Answer on Question # 71482, Physics / Mechanics | Relativity

Question

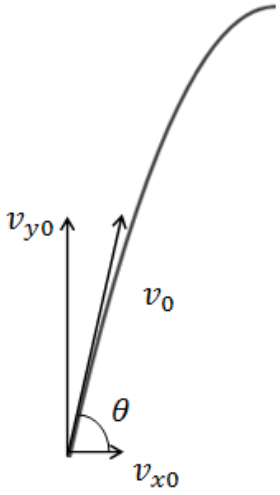
The launching speed of certain projectile is 5 times it has at its maximum height. Its angle of projection is

Solution

Let initial speed is v_0. Resolve or break the motion into horizontal and vertical components along the x- and y-axes. These axes are perpendicular, so the magnitudes of the components of the speed v_0 are

$$v_{x0} = v_0\cos\theta, \quad v_{y0} = v_0\sin\theta$$

where θ is the direction of velocity, as shown in Figure. Initial values are denoted with a subscript 0.



Treat the motion as two independent one-dimensional motions, one horizontal and the other vertical. The kinematic equations for horizontal and vertical motion have the following forms:

Horizontal Motion ($a_x = 0$) $v_x = v_{0x}$ velocity is a constant

Vertical Motion (assuming positive is up $a_y = -g = -9.8m/s^2$) $v_y = v_{y0} - gt$

The highest point in any trajectory is reached when $v_y = 0$, so at the maximum height the speed v of the projectile is $v = v_{x0}$. By the condition of problem $v_0 = 5v$, or $v_0 = 5v_{x0}$. Since

$$\cos\theta = \frac{v_{x0}}{v_0}$$

we get

$$\cos\theta = \frac{v_{x0}}{v_0} = \frac{v_{x0}}{5v_{x0}} = \frac{1}{5}$$

so

$$\theta = \cos^{-1}(0.2) = 78.5°$$

Answer: $\boldsymbol{\theta = 78.5°}$