Phys 2110-5 9/12/12

Note Title 9/12/2012

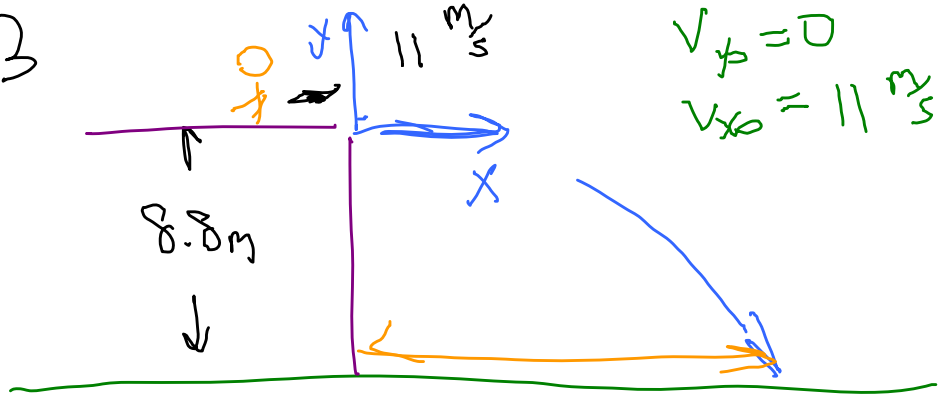
2D Motion.

Constant acceleration

x	y
$v_x = v_{ox} + a_x t$	$v_y = v_{oy} + a_y t$
$x = x_o + v_{ox} t + \frac{1}{2} a_x t^2$	$y = y_o + v_{oy} t + \frac{1}{2} a_y t^2$
$v_x^2 = v_{ox}^2 + 2 a_x (x - x_o)$	— —
$x = x_o + \frac{1}{2}(v_{ox} + v_x) t$	— —

Free-fall $a_x = 0$ $a_y = -9.8 \frac{m}{s^2} \approx -9$

3.33



$V_{y0} = 0$

$V_{x0} = 11 \frac{m}{s}$

a) How long in flight?

b) How far move horiz.

a) How long in flight?

When does $y = -8.8\,m$?

$a_y = -g$

$y = \cancel{V_{y0}}t + \frac{1}{2}a_y t^2$

$= \frac{1}{2}(-9.8 \frac{m}{s^2})t^2 = -8.8\,m$

$t = 1.34\,s$

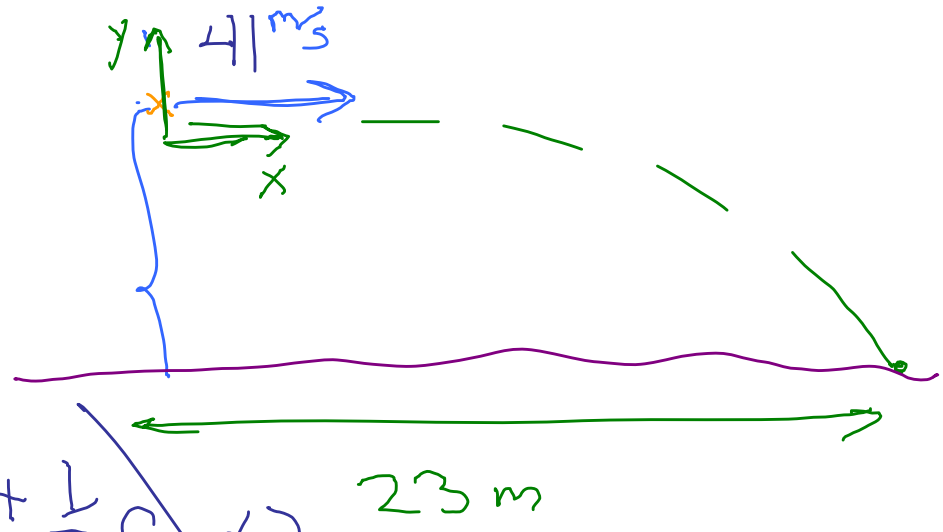
b) Horiz distance?
What is x at that time?

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$

$v_{x0} = 11\ \frac{m}{s}$, $a_x = 0$, $t = 1.34\ s$

$$= \left(11\ \frac{m}{s}\right)(1.34\ s) \approx 14.7\ m$$

3.34 An arrow fired horizontally at $41\frac{m}{s}$ travels horiz'ly 23 m, from what height was it shot?



Time in flight.
At impact

$X = 23m = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$

$= (41\frac{m}{s})t$

$t = \frac{23}{41}s = 0.561$

What is y at this time?

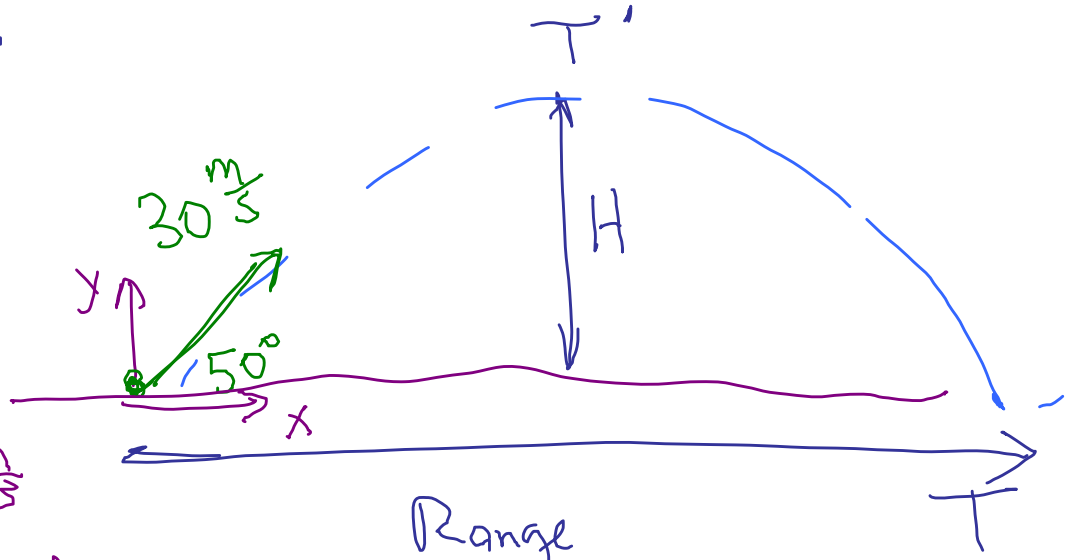
$y = y_0 - \frac{1}{2}gt^2 = -1.54m$

$\uparrow h = 1.54m$

New Problem

Projectile Problem

Find R, H, T, etc...



$a_x = 0 \quad a_y = -9.8 \frac{m}{s^2}$

$v_{x0} = 30 \frac{m}{s} \cos 50^\circ = 19.28 \frac{m}{s}$

$v_{y0} = 30 \frac{m}{s} \sin 50^\circ = 22.98 \frac{m}{s}$

$y = \cancel{y_0} + v_{y0} t - \frac{1}{2} g t^2$

$= (22.98 \frac{m}{s}) t - \frac{1}{2} g t^2$

$x = \cancel{x_0} + v_{x0} t + \sim$

$= (19.28 \frac{m}{s}) t$

a) How long was it "in air".
What is t when $y = 0$?

$$y = 22.98\,t - \tfrac{1}{2}9.8\,t^2 = 0$$

$$t(22.98 - 4.9\,t) = 0$$

$t = 0$, $t = 0$, $4.9t = 22.98$

$$t = \frac{22.98\ \frac{m}{s}}{4.9\ \frac{m}{s^2}} = 4.7\ s$$

What is Range? What is x at this time?

$$x = \left(19.28\ \tfrac{m}{s}\right)t = 90.4\ m$$

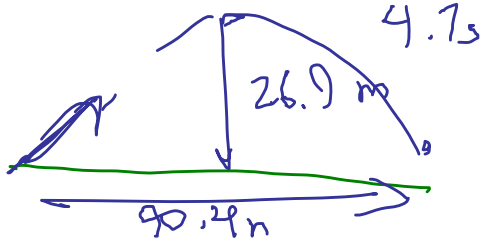
When did ball get to max ht?

When does $v_y = 0$?

$$v_y = v_{yo} + a_y t = \left(22.98 \tfrac{m}{s}\right) - \left(9.8 \tfrac{m}{s^2}\right) t$$

$$= 0$$

$$t = \frac{22.98}{9.8} = \boxed{2.34\ s}$$

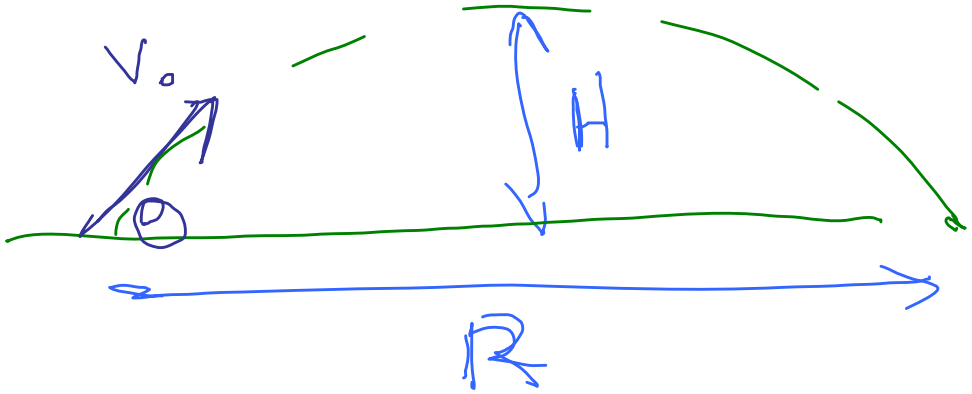


What is max?

What is y at this time?

$$y = \cancel{y_0} + \left(22.98 \tfrac{m}{s}\right) t - \tfrac{1}{2} g t^2$$

$$= \boxed{26.9\ m}$$



$V_{x0} = V_0 \cos\theta$ $\quad a_x = 0$

$V_{y0} = V_0 \sin\theta$ $\quad a_y = -g$

How long in flight? When does $y = 0$?

$$y = (V_0 \sin\theta)t - \frac{1}{2}gt^2 = 0 = t\left(V_0 \sin\theta - \frac{g}{2}t\right)$$

V_y

Two answers. $t \neq 0$

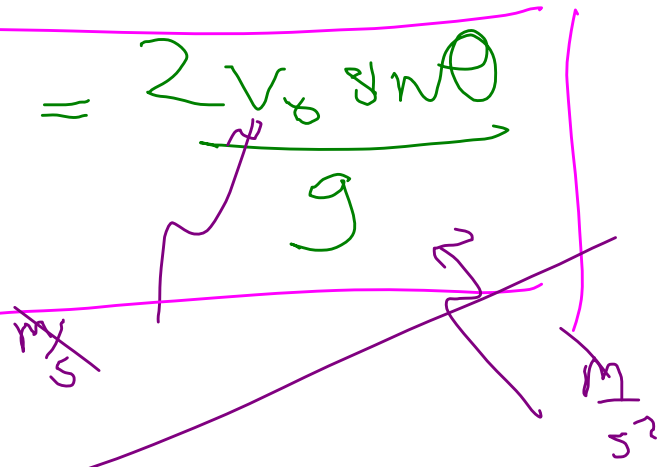
$$V_0 \sin\theta = \frac{gt}{2} \quad \text{or} \quad \boxed{t = \frac{2V_0 \sin\theta}{g}}$$

What is x at this time?

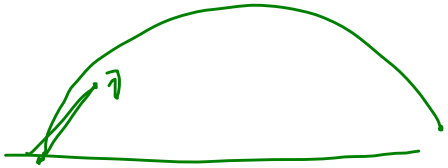
$$x = (V_0 \cos\theta)\, t$$

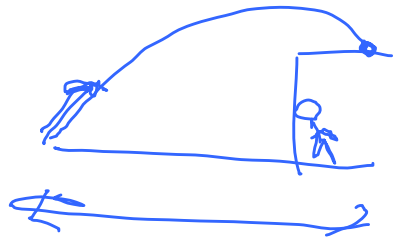
$$= (V_0 \cos\theta)\, \frac{2V_0 \sin\theta}{g}$$

$$= \boxed{\frac{2V_0^2 \sin\theta \cos\theta}{g} = R}$$



$= S$





$$R = \frac{2v_0^2 \sin\theta \cos\theta}{g}$$

$$= \frac{v_0^2 \sin 2\theta}{g}$$

Keep v_0 constant

For what θ is R biggest?

$2\theta = 90$

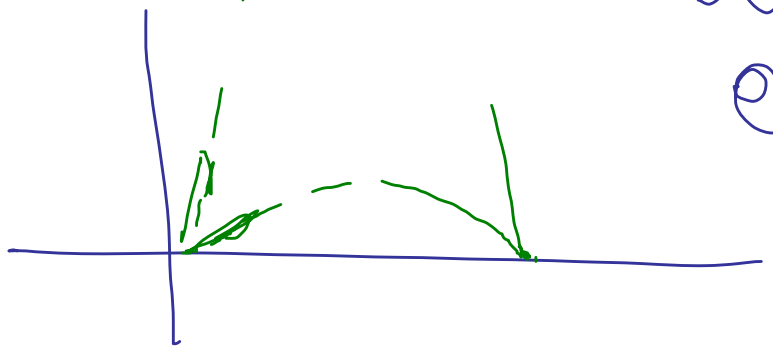
$\theta = 45$

$m =$

16, 80

28, 75

36, 66

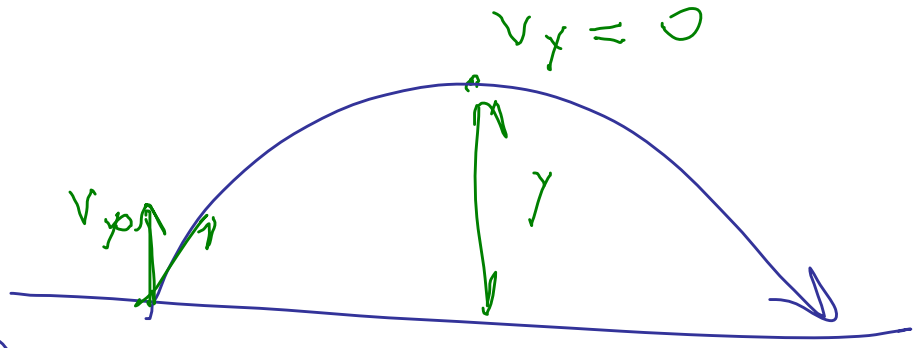


Time to get to max height:

$V_y = 0$

$V_y = V_{y0} - gt$

$\Rightarrow 0$



$$t = \frac{V_y}{g} = \frac{V_0 \sin\theta}{g} = \tfrac{1}{2} \text{ journey} \qquad a_y = -g$$

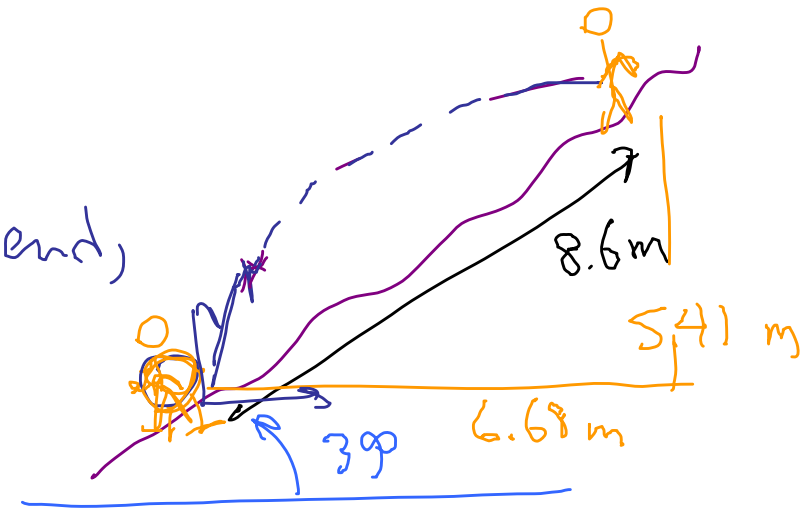
$V_y^2 = V_{y0}^2 + 2a(y - y_0)$

$0 = (V_0^2 \sin^2\theta) - 2gH$

$$H = \frac{V_0^2 \sin^2\theta}{2g}$$

3.62 Toss protein bar

Det. intial vel. so that when it gets to thin friend, moving horizontally.



$a_y = -g$ $\quad V_x$

$V_y = 0$

$\Delta y = 5.41\text{m}$

$V_y^2 = V_{y0}^2 + 2a_y(y - y_0)$

V_y: 0 $\quad V_{y0}$: ? $\quad a_y$: $-9.8\ \frac{m}{s^2}$ $\quad y - y_0$: 5.41

$V_{x0} = 10.3\ \frac{m}{s}$

$V_x = V_{x0} - g\,t$

$t = 1.05\text{s}$

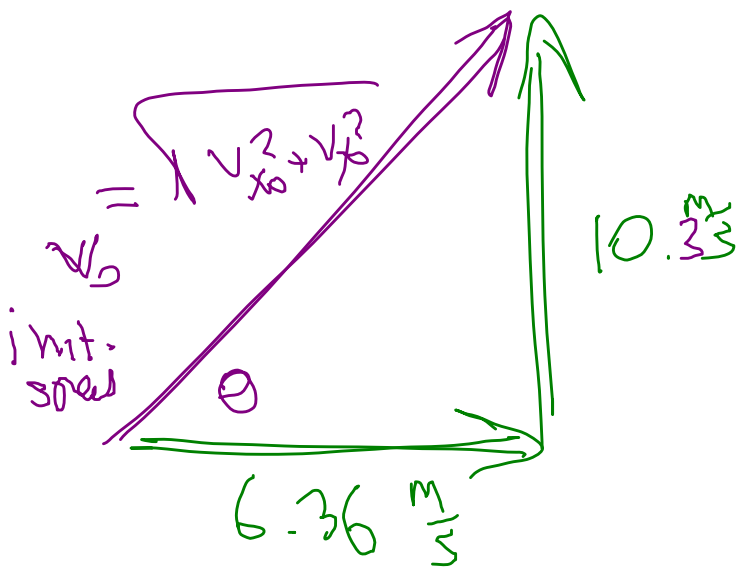
V_x: ∞ $\quad V_{x0}$: 10.3

X eqn:

$$X = v_{x_0} t$$

$$6.60\,m = v_{x_0}(1.05\,s)$$

$$\Longrightarrow 6.36\,\tfrac{m}{s} = v_{x_0}$$



$$\tan\theta = \frac{10.3}{6.36}$$

$$\Longrightarrow \theta = 58.3^\circ$$