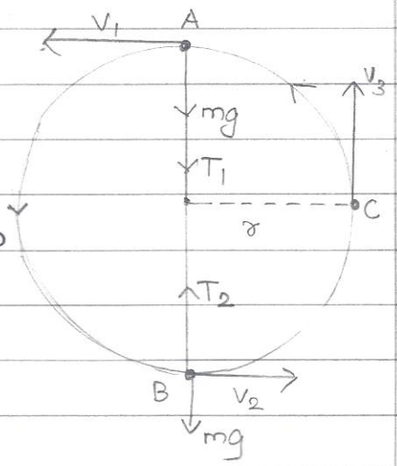
→ $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$



* Tension acting along the string of conical pendulum

$$T = mg\sqrt{1+\left(\frac{r}{h}\right)^2}$$

* For vertical circular motion:



→ $T_1 = \frac{mv_1^2}{r} - mg$ downward Tension

→ $T_2 = \frac{mv_2^2}{r} + mg$ upward Tension.

→ $V_1 = \sqrt{rg}$ - velocity at highest point.

→ $V_2 = \sqrt{5rg}$ - velocity at lowest point

→ $V_3 = \sqrt{3gr}$ - velocity at midway point.

Energy of particle in verticle circular motion

$$E = \frac{5}{2}mgr$$

→ $T_2 - T_1 = 6mg$ (Difference in tension).

Kinematical equations

1. $\vec{\omega} = \vec{\omega_0} + \vec{\alpha}t$
2. $\theta = \vec{\omega_0}t + \frac{1}{2}\vec{\alpha}t^2$
3. $\omega^2 = \omega_0^2 + 2\alpha\theta$