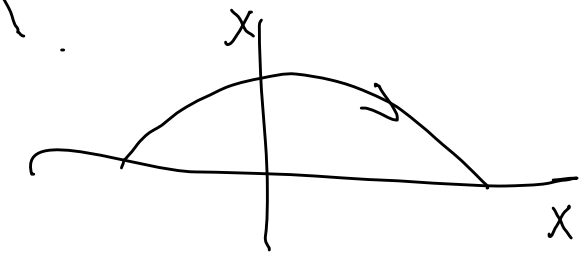
Phys 2110-4 9/14/11

Note Title 9/14/2011

Chap 3 2-Dim. motion.



x, y

$v_x = \frac{dx}{dt}$ $v_y = \frac{dy}{dt}$

$a_x = \frac{dv_x}{dt}$ $a_y = \frac{dv_y}{dt}$

Speed $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$ $\left(\frac{m}{s}\right)$

Constant accel:

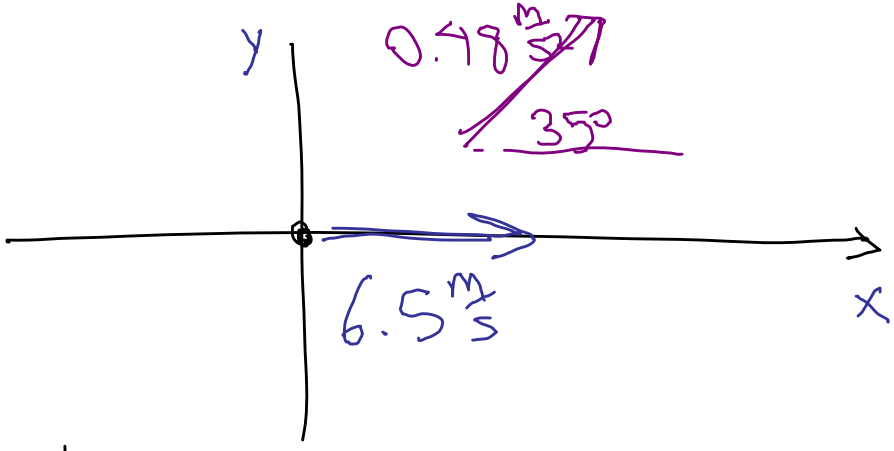
$$v_x = v_{ox} + a_x t \qquad v_y = v_{oy} + a_y t$$

$$x = x_0 + v_{ox} t + \frac{1}{2} a_x t^2 \qquad y = y_0 + v_{oy} t + \frac{1}{2} a_y t^2 \qquad (3.8)\ (3.9)$$

$$v_x^2 = v_{ox}^2 + 2a_x(x - x_0) \qquad v_y^2 = v_{oy}^2 + 2a_y(y - y_0)$$

3.31 ⇒ You're moving at $6.5\frac{m}{s}$ wind gust, lasts 6.3 s, acc's you at $0.18\frac{m}{s^2}$ at 35° to your original direction.

Find the magnitude and dir. of your displacement during the gust.



$v_{ox} = 6.5\ \frac{m}{s}$

$v_{oy} = 0$

$a_x = 0.458\ \frac{m}{s^2}$ $a_y = 0.142\ \frac{m}{s^2}$

$a_x = a\cos 35°$ $a_y = a \sin 35°$

$t = 6.3\,s$

$$x = x_0 + v_{ox}t + \frac{1}{2}a_x t^2 = 50.0\ m$$

(6.5 m/s, 0.458 m/s², Plug)

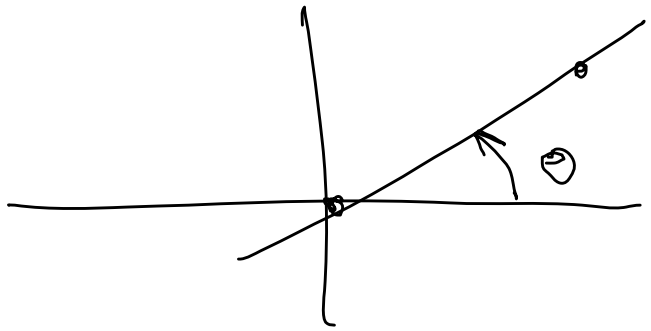
$$y = y_0 + v_{oy}t + \frac{1}{2}a_y t^2$$

$$= 0 + 0 + \frac{1}{2}\left(0.142\ \frac{m}{s^2}\right)(6.3\,s)^2 = 2.8\ m$$

$$\text{Mag} = |\vec{r}| = \sqrt{(50.0\ \text{m})^2 + (2.8\ \text{m})^2} = \quad \text{m}$$

Dir: $\tan\theta = \frac{y}{x}$

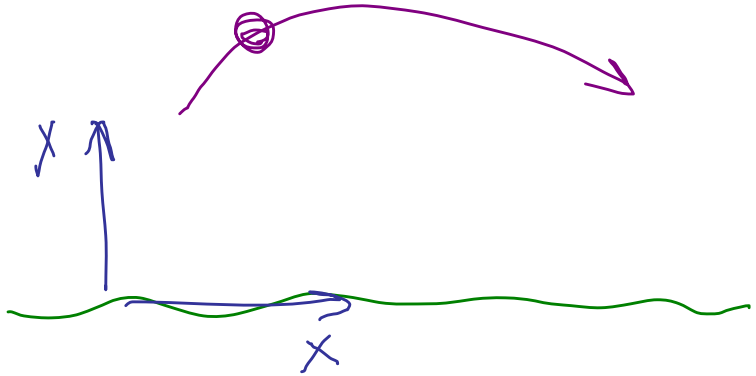
$$\Longrightarrow \quad \theta = 3.2^\circ$$



Projectile Motion

$a_x = 0 \qquad a_y = -g$

$= -9.8\ \frac{\text{m}}{\text{s}^2}$



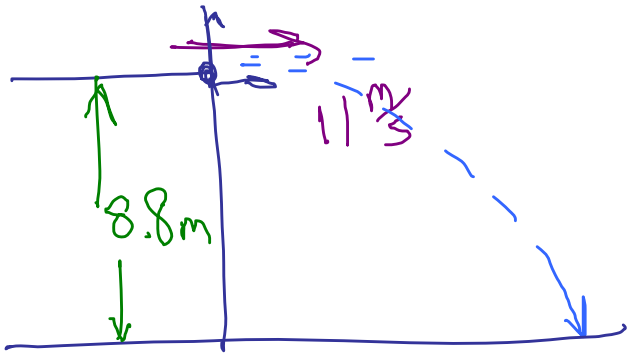
$$x = x_0 + v_{x0} t$$

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

3.33 A carpenter tosses shingle horizontally at $11 \frac{m}{s}$ off a 8.8 m-high roof.

a) How long does it take shingle to reach ground?

b) How far does it move horizontally?



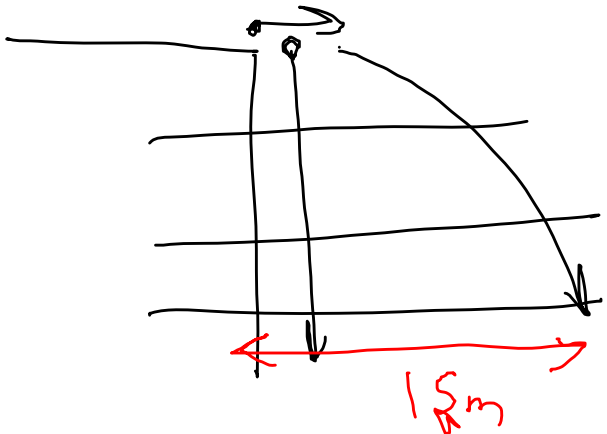
$x_0 = 0 \quad y_0 = 0$

$v_{ox} = 11 \frac{m}{s} \quad v_{oy} = 0$

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

$x = (11\ \frac{m}{s})\,t$

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



a) $y = -8.8\ m$

When does $y = -8.8\ m$?

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

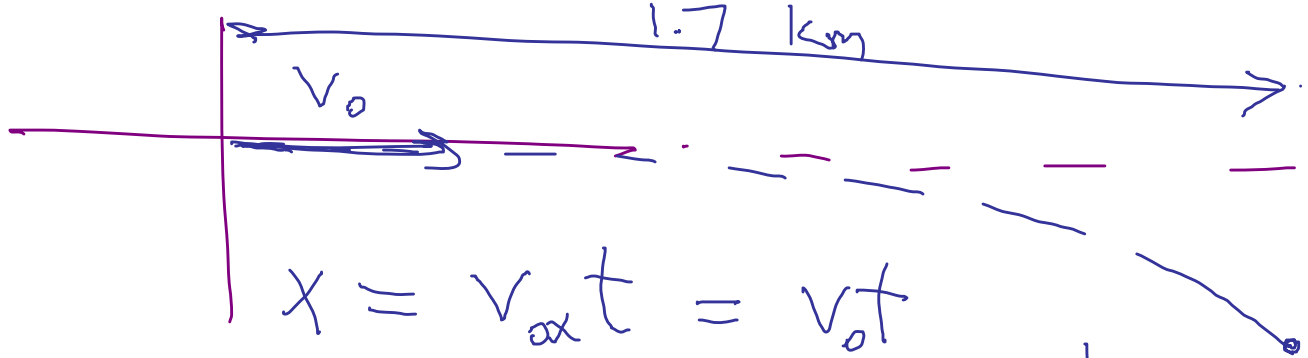
$t = 1.3\ s$

b) What is x at this time?

$x = (11\ \frac{m}{s})(1.3\ s)$

$= 15\ m$

3.36 Protons drop 1.2 μm over the 1.7-km length of a particle accelerator. What's their speed?



$x = v_{ox}t = v_0 t$

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

When does $y = -1.2\,\mu m$

$\frac{1}{2}(9.8\frac{m}{s^2})t^2 = 1.2\times10^{-6}\,m$

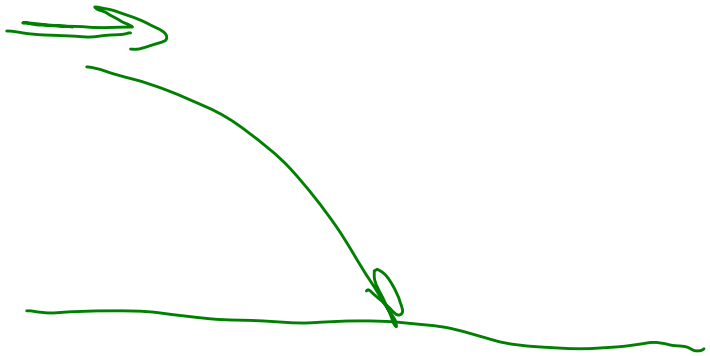
$\longrightarrow t = 4.94\times10^{-4}\,s$

At this time

$$x = 1.7 \times 10^{3}\ m = v_0 t$$

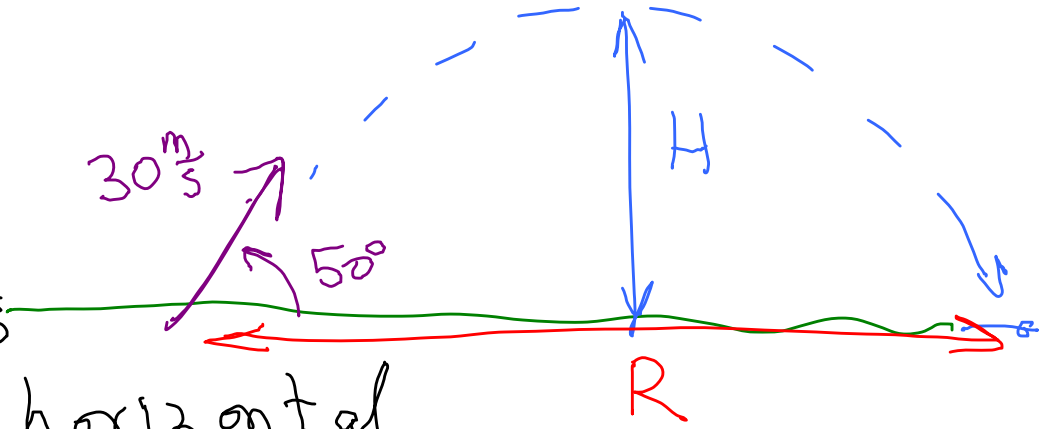
$$v_0 = \frac{1.7 \times 10^{3}\ m}{4.94 \times 10^{-4}\ s} = 3.47 \times 10^{6}\ \frac{m}{s}$$

fast



Example

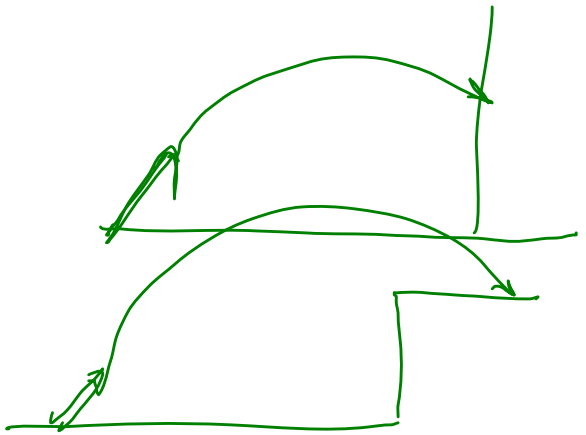
Projectile launched at init speed $30\frac{m}{s}$ at $50°$ up from horizontal.



a) How long is it in air?

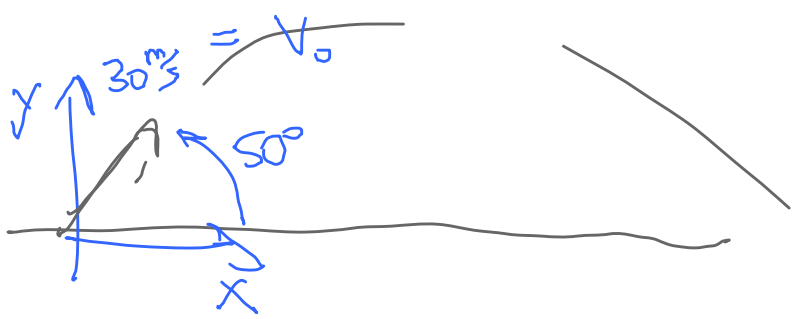
b) What is its range

c) What is max height, it



Ignore air resistance

$x_0 = 0 \quad y_0 = 0$



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

$= 19.28 \frac{m}{s}$

$v_{0y} = 22.98 \frac{m}{s}$

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

a) How long in air? When does $y = 0$?

$$y = (22.98 \tfrac{m}{s})t - \tfrac{1}{2}(9.8 \tfrac{m}{s^2})t^2 = 0$$

$$t\left[(22.98\,\tfrac{m}{s}) - 4.9\,\tfrac{m}{s^2}\,t\right] = 0$$

Two answers $t = 0$

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

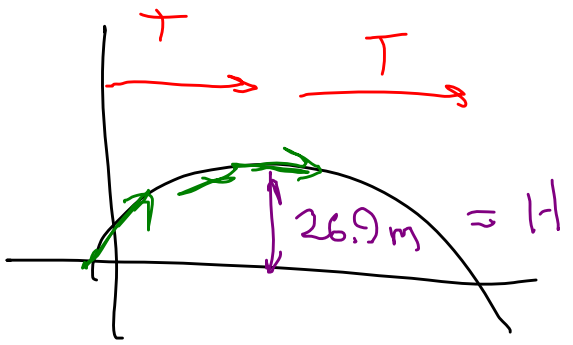
What is x at that time

$$x = (19.28\,\tfrac{m}{s})(4.7\,s) + \tfrac{1}{2}\,a_x t$$

$$= 90.4\,m \quad \text{(Range)}$$

What is max height?

$V_y = 0$ at that time?



V_x stay same

V_y changes

$$V_y = V_{oy} + a_y t$$

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

$$= 2.34\ s$$

what is y at this time? $= 26.9\ m$

$$y = 0 + \left(22.98 \tfrac{m}{s}\right)(2.34_s) - \tfrac{1}{2}\left(9.8 \tfrac{m}{s^2}\right)(2.34_s)^2$$

Do the same problem in general

Answer the same questions.

$x_0 = 0 \quad y_0 = 0$

$V_{0x} = V_0 \cos\theta \quad V_{0y} = V_0 \sin\theta$

$a_x = 0 \quad a_y = -g$

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

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

When does $y = 0$?

$$v_0 \sin\theta \, t - \frac{1}{2} g t^2 = 0$$

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

Solve $\longrightarrow = 0$

Do algebra.

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

What is x at this time

$$X = V_0 \cos\theta \, t$$

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

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

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

$2 \sin\theta \cos\theta = \sin 2\theta$

$\sin 2\theta = 1$

$2\theta = 90$

$\theta = 45°$