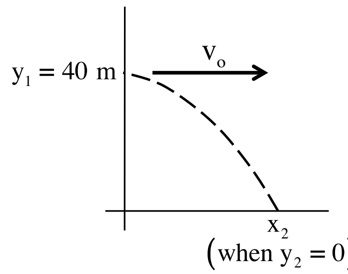
Problem 4.21

It takes 3.00 seconds for make the round trip the rock of 40.0 meter drop, then splash sound arriving back at the kicker. We'd like to determine that initial speed.



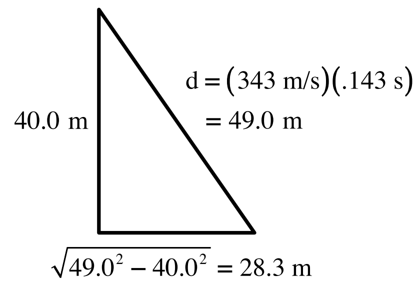
We need the time it takes for the rock to drop 40.0 m. Using what we know of it's y-motion, we can write:

$$\cancel{y_2}^{\,0} = y_1 + \cancel{v_{y,1}}^{\,0}\Delta t + \frac{1}{2}(-g)(\Delta t)^2$$

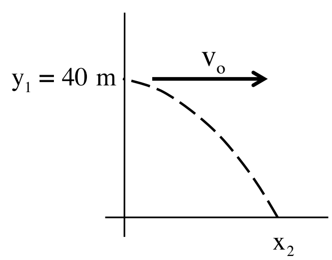
$$\Rightarrow \quad 0 = (40.0 \text{ m}) + \frac{1}{2}(-9.80 \text{ m/s}^2)(\Delta t)^2$$

$$\Rightarrow \quad \Delta t = 2.87 \text{ s}$$

This means that moving at 343 m/s, the sound only takes the remaining time of .143 seconds to travel STRAIGHT BACK to the kicker. That travel-back distance, then, must be (343 m/s)(.143 s) = 49.0 meters. Using that straight-line distance info and the triangle shown to the right, the *horizontal* distance is shown to be 28.3 meters.



The magnitude of the initial velocity is in the x-direction. Knowing the *distance* traveled in the x-direction, we can write:



$$x_2 = \cancel{x_1}^{\,0} + v_{1,x}\Delta t + \frac{1}{2}\cancel{a_x}^{\,0}(\Delta t)^2$$

$$\Rightarrow \quad (28.3 \text{ m}) = v_o(2.86 \text{ s})$$

$$\Rightarrow \quad v_o = 9.91 \text{ m/s}$$