Answer on Question #47597-Physics-Mechanics-Kinematics-Dynamics

You are walking around your neighborhood and you see a child on top of a roof of a building kick a soccer ball. The soccer ball is kicked at $\alpha = 49°$ from the edge of the building with an initial velocity of $v_0 = 13\frac{m}{s}$ and lands $s = 65$ meters away from the wall. How tall is the building that the child is standing on?

Solution

Ignoring air resistance:

$$V_{x0} = V_0 \cos\alpha = 13\frac{m}{s}\cos 49 = 8.5\frac{m}{s}$$

$$V_{y0} = V_0 \sin\alpha = 13\frac{m}{s}\sin 49 = 9.8\frac{m}{s}.$$

So how long does it take the ball to travel 65 meters along the x axis?

$$s = V_{x0}t \to t = \frac{s}{V_{x0}} = \frac{65}{8.5} = 7.6\ s.$$

We now know the total flight time of the ball was 7.6 seconds.

What about it's height?

$$S_y - S_{y0} = V_{y0}t - \left(\frac{1}{2}\right)gt^2.$$

where S_{y0} is the initial distance up the y axis (ie the height of the roof that we want to find); $S_y = 0$ is the final height of the ball (i.e. ground level); V_{y0} is the initial velocity along the y axis; $g = 9.8\frac{\text{m}}{\text{s}^2}$ is the acceleration of gravity; t is the total flight time.

Then

$$-S_{y0} = V_{y0}t - \left(\frac{1}{2}\right)gt^2 \to S_{y0} = \left(\frac{1}{2}\right)gt^2 - V_{y0}t = \left(\frac{1}{2}\right)9.8 \cdot 7.6^2 - 9.8 \cdot 7.6 = 208.5\ m.$$

So the child is on a roof that is 208.5 meters tall.

Answer: $208.5\ m$.