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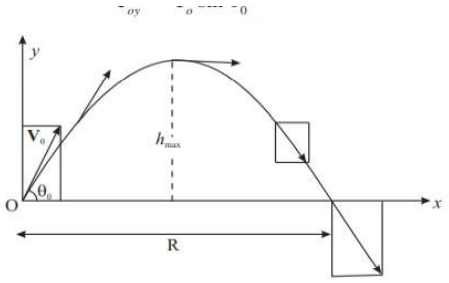
MOTION IN A PLANE

Projectile Motion

- The motion which has constant velocity in a certain direction and constant acceleration in a direction perpendicular to that of velocity

The two important properties of a projectile motion are :

(i) a constant horizontal velocity component
(ii) a constant vertically downward acceleration component.



Maximum height, time of flight and range of a projectile

Maximum height

At the instant when the projectile is at the maximum height, the vertical component of its velocity is zero.

$$h = \frac{v_0^2 sin_\theta^2}{2g}$$

The total time for which the projectile is in the air. This is termed as the time of flight

Time of Flight

The time of flight of a projectile is the time interval between the instant of its launch and the instant when it hits the ground.

$$T = \frac{2v_0 \sin\theta_0}{g}$$

Range

the path of any projectile launched at an angle to the horizontal is a parabola or a portion of a parabola.

$$R = \frac{v_0^2 \sin 2\theta_0}{g}$$

The trajectory of a projectile

$$y = y_o + (\tan\theta)(x - x_0) - \frac{g}{2[(v_0 \cos\theta_0)^2]}(x - x_0)^2$$

Circular Motion

It is a movement of object along the circumference of a circle along a circular path

$$\boldsymbol{v_{av}} = \frac{\Delta \boldsymbol{r}}{\Delta \boldsymbol{t}}$$

Uniform Circular Motion

uniform circular motion is motion with constant speed in a circle.

$V=\log_{\Delta t\to 0}\frac{\Delta_r}{\Delta_t}$

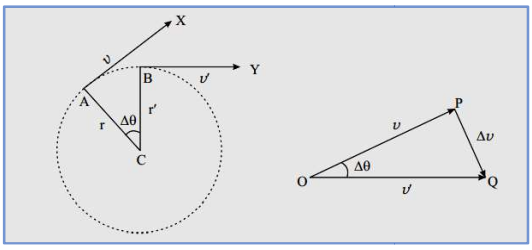
Centripetal Acceleration

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

$v= r\omega$

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

$F = mr\omega^2$



Acceleration = Rate of change of velocity

Applications of Uniform Circular Motion

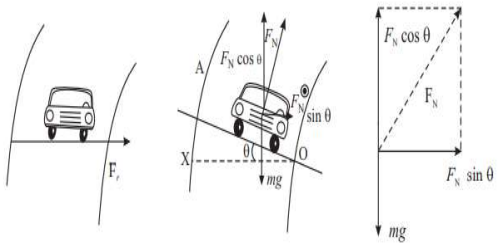
An important thing to understand and remember is that the term 'centripetal force' does not refer to a type of force of interaction like the force of gravitation or electrical force.

Banking of Roads

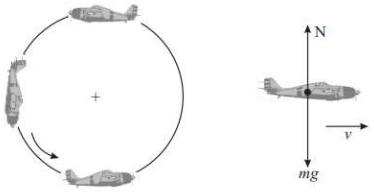
$$F_N \sin\theta = \frac{mv^2}{r}$$

$$F_N \cos\theta = mg$$

$$\theta = \tan^{-1}\frac{v^2}{rg}$$



AIRCRAFTS IN VERTICAL LOOPS



$$N = m\left(g + \frac{v^2}{r}\right)$$

CHECK YOURSELF

1. A shell is fired at an angle of 60^0 to the horizontal direction with a velocity of 392 ms^{-1} time of flight is
   A. 68.235
   B. 69.235
   C. 70.235
   D. 71.235
2. A body is projected with a velocity of 40ms^{-1} after 2s it crosses a tower of height 20.4m. angle of projection is
   A. 45^0
   B. 30^0
   C. 90^0
   D. 60^0
3. Centripetal force acting on the particle is given
   A. $F=mr\omega^2$
   B. $F=mr^2\omega^2$
   C. $F=m/r\omega^2$
   D. $F=mr/\omega$
4. In a circular motion.
   A. Speed is constant

B. Speed and velocity constant
C. Velocity is constant
D. None of the above

5. Range of the projectile is expressed as
   A. $R = V_0 \sin\theta$
   B. $R = \frac{v_0^2 \sin 2\theta_0}{g}$
   C. $R = \frac{v_0^2 \sin \theta_0}{g}$
   D. $R = \frac{v_0^2 \sin 2\theta_0}{2g}$

Answer to check yourself

1B) 2B) 3A) 4A) 5A)

STRETCH YOURSELF

1. Why does a bike rider bend inward while taking a turn on a circular path?
2. A stone tied at the end of string is whirled in a circle. If the string breaks, the stone flies away tangentially why?
3. What is uniform circular motion explain
4. Find a time of flight max height, horizontal range of projection with speed v_0 making an angle with horizontal direction form ground.
5. A car is rounding a curve of radius 100 m at a speed of 70kmh^{-1} what is the centripetal force on a passenger of mass m=100kg