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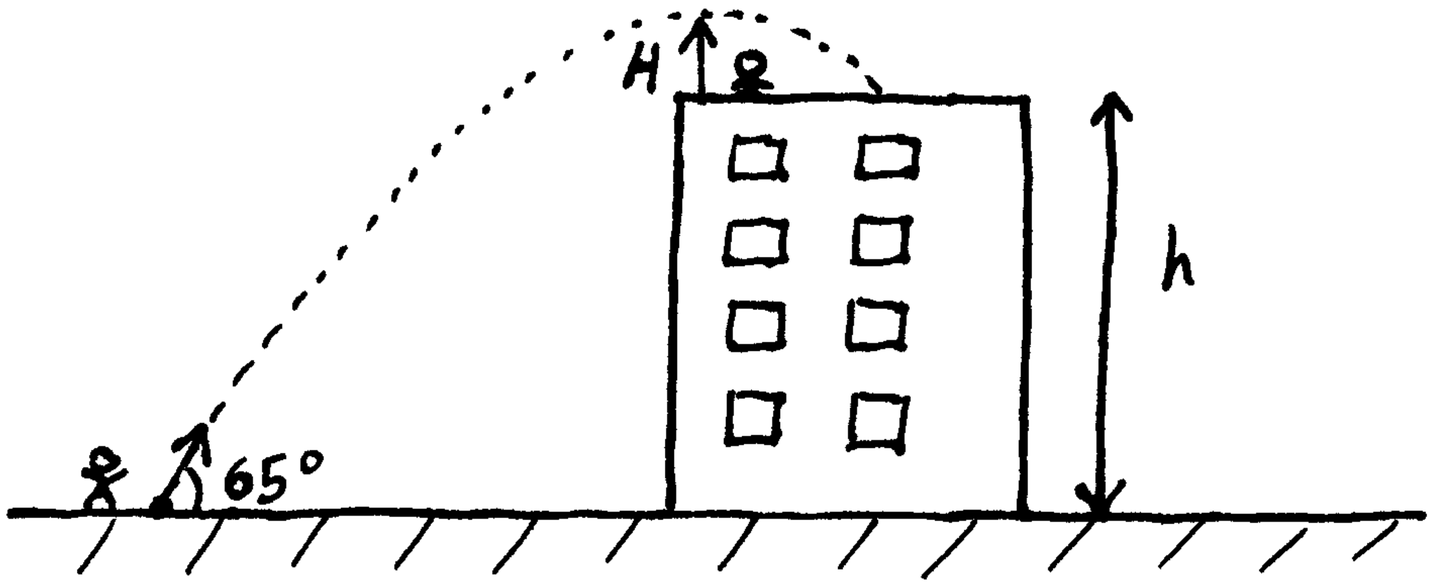
Feb. 2, 2020

This is a problem involving projectile motion.



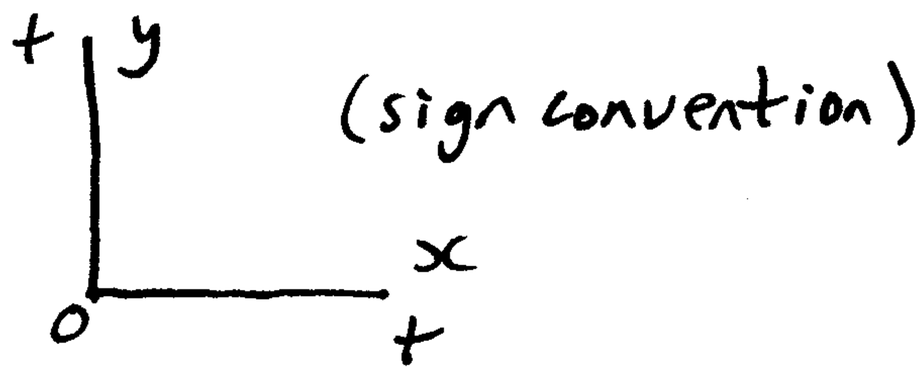
In order to calculate the height, h, of a building, a physics student launches a ball at an initial speed of 30 m/s at an angle of 65° above the horizontal. Another physics student is standing on the roof of the building, and determines that the ball lands on the roof of the building 3.5 s after it is launched.

(a) What is the height, h, of the building?

(b) What is the peak height, H reached by the ball, relative to the student on the roof?

Solution: Assumption: - Air resistance is negligible

Set up an xy coordinate frame with origin at the point of launch, as shown:



(a) The equation for vertical motion is:

$$d_y = (v_0 \sin 65^\circ)t - \frac{1}{2} g t^2$$

$d_y = ?$ (vertical displacement of ball when it lands on the roof)

$v_0 = 30\ m/s$ (magnitude of initial ball velocity)

$t = 3.5\ s$ (time it takes the ball to land on the roof)

$g = 9.8\ m/s^2$

Substitute:

$$d_y = (30 \sin 65^\circ)(3.5) - \frac{1}{2}(9.8)(3.5)^2$$

$$d_y = 35.1\ m = h \text{ (answer)}$$

(b) Use the kinematic equation: $v_y^2 = (v_0 \sin 65^\circ)^2 - 2g d_y$

At peak height, $v_y = 0$

and from the above equation,

$$d_y = \frac{(v_0 \sin 65^\circ)^2}{2g}$$ (peak height measured from ground level)

Substitute:

$$d_y = \frac{(30 \sin 65^\circ)^2}{2(9.8)} = 37.7\ m$$

Therefore, $H = 37.7\ m - h = 2.6\ m$ (answer)