Subject : Physics

Class : XI **Kannada**

Motion in a Plane

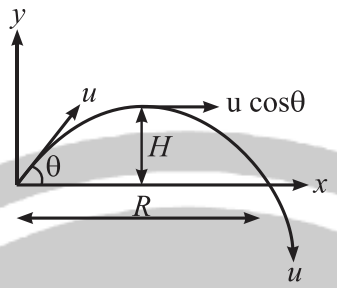
Projection Motion

Horizontal motion of projectile

$u\cos\theta = u_x$

$a_x = 0$

$x = u_x t = (u\cos\theta)t$



Vertical Motion of Projectile

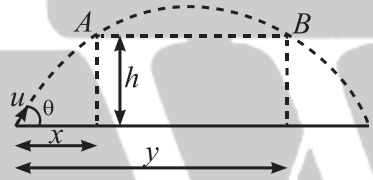
$v_y = u_y - gt$ where $u_y = u\sin\theta; y = u_y t - \frac{1}{2}gt^2 = u\sin\theta t - \frac{1}{2}gtt^2$ Net acceleration $\vec{a} = a_x\hat{i} + a_y\hat{j} = -g\hat{j}$

At any Instant

$v_x = u\cos\theta, \quad v_y = u\sin\theta - gt$

For Projectile Motion

A body crosses two points at same height in time t_1 and t_2 the points are at distance x and y from starting point then



- $x + y = R$
- $t_1 + t_2 = T$
- $h = 1/2\ gt_1t_2$
- Average velocity from *A* to *B* is $u\cos\theta$

If a person can throw a ball to a maximum distance '*x*' then the maximum height to which he can throw the ball will be $(x/2)$.

Velocity of Particle at Time t

- $\vec{v} = v_x\hat{i} + v_y\hat{j} = u_x\hat{i} + \left(u_y - gt\right)\hat{j} = u\cos\theta\hat{i} + (u\sin\theta - gt)\hat{j}$
- If angle of velocity $\vec{v}$ with horizontal is α, then

$$\tan\alpha = \frac{v_y}{v_x} = \frac{u_y - gt}{u_x} = \frac{u\sin\theta - gt}{u\cos\theta} = \tan\theta - \frac{gt}{u\cos\theta}$$

At highest point : $v_y = 0, v_x = u\cos\theta$

Time of flight: $T = \frac{2u_y}{g} = \frac{2u\sin\theta}{g}$

Horizontal range: $R = (u\cos\theta)T$

$$= \frac{2u^2\sin\theta\cos\theta}{g} = \frac{u^2\sin 2\theta}{g} = \frac{2u_xu_y}{g}$$

It is same for θ and $(90° - \theta)$ and maximum for $\theta = 45°$.

Maximum height: $H = \frac{u_y^2}{2g} = \frac{u^2 \sin^2\theta}{2g} = \frac{1}{8} g T^2$

$$\frac{H}{R} = \frac{1}{4}\tan\theta$$

Equation of trajectory:

$$y = x\tan\theta - \frac{g^2}{2u^2\cos^2\theta} = x\tan\theta\left(1 - \frac{x}{R}\right)$$

Horizontal Projection from a Height *h*

Time of flight: $T = \sqrt{\frac{2h}{g}}$

Horizontal range : $R = uT = u\sqrt{\frac{2h}{g}}$

Angle of velocity at any instant with horizontal: $\theta = \tan^{-1}\left(\frac{gt}{u}\right)$

