Flipping Physics Lecture Notes:
An Introductory Projectile Motion Problem
with an Initial Horizontal Velocity
(Part 1 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?

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:

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

In the video I said, “If you decrease the speed of the car by half a mile per hour, you decrease the displacement in the x-direction of the ball by more than 8 cm.” Here is the mathematical proof:

Let’s start by decreasing the car by half a mile per hour, this makes the initial velocity in the x-direction 9.5 mph.

Known variables:

x-direction: $\Delta x = ?,\ v_x = 9.5\frac{mi}{hr}\times\frac{1hr}{3600\sec}\times\frac{1609m}{1mi} = 4.24597\overline{2}\frac{m}{s}$

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

The y-direction information doesn’t change at all so we still get 0.377772 seconds for the change in time.

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

$\Rightarrow \Delta t^2 = \frac{(2)(-0.7)}{-9.81} \Rightarrow \Delta t = \sqrt{\frac{(2)(-0.7)}{-9.81}} = 0.377772\sec$ (see, it didn’t change! ☺)

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

$$v_x = \frac{\Delta x}{\Delta t} \Rightarrow \Delta x = v_x\Delta t = \left(4.24597\overline{2}\right)(0.377772) = 1.60401\text{m}$$

The difference in x displacement then is:

$1.68843 - 1.60401 = 0.084421m \times \frac{100cm}{1m} \approx \boxed{8.4cm}$ (which is greater than 8 cm.)