Flipping Physics Lecture Notes:
An Introductory Projectile Motion Problem
with an Initial Horizontal Velocity
(Part 2 of 2)

Example Problem: While in a car moving at 10.0 miles per hour, mr.p drops a ball from a height of 0.70 m above the top of a bucket. Part 1) How far in front of the bucket should he drop the ball such that the ball will land in the bucket? *(Yes, I left the solution to part 1 in here. It just seemed more logical to me that way.)*

This is a projectile motion problem, so we should list our know variables in the x and y directions:

x-direction: $\Delta x = ?,\ v_x = 10.0\frac{mi}{hr}\times\frac{1hr}{3600\sec}\times\frac{1609m}{1mi} = 4.469\overline{4}\frac{m}{s}$

y-direction: $\Delta y = -0.70m,\ a_y = -9.81\frac{m}{s^2},\ v_{iy} = 0$

Because we know three variables in the y direction, we should start there to find the change in time.

$$\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2 \Rightarrow -0.7 = (0)\Delta t + \frac{1}{2}(-9.81)\Delta t^2 \Rightarrow (2)(-0.7) = -9.81\Delta t^2$$

$$\Rightarrow \Delta t^2 = \frac{(2)(-0.7)}{-9.81} \Rightarrow \Delta t = \sqrt{\frac{(2)(-0.7)}{-9.81}} = 0.377772\sec$$

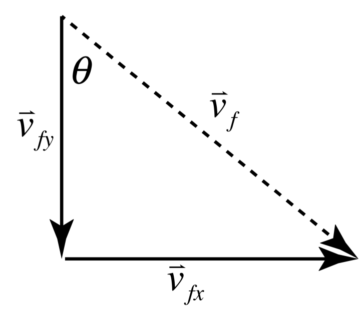
Because change in time is a scalar and therefore independent of direction, we can use it in the x-direction:

$$v_x = \frac{\Delta x}{\Delta t} \Rightarrow \Delta x = v_x\Delta t = \left(4.469\overline{4}\right)(0.377772) = 1.68843 \approx \boxed{1.7m}$$

Part 2) what is the final velocity of the ball right before it enters the bucket? In the y-direction:

$$v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y = 0^2 + (2)(-9.81)(-0.7) \Rightarrow v_{fy} = \sqrt{(2)(-9.81)(-0.7)} = \pm 3.70594 = -3.70594\frac{m}{s}$$

In the x-direction the ball is moving with a constant velocity and therefore $v_x = 4.469\overline{4}\frac{m}{s}$. Now, to find the magnitude of the final velocity we can use the Pythagorean theorem:



$$a^2 + b^2 = c^2 \Rightarrow v_f^2 = v_{fx}^2 + v_{fy}^2$$

$$\Rightarrow v_f = \sqrt{v_{fx}^2 + v_{fy}^2} = \sqrt{\left(4.469\overline{4}\right)^2 + (-3.70594)^2} = \pm 5.80602\frac{m}{s}$$

And now we need to find the direction:

$$\sin\theta = \frac{O}{H} = \frac{v_{fx}}{v_f} \Rightarrow \theta = \sin^{-1}\left(\frac{v_{fx}}{v_f}\right) = \sin^{-1}\left(\frac{4.469\overline{4}}{5.80602}\right) = 50.3354°$$

Therefore the final velocity is: $\boxed{v_f \approx 5.8\frac{m}{s} @ \left(5.0\times 10^1\right)° \text{ in front of the -y axis.}}$

Possible useful definitions:

- Cheeky (adjective): impudent or irreverent, typically in an endearing or amusing way.
- Gormless (adjective): lacking sense or initiative; foolish.
- Nimwit (noun): a stupid or silly person.
- Ill-fated (adjective): destined to fail or have bad luck.
- Buffoon (noun): a ridiculous but amusing person; a clown.