

Flipping Physics Lecture Notes: Nerd-A-Pult – An Introductory Projectile Motion Problem

First off, the Nerd-A-Pult can be purchased at www.marshmallowcatapults.com

Example Problem: A ball is launched from the Nerd-A-Pult with an initial speed of 3.25 m/s at an angle of 61.7° above the horizontal. If the basket is 93 cm from the ball horizontally, where should the basket be placed vertically relative to the ball so the ball lands in the basket?

Before we start listing what we know in the x and y directions, we should split the initial velocity in to it's components.

$$\sin\theta = \frac{O}{H} \Rightarrow \sin\theta_i = \frac{v_{iy}}{v_i} \Rightarrow v_{iy} = v_i \sin\theta_i = (3.25)\sin(61.7^\circ) = 2.86155\frac{m}{s}$$

$$\cos\theta = \frac{A}{H} \Longrightarrow \cos\theta_i = \frac{v_{ix}}{v_i} \Longrightarrow v_{ix} = v_i \cos\theta_i = (3.25)\cos(61.7) = 1.54079\frac{m}{s}$$

Now we can list our x & y direction knowns.

x-direction: 
$$v_{ix} = 1.54079 \frac{m}{s}, \Delta x = 93 cm \times \frac{1m}{100 cm} = 0.93 m$$
  
y-direction:  $v_{iy} = 2.86155 \frac{m}{s}, a_y = -9.81 \frac{m}{s^2}, \Delta y = ?$ 

We know two variables in both the x and y directions so we should start by finding the change in time in the x-direction and then use that  $\Delta t$  in the y-direction. We can't start with the y-direction because we need to know 3 variable in the y-direction and only 2 in the x-direction.

x-direction: Remember the velocity initial in the x-direction is the same as the velocity in the x-direction because all objects in projectile motion have a constant velocity in the x-direction.

$$v_{ix} = v_x = \frac{\Delta x}{\Delta t} \Rightarrow v_x \Delta t = \Delta x \Rightarrow \Delta t = \frac{\Delta x}{v_x} = \frac{0.93}{1.54079} = 0.603588 \text{ sec}$$

y-direction:  $\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2 = (2.86155)(0.603588) + \frac{1}{2}(-9.81)(0.603588)^2 = -0.059785m$  $\Rightarrow \Delta y = -0.059785m \times \frac{100cm}{1m} = -5.9785cm \approx -6.0cm$ 



<sup>•</sup> For those of you who plug this into your calculator and get  $\Delta t = \frac{0.93}{1.54079} = 0.6035864719 \approx 0.603587 \text{ sec}$ , please realize that I usually use the answer button on my calculator instead of typing in the numbers. Therefore I didn't actually use 1.54079 for my v<sub>x</sub>, I used 1.540786679 which gives you  $\Delta t = \frac{0.93}{1.540786679} = 0.6036877727 \approx 0.603588 \text{ sec}$ . After rounding at the end of the problem, it doesn't matter, however, I knew there would be some people who would question my math.  $\textcircled{\odot}$