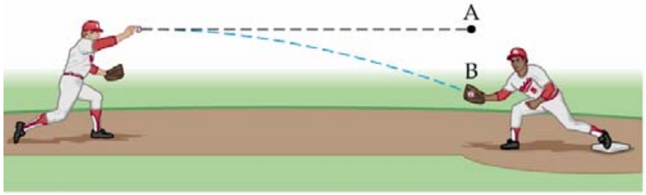
Physics 151 Class Exercise: 2-D Kinematics

1. Playing shortstop, you pick up a ground ball and throw it to second base. The ball is thrown horizontally, with a speed of 22. m/s, directory toward point A. When the ball reaches the second baseman 0.45 s later, it is caught at point B.
(a) How far were you from the second baseman?
(b) What is the distance of vertical drop?



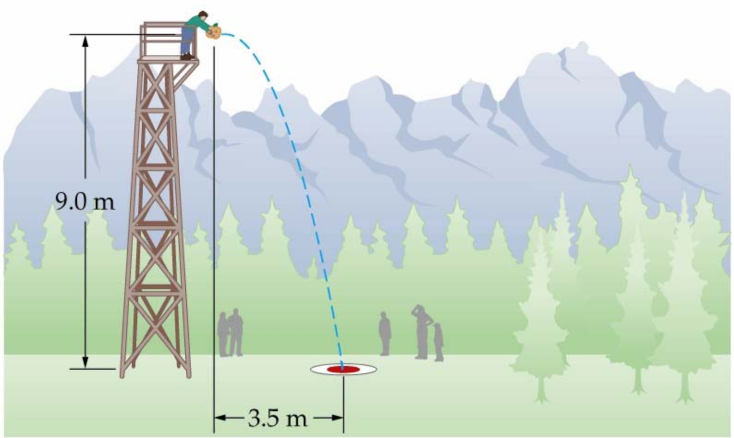
(a) Note that the time is given in this problem which greatly simplifies the calculations. We simply need to calculate how far the ball travels horizontally in the 0.45 s.

$$x = v_x t = \left(22 \ \frac{\text{m}}{\text{s}}\right)(0.45 \text{ s}) = \boxed{9.9 \text{ m}}$$

(b) The vertical drop is how far an object falls in 0.45 s, since the x and y motions are entirely independent. With $v_{0y} = 0$ and the coordinate system increasing downward.

$$y = \frac{1}{2}gt^2 = \frac{1}{2}\left(9.81 \ \frac{\text{m}}{\text{s}^2}\right)(0.45 \text{ s})^2 = \boxed{0.99 \text{ m}}$$

2. In Denver, children bring their old jack-o-lanterns to the top of a tower and compete for accuracy in hitting a target on the ground. Suppose that the tower is 9.0 m high and that the bulls-eye is a horizontal distance of 3.5 m from the launch point. If the pumpkin is thrown horizontally, what is the launch speed needed to hit the bulls-eye?



We need to solve for the time the pumpkin is in the air using y-motion and then use that time in the x-motion to solve for the launch velocity.

The pumpkin will fall the 9.0 m in t seconds, given by

$$\Delta y = -\frac{1}{2}gt^2$$

$$t = \sqrt{\frac{-2\Delta y}{g}} = \sqrt{\frac{-2(-9.0 \text{ m})}{9.81 \ \frac{\text{m}}{\text{s}^2}}} = 1.355 \text{ s}$$

and the initial horizontal speed needed is

$$v_x = \frac{x}{t} = \frac{3.5 \text{ m}}{1.355 \text{ s}} = \boxed{2.6 \text{ m/s}}.$$