MCCC FALL 2010 COLLEGE PHYSICS 101

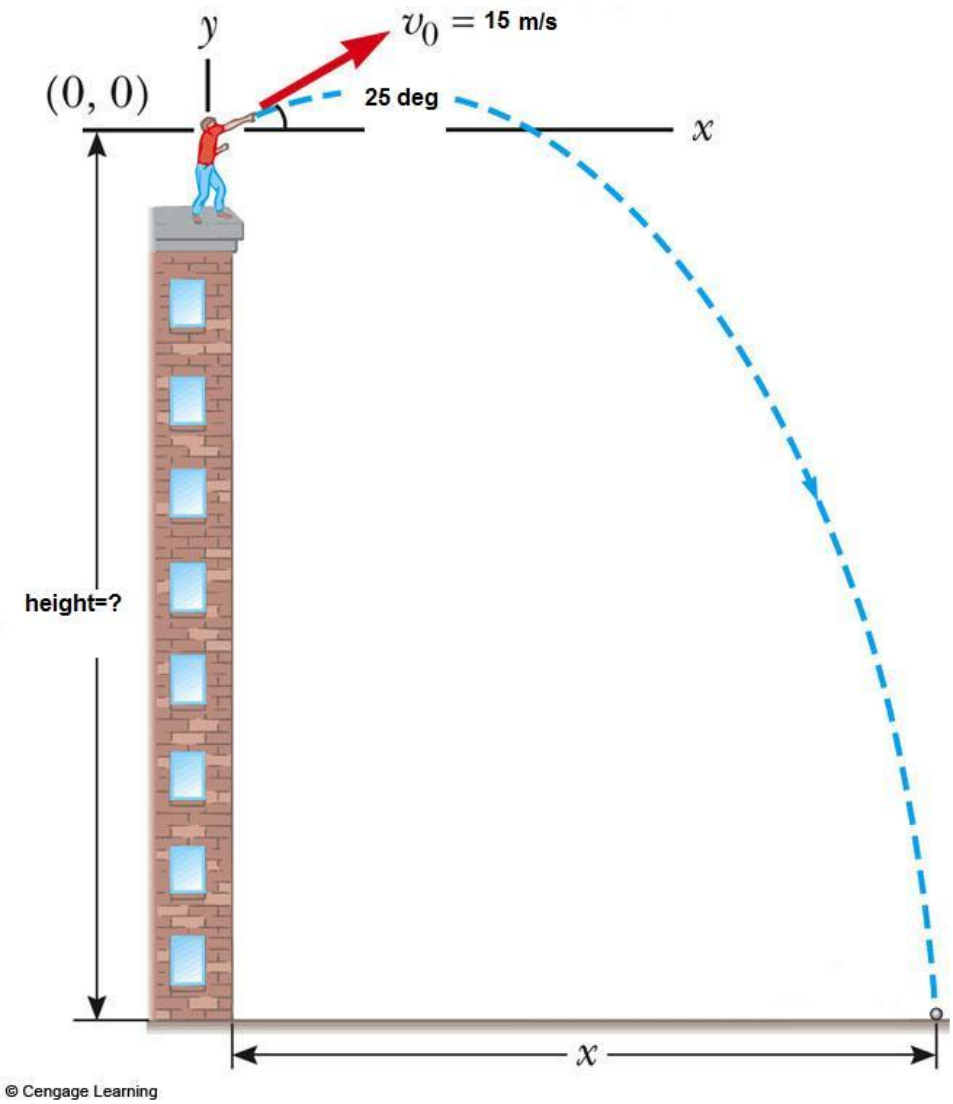
Chapter 3 Vectors and Two-Dimensional Motion

Solution for Problem 29, page 78

A brick is thrown upward from the top of a building at an angle of 25^0 to the horizontal and with an initial speed of 15 m/s. If the brick is in flight for 3.0 s, how tall is the building?

Goal:

To find the height of the building, we need **the displacement of the projectile in the y-direction after 3.0 s** from the time it was launched.



Strategy:

The straight forward application of the set of the three kinematic equations each for the x-direction and y-direction can be used for this problem because these equations are valid for the entire duration (3.0 s) of the flight. **We assume upward direction to be along the positive y-axis and the origin (0, 0) to coincide with the point of launch.**

x-direction	y-direction
$v_x = v_{0x} + a_x t$	$v_y = v_{oy} + a_y t$
$\Delta x = v_{0x} t + \frac{1}{2} a_x t^2$	$\Delta y = v_{oy} t + \frac{1}{2} a_y t^2$
$v_x^2 = v_{0x}^2 + 2 a_x \Delta x$	$v_y^2 = v_{0y}^2 + 2 a_y \Delta y$

Given:

Initial speed =magnitude of initial velocity vector = $|\overrightarrow{v_0}| = 15$ m/s

Launching Angle to the horizontal = θ =25^0

Time of travel = 3.0 s

Step 1:

Find $v_{0x}\ and\ v_{0y}$ which are the x-component of the initial velocity vector and y-component of the initial velocity vector respectively.

Using $v_{0x} = |\overrightarrow{v_0}| \times cos\theta\ \ and\ v_{0y} = |\overrightarrow{v_0}| \times \sin\theta$

and substituting given values from above, we write,

$$v_{0x} = 15 m/s \times \cos 25^0 = 13.6 \frac{m}{s}\ \ and\ v_{0y} = 15 m/s \times \sin 25^0 = 6.34\ m/s$$

Step 2:

We know that for the projectile $\boldsymbol{a_x = 0\ and\ a_y = -9.80\ m/s^2}$ throughout the flight.

Step 3:

Substitute the values from Step 1 and Step 2 and the value of t = 3.0 s into the kinematic equation no. 2 for the y-direction as follows:

$\Delta y = v_{0y}t + \frac{1}{2}a_y t^2$ = (6.34) x (3.0) + ½ x (-9.80) x $(3.0)^2$ = -25.08 m

Height of the building = 25 m (answer given to 2 significant figures)