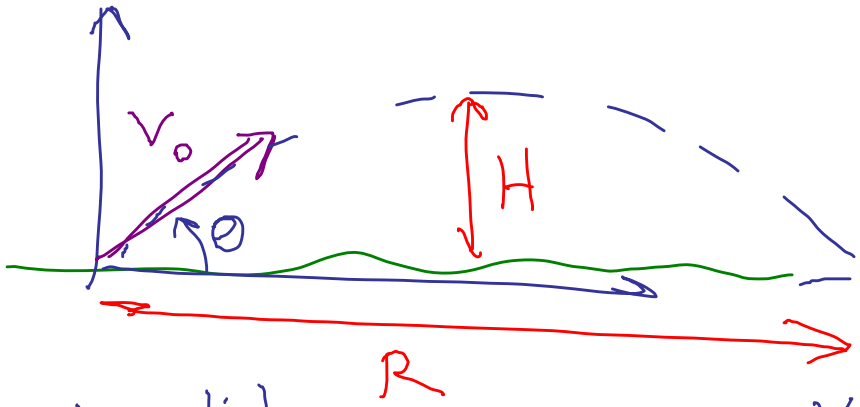
Phys 2110-4 9/16/11

Note Title 9/16/2011

Chap 3 2-dim motion



projectile

$v_{0x} = v_0 \cos\theta$

$v_{0y} = v_0 \sin\theta$

$a_x = 0 \qquad a_y = -g$

$g = 9.8\ m/s^2$

$x = (v_0 \cos\theta)\, t$

$y = (v_0 \sin\theta)\, t - \frac{1}{2} g t^2$

Time of flight: $y = 0$

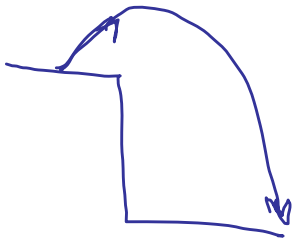
$$y = t\left[v_0 \sin\theta - \tfrac{1}{2} g t\right] = 0$$

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

$\longrightarrow$ Find x at that time

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

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



Given v_0 what θ gives max R $\quad \theta = 45^\circ$

Max ht is when $v_y = 0$

$$v_y = (v_0 \sin\theta) - gt$$

$$= 0 \qquad t = \frac{v_0 \sin\theta}{g}$$

$\frac{1}{2}$ time for whole flight

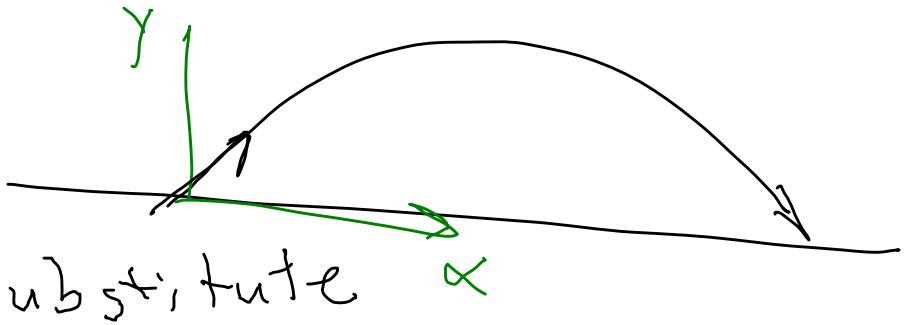
H = value of y

$$= (v_0 \sin\theta)\left(\frac{v_0 \sin\theta}{g}\right) - \frac{1}{2} g \left(\frac{v_0 \sin\theta}{g}\right)^2$$

$$= \frac{v_0^2 \sin^2\theta}{g} - \frac{1}{2}\frac{v_0^2 \sin^2\theta}{g} = \frac{1}{2}\frac{v_0^2 \sin^2\theta}{g}$$

$$x = v_0 \cos\theta \, t$$

$$t = \frac{x}{v_0 \cos\theta}$$



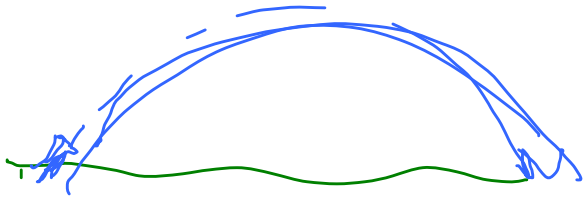
Substitute

$$y = (v_0 \sin\theta)\left(\frac{x}{v_0 \cos\theta}\right) - \frac{1}{2} g \left(\frac{x}{v_0 \cos\theta}\right)^2$$

$$= \tan\theta \, x - \frac{g x^2}{2 v_0^2 \cos^2\theta}$$

Relate y & x

Parabola



Example Kick football at gr. level at $20\ \frac{m}{s}$, 45° from horizontal toward goal is 4 m high, 30 m from launch point.

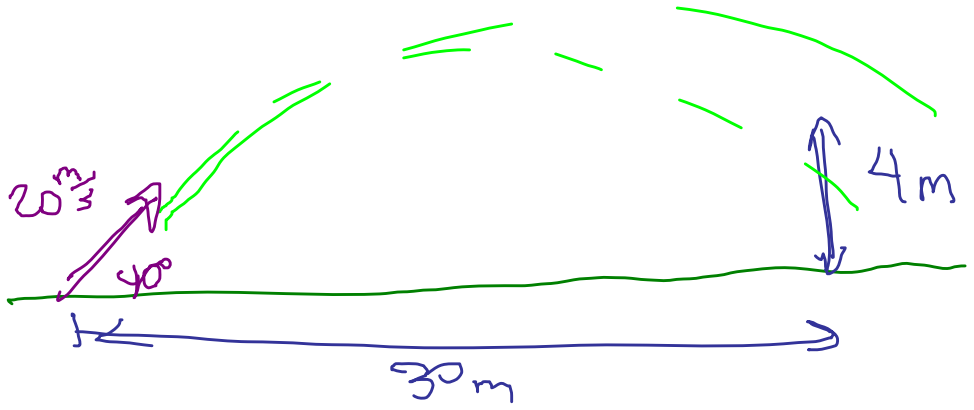
Does it clear the goal?

Full range

$$R = \frac{v_0^2 \sin 2\theta}{g} = 40.2\ m$$

$\Rightarrow$ When $x = 30$ m

what is y?



When does $x = 30\,m$

$V_{ox} = 15.32 \frac{m}{s}$ $\quad V_{oy} = 12.86 \frac{m}{s}$

$x = V_{ox} t \qquad t = \frac{30\,m}{15.32 \frac{m}{s}} = 1.96\,s$

$x = 30\,m$

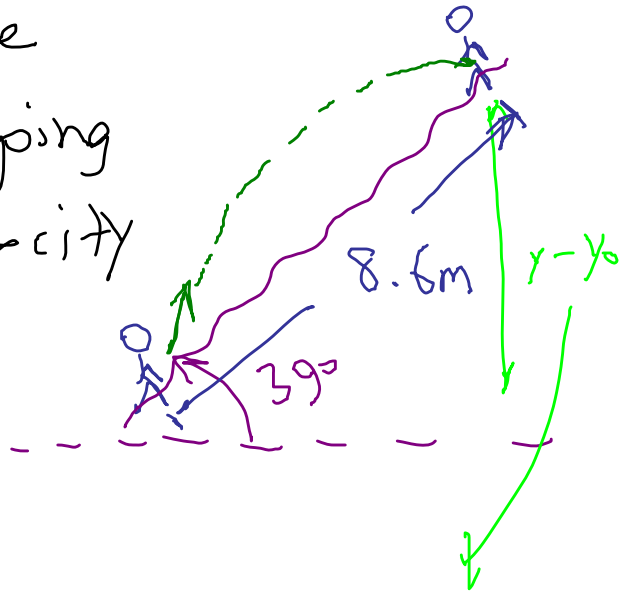
what is y?

$$y = (12.86 \tfrac{m}{s})(1.96\,s) - \tfrac{1}{2} g (1.96\,s)^2$$

$$= 6.36\,m$$

clears the goalposts.

3.62 You toss food to companion located 8.6m up 39° slope When it arrives food is going horizontally. Find initial velocity of food. (Dir & mag.)



Find v_{ox}, v_{oy}. $\quad v_y = 0$

$$v_y^2 = v_{oy}^2 + 2a_y(y - y_0)$$

$$0 = v_{oy}^2 + 2\left(-9.8\tfrac{m}{s^2}\right)(5.412\,m)$$

$$\longrightarrow \quad v_{oy} = 10.3\tfrac{m}{s}$$

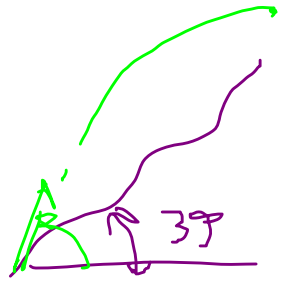
Time in flight

$V = V_{oy} + a_y t$

$0 \quad 10.3\ m/s \quad -9.8\ m/s^2$

t in flight

$1.05\ s$



$\Delta x = V_{ox} t \qquad 6.68\ m = V_{ox}(1.05\ s)$

$V_{ox} = 6.36\ m/s$

Speed

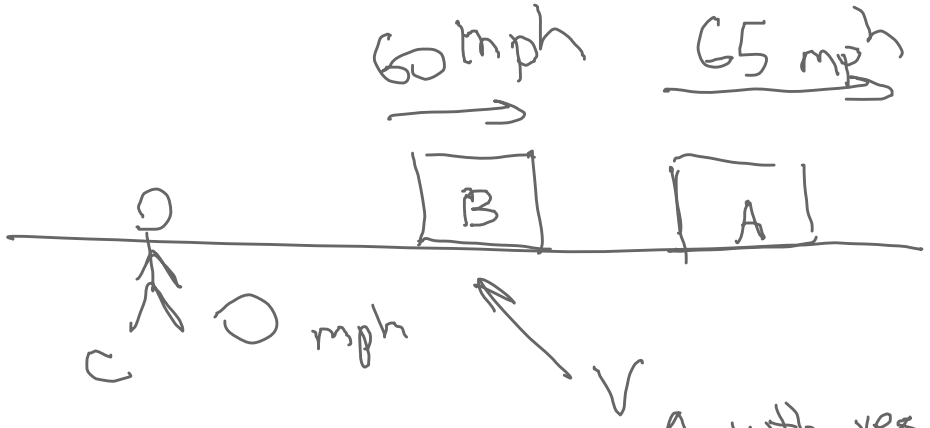
$V_0 = \sqrt{V_{ox}^2 + V_{oy}^2} = 12.1\ m/s$

Plug in

$\tan\theta = \frac{V_{oy}}{V_{ox}}$

$\theta = 58.3^\circ$

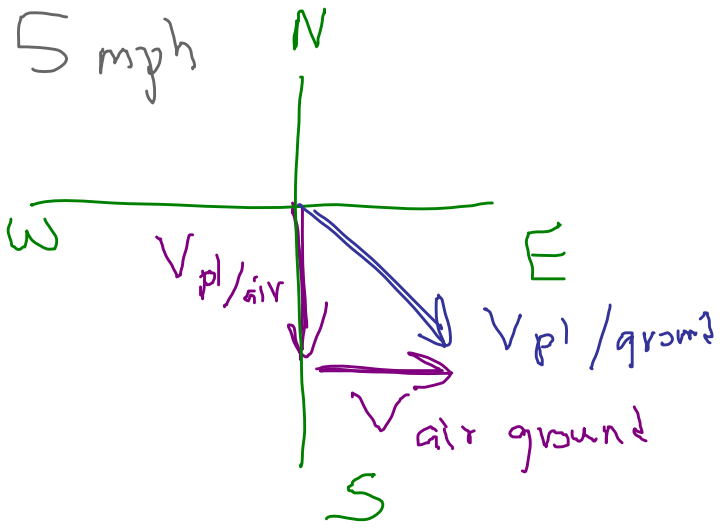
Sec 33 Relative Motion



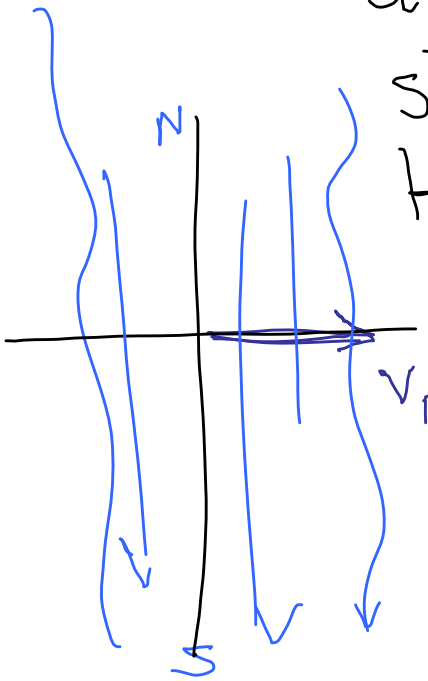
$$V_{AC} = V_{AB} + V_{BC}$$

More generally

$$\vec{V}_{AC} = \vec{V}_{AB} + \vec{V}_{BC}$$

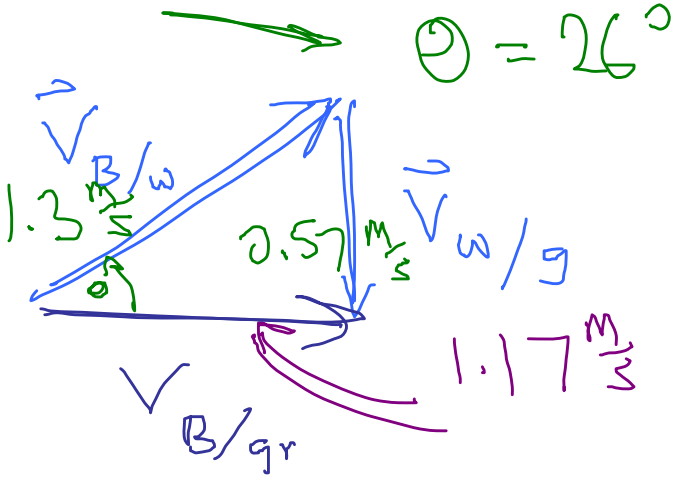


3.27 You wish to row straight across 63-m wide river. You can row $1.3\ \frac{m}{s}$ rel to water and river flows at $0.57\ \frac{m}{s}$. a) What direction should you head? b) How long it take to cross river?

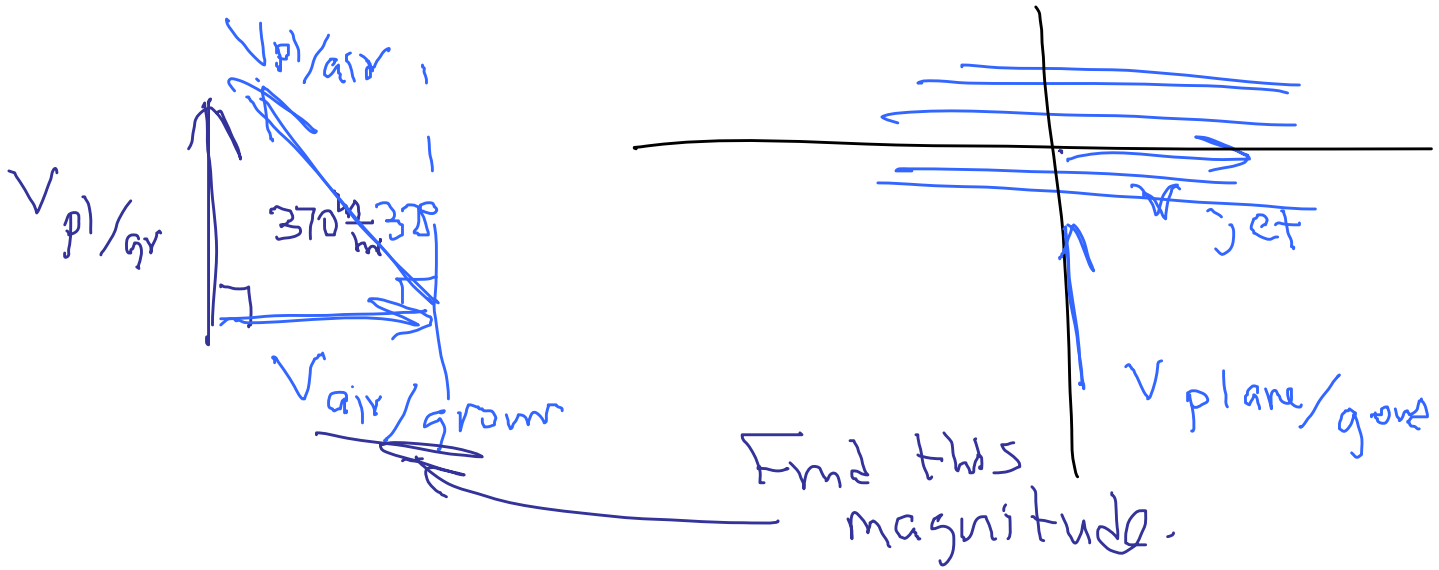


$$t = \frac{63\ m}{1.17\ \frac{m}{s}}$$

$$= 53.9\ s$$



3.28 Plane w/ airspeed 370 $\frac{km}{h}$ flies perp across jet stream nose pointed w/ land at 32° from perp to jetstream direction. Find speed of jetstream



Circular Motion

Speed constant