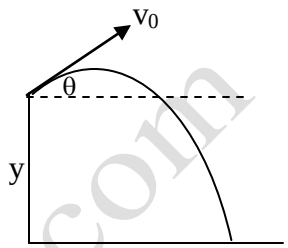
Q- An airplane with a speed of 75.0 m/s is climbing upward at an angle of 30.0 ° with respect to the horizontal. When the plane's altitude is 600 m, the pilot releases a package.
(a) Calculate the distance along the ground, measured from a point directly beneath the point of release, to where the package hits the earth.
(b) Relative to the ground, determine the angle of the velocity vector of the package just before impact.



At the time of release the velocity of the package v_0 will be same as that of the plane means 75 m/s at 30 degree above horizontal.

Horizontal component of its velocity will be

$v_x = 75.0*\cos(30.0^0) = 75*0.866 = 65.0$ m/s

Initial vertical velocity

$v_y = 75.0*\sin(30.0^0) = 75.0*0.500 = 37.5$ m/s

Vertical displacement is given by the second equation of motion as

$[s = u*t + ½\ a*t^2]$

(Upward positive, hence y is negative from the point of release)

$-600 = 37.5*t + 0.5*(-9.80)*t^2$

Or $4.90*t^2 – 37.5*t - 600 = 0$

Gives $t = \frac{37.5 \pm \sqrt{(37.5)^2 - 4*4.90*(-600)}}{2*4.90}$

Or $t = \frac{37.5 \pm 115}{9.80} = 15.5$

Gives t = 15.5 s (cannot have negative value)

Hence the horizontal distance covered by the package will be

$x = v_x*t = 65.0*15.5 =$ **1007 m**

The vertical velocity of the package will be given by

$v_y' = v_y + g*t$

or $v_y' = 37.5 + (-9.8)*15.5 = -114$ m/s

(Negative means downwards)

Hence the velocity vector makes and angle with the horizontal given by

$\tan\theta = v_y/v_x = 114/65.0 = 1.75$

Gives $\theta =$ **60.3^0**.