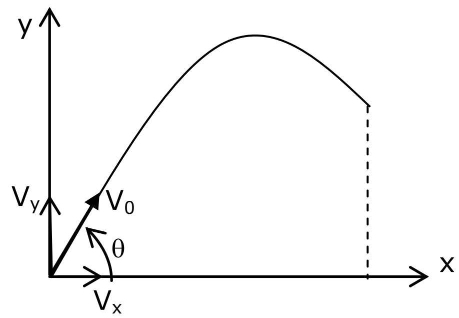
Q- An artillery shell is fired with an initial velocity of 300 m/s at 60 degrees above the horizontal. It explodes 40.0s after firing. What are the x and y coordinates of the shell where it explodes relative to its firing point?

As the motion of the shell is in a plane (two dimensional space) and the acceleration is that due to gravity which is vertically downward, we resolve initial velocity of the shell v_o in horizontal and vertical directions.



If the initial velocity of the shell is making angle θ with the horizontal, the horizontal component of initial velocity will be

$$v_x = v_0 * \cos\theta$$

As the acceleration of the shell is vertical having no horizontal component, the shell may be considered to move horizontally with constant velocity of v_x and hence the horizontal distance covered (or the x coordinate of the shell with point of projection as origin) is given by

[Distance = velocity*time]

$$X = v_x * t = v_0 * \cos\theta * t = 300 * \cos 60^0 * 40.0 = 300 * 0.500 * 40 = 6000 \text{ m}$$

Or **x = 6000 m**

The vertical component of the initial velocity will be

$$v_y = v_0 * \sin\theta$$

The acceleration of gravity is vertically downward and is $g = -9.8 \text{ m/s}^2$, hence the vertical distance covered (or y coordinate of the shell) is given by the second equation of motion [$s = v_0 * t + ½ at^2$] as

$$Y = v_0 * \sin\theta * t + ½ gt^2$$

Or $y = 300 * \sin 60^0 * 40.0 + 0.5 * (-9.8) * (40.0)^2$

Or $y = 300 * 0.866 * 40.0 - 0.5 * 9.8 * 1600 = 10392 - 7840 = 2552$ m

Or **y = 2552 m.**