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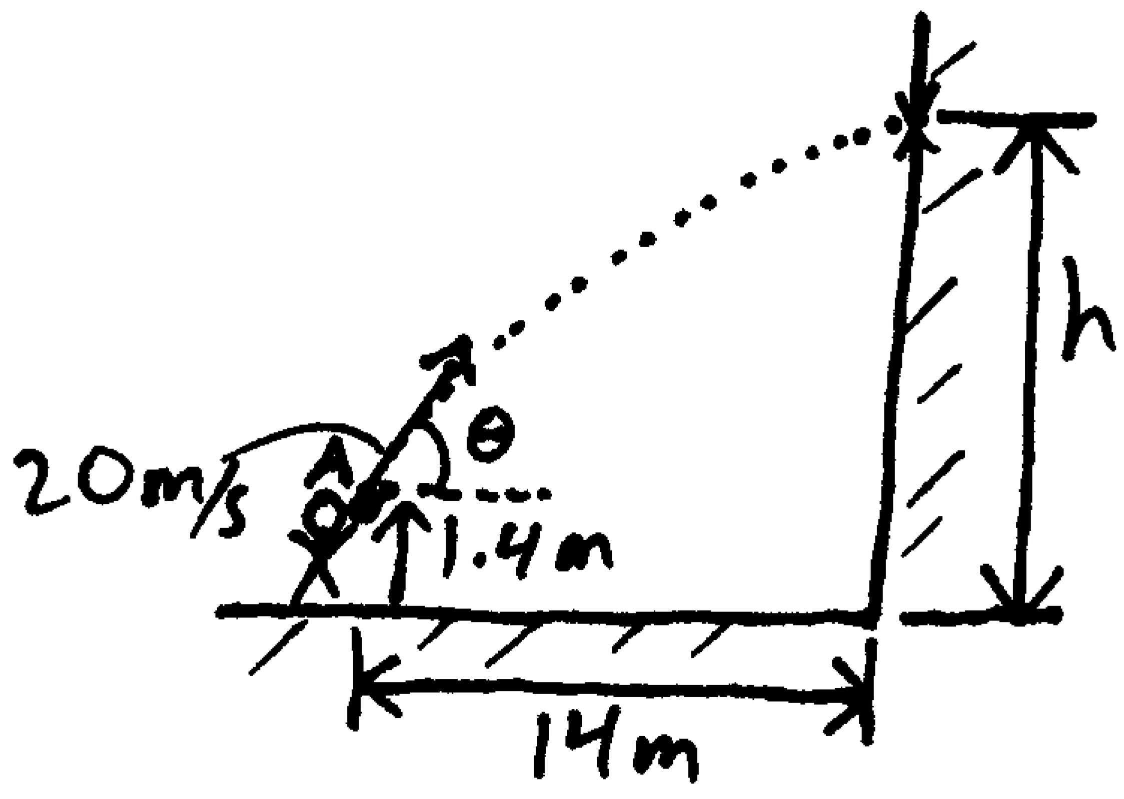
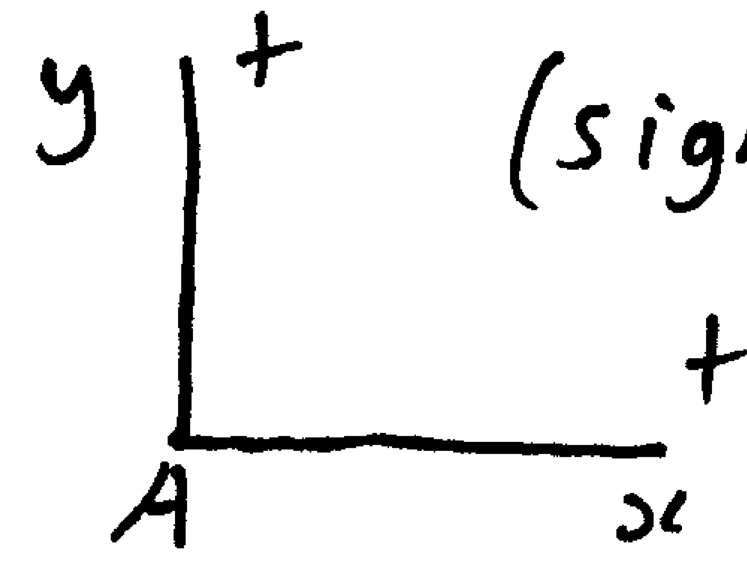


A baseball player throws a ball at an initial speed of 20 m/s, from point A, which is 1.4 m above the ground and 14 m from a wall. What is the launch angle θ so that the height h, which is the distance from the ground to the point of impact on the wall, is a maximum?

Solution: Assumption:- Air resistance is negligible

Set up an xy coordinate frame with origin at point A, as shown:



(sign convention)

The equation for horizontal motion is:

$$d_x = (v_0 \cos\theta)t \qquad (1)$$

$d_x = 14\,m$ (horizontal displacement of ball when it hits the wall)

$v_0 = 20\,m/s$ (magnitude of initial ball velocity)

$t = ?$ (time it takes for the ball to hit the wall)

The equation for vertical motion is:

$$d_y = (v_0 \sin\theta)t - \frac{1}{2}gt^2 \quad (2)$$

$d_y = ?$ (vertical displacement of ball when it hits the wall - maximize this)

$g = 9.8\, m/s^2$

From equation (1), $t = \dfrac{d_x}{v_0 \cos\theta} = \dfrac{14}{20\cos\theta}$

Substitute this into equation (2):

$$d_y = d_x \tan\theta - \frac{1}{2}g\left(\frac{d_x}{v_0\cos\theta}\right)^2$$

$$d_y = 14\tan\theta - \frac{2.4}{(\cos\theta)^2}$$

Find the value of θ so that d_y is a maximum. The easiest way to do this is to try out different values of θ, and using trial and error determine for which θ the value of d_y is maximum.

maximum $d_y = 18.0\, m$
when $\theta = 71°$

Therefore, maximum $h = 18.0 + 1.4 = 19.4\, m$
when $\theta = 71°$ (answer)