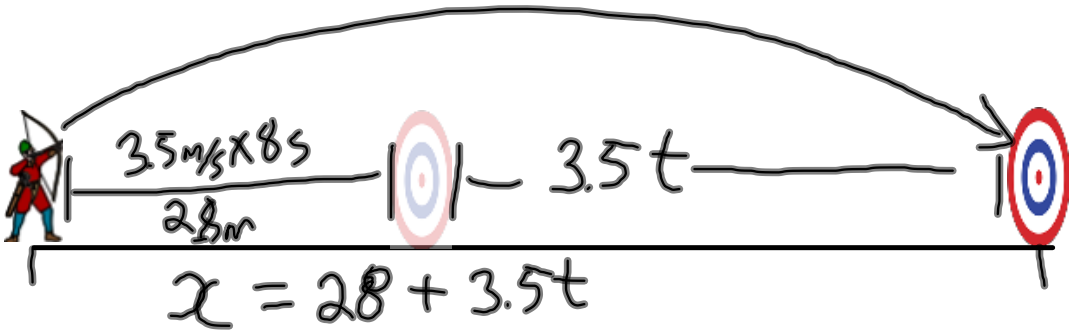
Hitting a Moving Target

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 $V_x = V\cos45^{o}$.
- Combine the above to have a formula for V.
- Write $V_{iy} = V\sin45^{o}$.
- Write the formula for vertical displacement, y.
- In the above substitute $V\sin45^{o}$ for V_{iy}.
- Now substitute the formula for V into the vertical displacement expression.
- Solve for t.
- Use that value to find V.

$$v_x = \frac{x}{t} \qquad x = 28 + 3.5t$$

$$v_x = v\cos 45^\circ$$

$$v\cos 45 = \frac{28 + 3.5t}{t}$$

$$v = \frac{28 + 3.5t}{t\cos 45}$$

$$v_{iy} = v\sin 45$$

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

$$0 = v\sin 45\, t + \frac{1}{2}at^2$$

$$0 = \left[\frac{28 + 3.5t}{t\cos 45}\right](\sin 45)t + \frac{1}{2}at^2$$

$$0 = 28 + 3.5t - 4.905t^2$$

$$4.905t^2 - 3.5t - 28 = 0$$

$$t = \frac{3.5 \pm \sqrt{(3.5)^2 - 4(4.905)(-28)}}{2(4.905)}$$

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

$$t = -2.06\,s \quad \text{and} \quad \boxed{2.77\,s}$$

$$v = \frac{28 + 3.5(2.77)}{(2.77)\cos 45}$$

$$\boxed{v = 19.2\ m/s}$$