Suppose the left-centre field wall is 4.1 m high and located 100.8 m from home plate. A batter connects the ball 1.0 m above the ground at an angle of 45° and the ball has a speed of 31 m/s. Will this be a home run?

$y > 3.1\text{ m}$ ✓ when $x = 100.8\text{ m}$

$v = 31\text{ m/s}$

$\theta = 45°$ (max. range)

$y = v_{oy}t + \frac{1}{2}at^2$

time

$v_x = v\cos\theta$

$y = (31\sin 45)(4.6) - 4.9(4.6)^2$

$v\cos\theta = \frac{x}{t}$

$y = 100.8 - 103.7$

$t = \frac{100.8}{31\cos 45}$

$y = -2.9\text{ m}$

Not $> 3.1\text{ m}$

So not home run

$t = 4.6\text{ s}$

With what minimum speed does a baseball have to come off the bat to clear the Green Monster at Fenway Park? The wall is 115.5 m from home plate and 11.3 m high. Assume the batter makes contact 1.0 m off the ground at an angle of 45°.

$y = 10.3\,m$

$x = 115.5\,m$

$\theta = 45°$

$v = ?$

$v_x = v\cos 45$

$v_x = \frac{x}{t}$

$v\cos 45 = \frac{115.5}{t}$ (Eq 1)

$y = v_{oy}t + \frac{1}{2}at^2$ $\quad v_{oy} = v\sin\theta$

$10.3 = (v\sin 45)t - 4.9t^2$ (Eq 2)

(Eq 1) $\quad v = \frac{115.5}{t\cos 45}$ $\quad$ Sub in Eq 2

$10.3 = \left(\frac{115.5}{t\cos 45}\right)(\sin 45)t - 4.9t^2$

$10.3 = 115.5 - 4.9t^2$

$-105.2 = -4.9t^2$

$21.5 = t^2$

$4.63\,s = t$

$v = \frac{115.5}{(4.63)\cos 45}$

$v = 35.3\,m/s$

## Hitting a Moving Target

In an archery skills competition an archer stands next to her target. A bell rings and the target begins to move away from the archer at 3.5 m/s but the archer must wait a certain amount of time before shooting. This archer releases the arrow 8.0 s after the bell has rung in an attempt to hit the moving target. Assuming the launch angle is $45^{o}$ and the arrow is launched at the same height as the target, determine the initial speed of the arrow to successfully hit the target.

- Find an expression for the horizontal distance covered by the arrow.
- Write the expression for $V_x$ using x/t and remember that $V_x = V\cos 45^{o}$.
- Combine the above to have a formula for V.
- Write $V_{iy} = V\sin 45^{o}$.
- Write the formula for vertical displacement, y.
- In the above substitute $V\sin 45^{o}$ for $V_{iy}$.
- Now substitute the formula for V into the vertical displacement expression.
- Solve for t.
- Use that value to find V.

## Hitting a Moving Target

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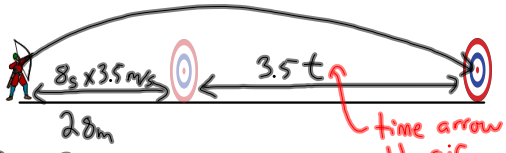


$x = 28 + 3.5t$

$y = 0m$ $\quad v_x = v\cos 45$

$\theta = 45°$ $\quad v\cos 45 = \frac{x}{t}$

$v = ?$

$$v = \frac{28 + 3.5t}{t\cos 45} \quad (Eq\,1)$$

$y = v_{oy}t + \frac{1}{2}at^2$ $\quad v_{oy} = v\sin 45$

$$0 = (v\sin 45)t - 4.9t^2 \quad (Eq\,2)$$

$$0 = \left(\frac{28 + 3.5t}{t\cos 45}\right)(\sin 45)t - 4.9t^2$$

$$0 = 28 + 3.5t - 4.9t^2$$

$$4.9t^2 - 3.5t - 28 = 0$$

$$t = \frac{-(-3.5) \pm \sqrt{(-3.5)^2 - 4(9.9)(-28)}}{9.81}$$

$$t = \frac{3.5 \pm \sqrt{561.05}}{9.81}$$

$$t = \frac{3.5 \pm 23.7}{9.81}$$

$t = \frac{3.5 + 23.7}{9.81} = 2.77s$ ← makes sense

or $t = \frac{3.5 - 23.7}{9.81} = -2.1s$ ← not physically possible

$$v = \frac{28 + 3.5(2.77)}{2.77\cos 45} = 19.2\ m/s$$