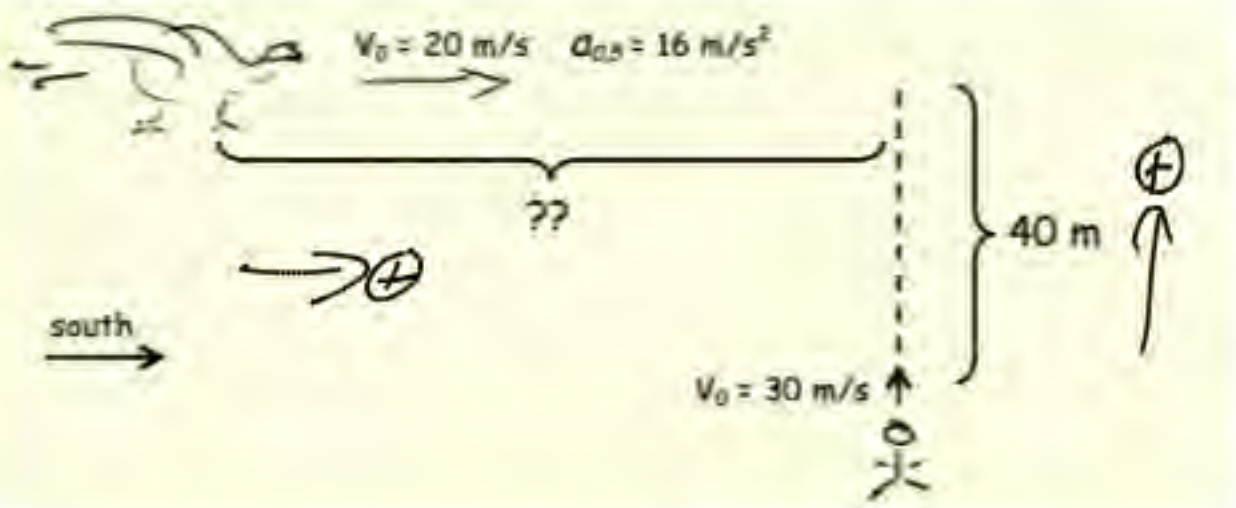


a) How far North of the QVH should the Big Ol' Duck be at the moment the shot is fired, if the shot is to hit the Big Ol' Duck?

$$\Delta X = \frac{1}{2} a t^2 + V_0 t$$

$$40_m = \frac{1}{2}(-10\,m/s^2)(t^2) + (30\,m/s)\,t$$

$$0 = -5t^2 + 30t - 40$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$t = \frac{-30 \pm \sqrt{30^2 - 4(-5)(-40)}}{2(-5)}$$

$t = 2_s$ $\quad$ $t = 4_s$

The bullet will be at a height of 40m at those times

$$\Delta X = \frac{1}{2} a t^2 + V_0 t$$

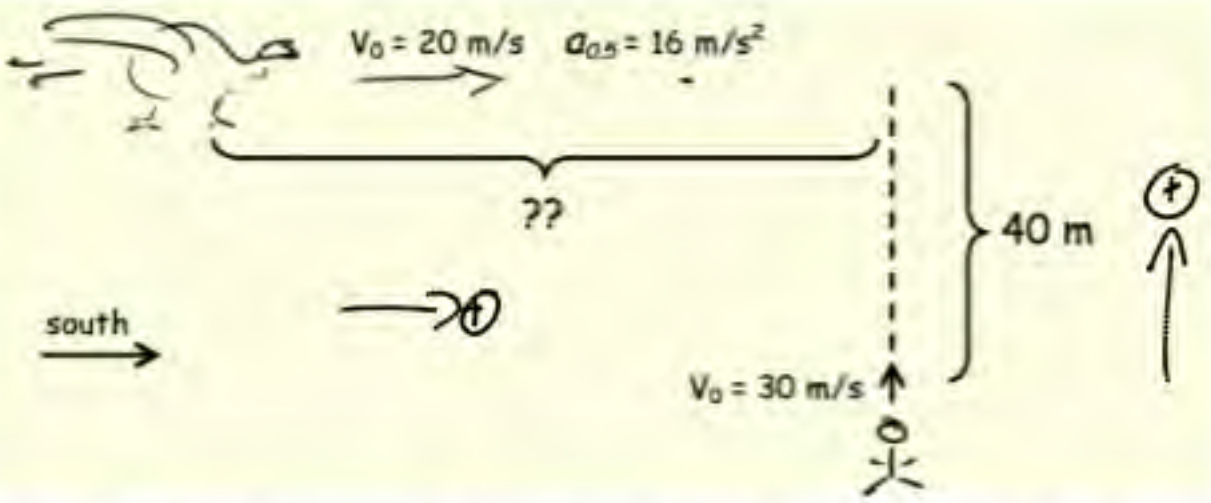
$$\Delta X = \frac{1}{2}(16\,m/s^2)(1.5_s)^2 + (20\,m/s)(1.5_s)$$

$$\Delta x = 48_m + (20\,m/s)(0.5_s) = \boxed{58_m}$$

$$\Delta X = \frac{1}{2} a t^2 + V_0 t$$

$$\Delta X = \frac{1}{2}(16\,m/s^2)(3.5_s)^2 + (20\,m/s)(3.5_s)$$

$$\Delta X = 168_m + (20\,m/s)(0.5_s) = \boxed{178_m}$$



b) Why are there two mathematically possible answers to the above question (a)? Are both mathematical "roots" physically meaningful?

c) What if the Big Ol' Duck had accelerated at the same constant rate but toward the North? Can you find *four* mathematical "roots" to the problem? Are there four physically meaningful answers to the problem?

With this new "a" Where will the BOD need to be (How far away from the QYH.)

$$\Delta x = \frac{1}{2} a t^2 + V_0 t$$

$$\Delta x = \frac{1}{2}\left(-16 \tfrac{m}{s^2}\right)(1.5s)^2 + \left(20 \tfrac{m}{s}\right)(1.5s)$$

$\Delta x = 12m$ (after the 0.5s)

$$\Delta x = \frac{1}{2} a t^2 + V_0 t$$

$$\Delta x = \frac{1}{2}\left(-16 \tfrac{m}{s^2}\right)(3.5s)^2 + 20 \tfrac{m}{s}(3.5s)$$

$\Delta x = -28m$ (after the 0.5s)

Reverse, Reverse

@ what "t" will the BOD be at position $x = 0m$

$$\Delta x = \frac{1}{2}at^2 + V_0 t$$

$$12m = \frac{1}{2}\left(-16\frac{m}{s}\right)t^2 + \left(20\frac{m}{s}\right)t$$

$$0 = -8t^2 + 20t - 12$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad t = \frac{-20 \pm \sqrt{(20)^2 - 4(-8)(-12)}}{2(-8)}$$

$t = 1s + .5s = \boxed{1.5s}$ $\quad t = 1.5s + .5s = \boxed{2s}$

$$\Delta x = \frac{1}{2}at^2 + V_0 t$$

$$-28m = \frac{1}{2}\left(-16\frac{m}{s}\right)t^2 + \left(20\frac{m}{s}\right)t$$

$$0 = -8t^2 + 20t + 28$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad t = \frac{-20 \pm \sqrt{(20)^2 - 4(-8)(28)}}{2(-8)}$$

$t = -1s + .5s = \boxed{-.5s}$ $\quad t = 3.5s + .5s = \boxed{4s}$

Analysis

We now have 4 roots to the question "When will the BOD be @ X=0m"

OR... when will the BOD be UNDER the QYH

SO..... Are all roots meaningful for the question?

NO !!

Why? Because the BOD can be at that Position whenever it will like BUT the bullet is at that position ONLY at 2s and 4s

The BOD can be there at t=-0.5s but the bullet wasn't fired yet

The BOD can be there at t=1.5s but the bullet has not reached the BOD yet