Answer on Question #40583 – Physics –Mechanics | Kinametics | Dynamics

1. A projectile is shot from the ground at an angle of 60 degrees with respect to the horizontal, and it lands on the ground 5 seconds later. Find: a) the horizontal component of initial velocity; b) the vertical component of initial velocity; c) the magnitude and the direction of velocity, when the projectile hits the ground.

$\alpha = 60^0$ $t_1 = 5s$	*Solution.*
$v_{0x}, v_{0y}, v_1, \alpha_1 - ?$	Let denote $y = v_0 \sin\alpha \cdot t - \frac{gt^2}{2}$ as initial velocity of the projectile.

In the horizontal direction the movement is with the constant velocity:

$v_x = v_0 \cos\alpha$, $x = v_0 \cos\alpha \cdot t$.

In vertical direction the movement is with the constant acceleration g:

$$v_y = v_0 \sin\alpha - gt, \quad y = v_0 \sin\alpha \cdot t - \frac{gt^2}{2}.$$

At the moment $t = t_1$, the y-coordinate is zero.

$$y = 0, \quad 0 = v_0 \sin\alpha \cdot t_1 - \frac{gt_1^2}{2}, \quad v_0 = \frac{gt_1}{2\sin\alpha}.$$

So, the horizontal and vertical components of the initial velocity are:

$$\boxed{v_{0x} = \frac{gt_1}{2} ctg\,\alpha}, \quad \boxed{v_{0y} = \frac{gt_1}{2}}.$$

The magnitude and the direction of the final velocity are:

$$v_1 = \sqrt{v_{1x}^2 + v_{1y}^2} = \sqrt{\left(\frac{gt_1}{2} ctg\,\alpha\right)^2 + \left(\frac{gt_1}{2} - g \cdot t_1\right)^2}, \quad \boxed{v_1 = \frac{gt_1}{2\sin\alpha}}.$$

$$\alpha_1 = arctg\frac{v_{1y}}{v_{1x}} = arctg\frac{\frac{gt_1}{2} - g \cdot t_1}{\frac{gt_1}{2} ctg\,\alpha}, \quad \boxed{\alpha_1 = -\alpha}.$$

Let check the dimensions.

$$[v_{0x}] = [v_{0y}] = [v_1] = \frac{m}{s^2} \cdot s = \frac{m}{s}, \quad [\alpha_1] = {}^0.$$

Let evaluate the quantities.

$$v_{0x} = \frac{9.8 \cdot 5}{2} \cdot ctg\ 60^0 = 14.1\left(\frac{m}{s}\right), \quad v_{0y} = \frac{9.8 \cdot 5}{2} = 24.5\left(\frac{m}{s}\right), \quad v_1 = \frac{9.8 \cdot 5}{2 \cdot \sin 60^0} = 28.3\left(\frac{m}{s}\right).$$

Answer: a) $14.1\frac{m}{s}$; b) $24.5\frac{m}{s}$; c) $28.3\frac{m}{s}$, -60^0.