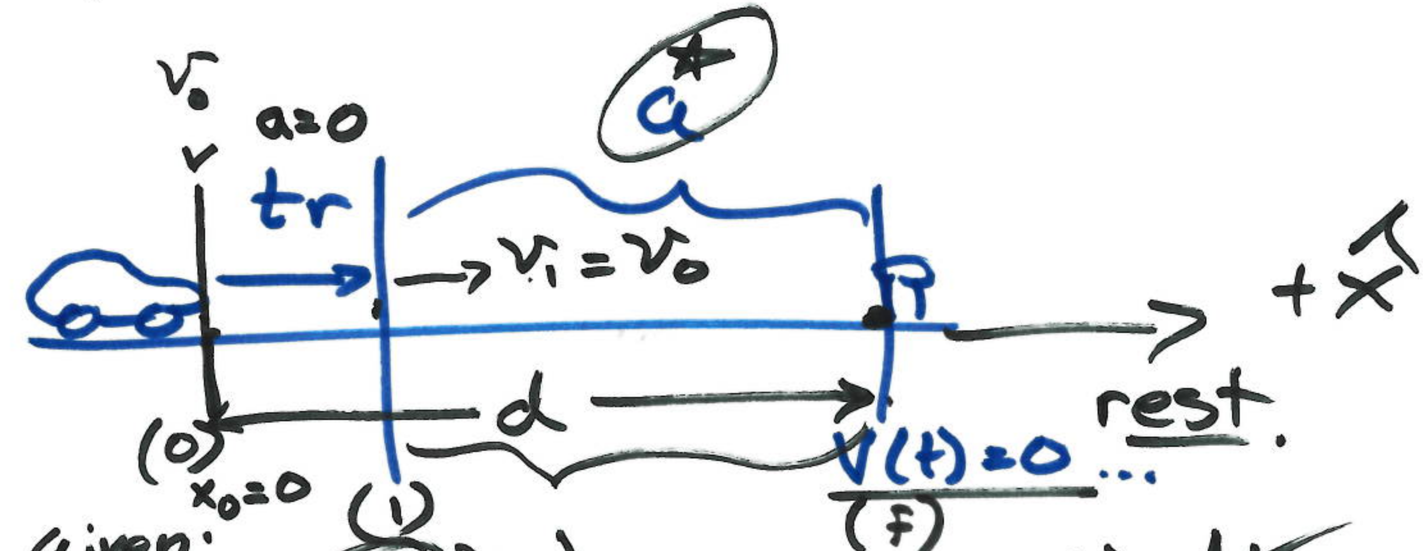
Physics 200

Day # 4

Motion in 1-D

Homework?



given: $\quad \quad x_1 =$ find: $\quad \quad x_f = x(t) = d$ ✓

t_r

d

v_0

$$\underbrace{x_1 = x_0 + v_0 t_r}_{d = rt} + \frac{1}{2} \cancel{a}^{\,0} t_r^2$$

a=0 here

$$x_1 = v_0 t_r$$

from (1) $\rightarrow$ (f):

$v_0 \longrightarrow v(t) = 0$

dist $= d - v_0 t_r$

time = ??.

find: a $\quad$ (III) $v^2(t) = v_0^2 + 2a(x(t) - x_0)$

from (1) to (f).

$v(t)=0$

$$0 = v_0^2 + 2\overset{\star}{a}(d - v_0 t_r)$$

Motion in 2-d at constant a:

in projectile motion: $\vec{a} = -g\hat{y} + 0\hat{x}$

$g = 9.8\,m/s^2$ down Not x

x $a_x = 0$

$v_x(t) = v_{0_x} + 0t$

$$\boxed{x(t) = x_0 + v_{0_x} t} + 0$$

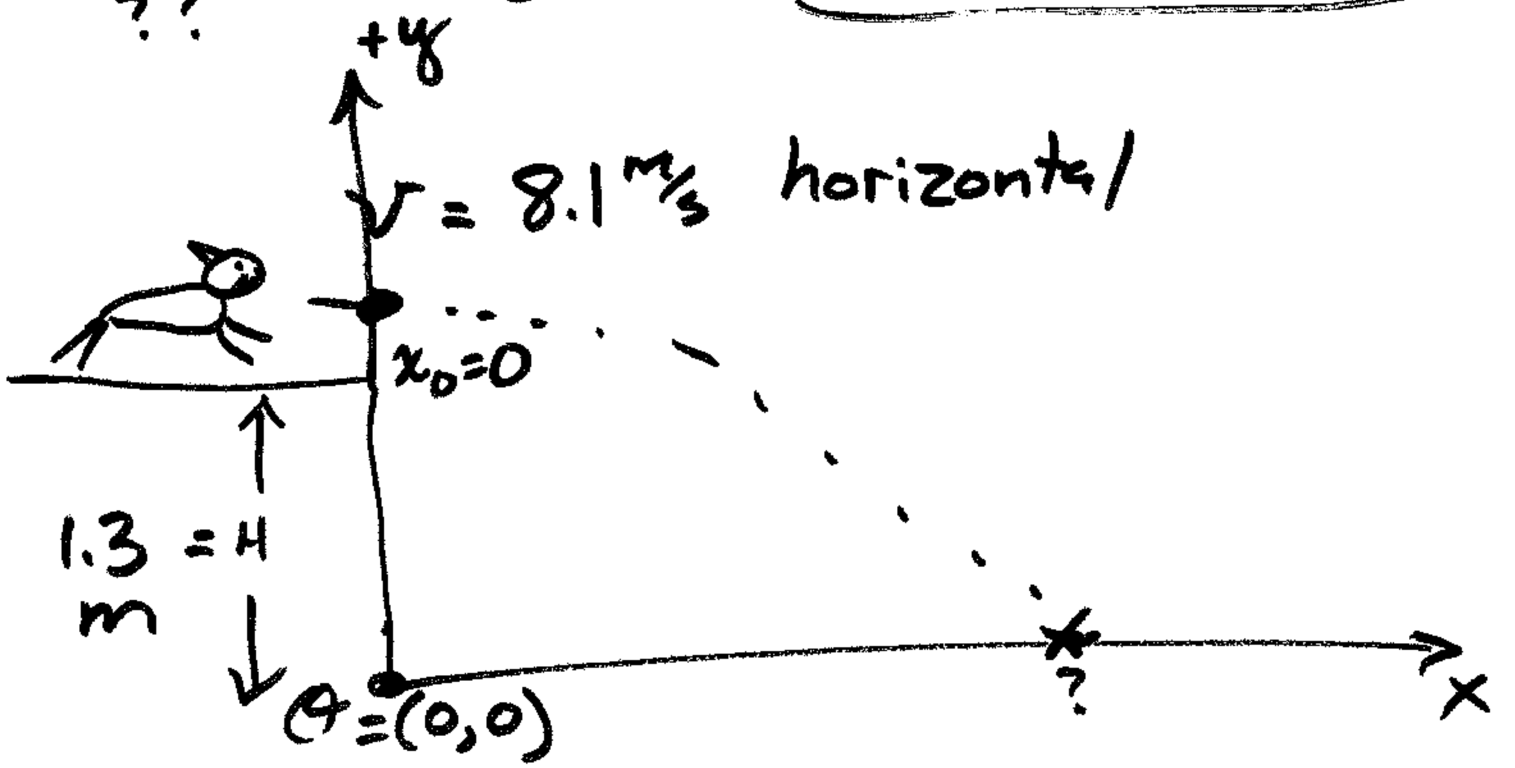
range

$v_x^2(t) = v_{0_x}^2 + \cancel{2a_x(x - x_0)}$ 0 0

??

y $a_y = -g$

$$\boxed{\begin{aligned} v_y(t) &= v_{0_y} - gt \\ y(t) &= y_0 + v_{0y} t - \tfrac{1}{2} g t^2 \\ v_y^2(t) &= v_{0_y}^2 - 2g(y(t) - y_0) \end{aligned}}$$



Find where cat lands, and how fast?

$x(t) = x_0 + v_{0x} t$

★ $= 0 + \underbrace{8.1\frac{m}{s}}_{\text{given}} t$

need to find t.

$v_y(t) = \underbrace{\cancel{v_{0y}}}_{\substack{0 \\ \text{horiz.}}} - gt$

$v_y(t) = -gt$

$y(t) = y_0 + 0 - \frac{1}{2}gt^2$

$0 = +1.3m + 0 - \frac{1}{2}gt^2$

$-1.3m = -4.9\frac{m}{s^2}t^2$

$\frac{-1.3m}{-4.9m/s^2} = t^2$

$\pm\sqrt{0.265\, s^2} = \sqrt{t^2}$

$+ 0.515\, s = t$

choose +.

$x(t) = v_{0x} t$

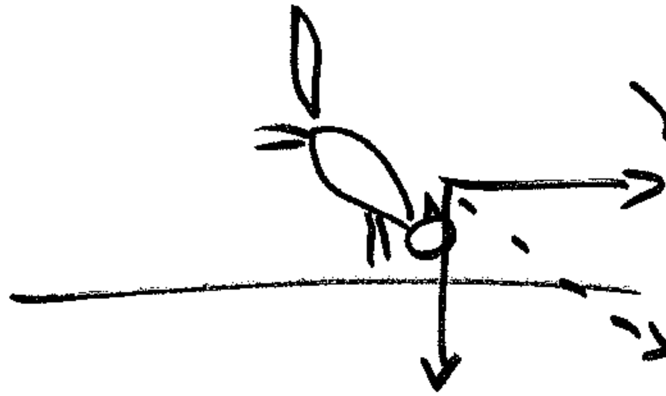
$= 8.1\frac{m}{\cancel{s}} \cdot 0.515\cancel{s}$

$\boxed{x(t) = 4.17m}$

$v_y(t) = -gt$

$= -9.8\frac{m}{s^{\cancel{2}}} \times (0.515\cancel{s})$

$v_y(t) = \boxed{-5.05\frac{m}{s}}$



$v_x(t) = v_{0x} = 8.1\,\frac{m}{s}$ since $\underline{a_x = 0}$.

$v(t) =$

$v_y(t) = -5.05\,\frac{m}{s}$

$v(t) = \sqrt{v_x^2(t) + v_y^2(t)}$ pythagorean

$= \sqrt{(8.1\,\frac{m}{s})^2 + (-5.05\,\frac{m}{s})^2}$

$$\boxed{v(t) = 9.54\,\frac{m}{s}}$$

back to Eq. III in y direction:

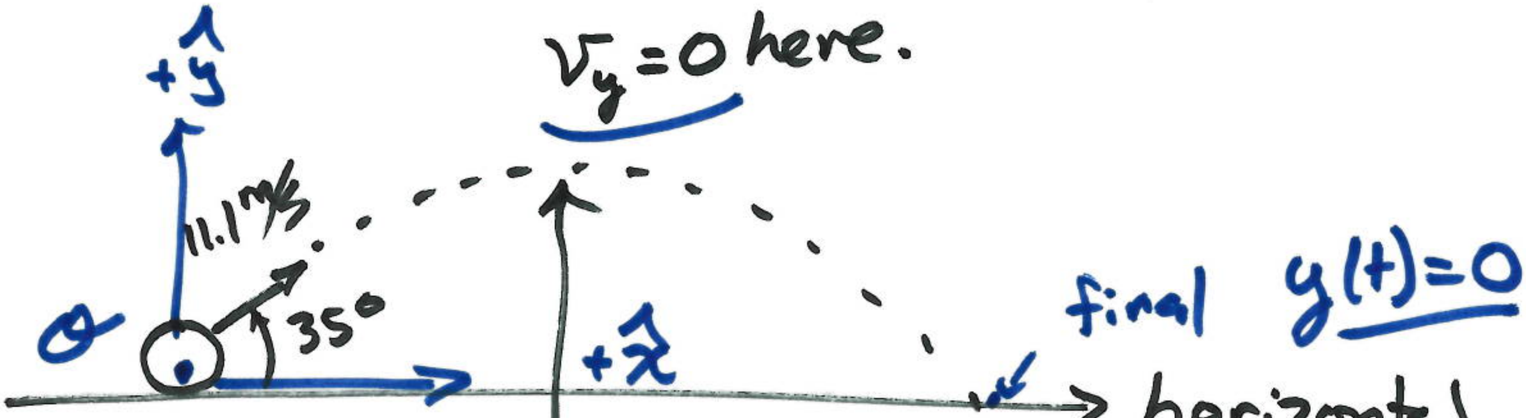
$$v_y^2(t) = \underbrace{v_{0y}^2}_{=0} + 2\underbrace{(a_y)}_{-g}(y(t) - y_0)$$

$$v_y^2(t) = 0 - 2(9.8\,\tfrac{m}{s^2})(0 - 1.3\,m)$$

$$\pm\sqrt{v_y^2(t)} = \sqrt{25.5\,\frac{m^2}{s^2}}$$

$$v_y(t) = \pm 5.05\,\frac{m}{s}$$

choose $-$: going <u>down</u>.



max height
time to reach max. height

range
time of flight
$\vec{v}$ just before hits ground.

init

$x_0 = 0 \quad v_{0x} =$

$y_0 = 0 \quad v_{0y} =$

$v_{0y} = 11.1\frac{m}{s} \sin 35° = \boxed{6.37\frac{m}{s}}$

$v_{0x} = 11.1\frac{m}{s} \cos 35° = \boxed{9.09 \text{ m/s}}$

$$\overset{*}{x}(t) = \underbrace{x_0}_{=0} + v_{0x}\, t^{?}_{**}$$

$$y(t) = y_0 + v_{0y} t - \frac{1}{2} g t^2$$

$$0 = 0 + 6.37\tfrac{m}{s} t - 4.9\tfrac{m}{s^2} t^2$$

$$0 = 6.37\tfrac{m}{s} - 4.9\tfrac{m}{s^2}\,t$$

solve

$$t = \frac{6.37\,m/s}{4.9\,m/s^2} = \boxed{1.3\,s = t}$$

full flight

$$x(t) = 0 + 9.09\tfrac{m}{s}\,(1.3\,s) = \boxed{11.8\,m}$$

$\vec{v}$ just before flight ends:

$$V_x(t) = 9.09\tfrac{m}{s}$$

$$V_y(t) = \star.$$

$(I)_y$: $$V_y(t) = v_{0y} - gt$$

$$= 6.37\tfrac{m}{s} - 9.8\tfrac{m}{s^2}\,(1.3\,s)$$

$$\boxed{V_y(t) = -6.37\tfrac{m}{s}}$$