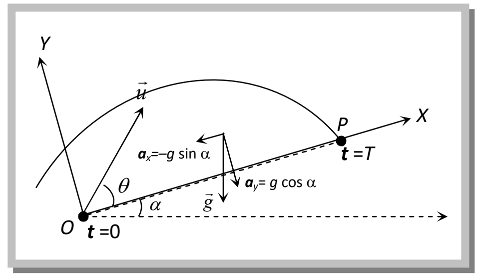
Projectile Motion on an Inclined Plane.

Let a particle be projected up with a speed u from an inclined plane which makes an angle α with the horizontal velocity of projection makes an angle θ with the inclined plane.

We have taken reference x-axis in the direction of plane.

Hence the component of initial velocity parallel and perpendicular to the plane are equal to $u\cos\theta$ and $u\sin\theta$ respectively i.e. $u_{\parallel} = u\cos\theta$ and $u_{\perp} = u\sin\theta$.



The component of g along the plane is $g\sin\alpha$ and perpendicular to the plane is $g\cos\alpha$ as shown in the figure i.e. $a_{\parallel} = -g\sin\alpha$ and $a_{\perp} = g\cos\alpha$.

Therefore the particle decelerates at a rate of $g\sin\alpha$ as it moves from O to P.

(1) **Time of flight:** We know for oblique projectile motion $T = \frac{2u\sin\theta}{g}$

or we can say $T = \frac{2u_{\perp}}{a_{\perp}}$

$\therefore$ Time of flight on an inclined plane $T = \frac{2u\sin\theta}{g\cos\alpha}$

(2) **Maximum height:** We know for oblique projectile motion $H = \frac{u^2\sin^2\theta}{2g}$

or we can say $H = \frac{u_{\perp}^2}{2a_{\perp}}$

$\therefore$ Maximum height on an inclined plane $H = \frac{u^2\sin^2\theta}{2g\cos\alpha}$

(3) **Horizontal range:** For one dimensional motion $s = ut + \frac{1}{2}at^2$

Horizontal range on an inclined plane $R = u_{\parallel}T + \frac{1}{2}a_{\parallel}T^2$

$$R = u\cos\theta\, T - \frac{1}{2}g\sin\alpha\, T^2$$

$$R = u\cos\theta\left(\frac{2u\sin\theta}{g\cos\alpha}\right) - \frac{1}{2}g\sin\alpha\left(\frac{2u\sin\theta}{g\cos\alpha}\right)^2$$

By solving $R = \frac{2u^2}{g}\frac{\sin\theta\cos(\theta+\alpha)}{\cos^2\alpha}$

(i) Maximum range occurs when $\theta = \frac{\pi}{4} - \frac{\alpha}{2}$

(ii) The maximum range along the inclined plane when the projectile is thrown upwards is given by

$$R_{max} = \frac{u^2}{g(1+\sin\alpha)}$$

(iii) The maximum range along the inclined plane when the projectile is thrown downwards is given by

$$R_{max} = \frac{u^2}{g(1-\sin\alpha)}$$

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