

Answer on Question #59502-Physics – Mechanics | Relativity

At what point will the speed of a projectile be maximum? Calculate the range of projectile.

Solution

Let the projectile be launched with an initial velocity v_0 at the angle θ .

At any time t , the projectile's horizontal and vertical displacement are:

$$x = v_0 t \cos(\theta)$$

$$y = v_0 t \sin(\theta) - \frac{1}{2}gt^2$$

The horizontal component of the velocity of the object remains unchanged throughout the motion. The downward vertical component of the velocity increases linearly, because the acceleration due to gravity is constant.

$$v_x = v_0 \cos(\theta)$$

$$v_y = v_0 \sin(\theta) - gt$$

The speed of a projectile will be maximum at the lowest height of trajectory.

The horizontal range d of the projectile is the horizontal distance it has travelled when it returns to its initial height ($y = 0$).

$$0 = v_0 t_d \sin(\theta) - \frac{1}{2}gt_d^2$$

Time to reach ground:

$$t_d = \frac{2v_0 \sin(\theta)}{g}$$

From the horizontal displacement the maximum distance of projectile:

$$d = v_0 t_d \cos(\theta)$$

So,

$$d = \frac{v_0^2}{g} \sin(2\theta)$$