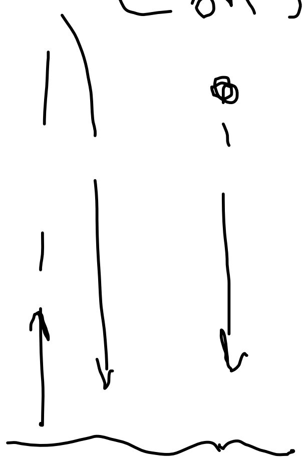
Phys 2110-4 1/23/12

Note Title 1/23/2012

1-Dim motion

Constant acceleration



$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

Example

How high did it go?

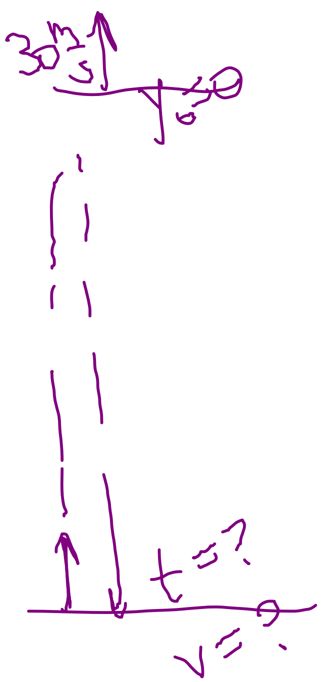
How long is total flight?

What is vel. when it lands?

$\circledcirc\ v = 0$ $\qquad y$

$t = 3.06\,s$

$a = -g$
$= 9.8\ m/s^2$



$$v^2 = v_0^2 + 2ay$$

$$0 = \left(30\,\tfrac{m}{s}\right)^2 + 2\left(-9.8\,\tfrac{m}{s^2}\right) y$$

$$y = \frac{-\left(30\,\frac{m}{s}\right)^2}{2\left(-9.8\,\frac{m}{s^2}\right)} = 47\,m$$

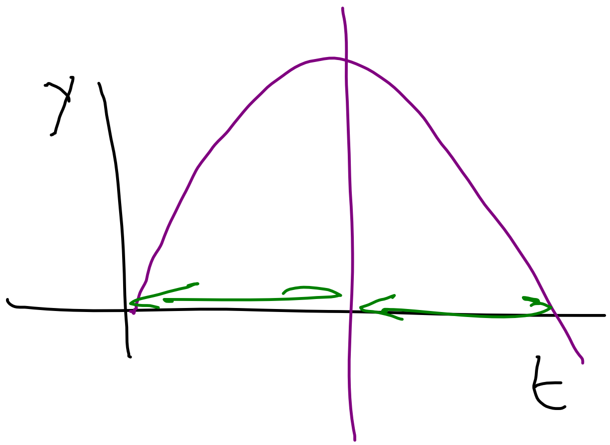
$$\frac{m^2/s^2}{m/s^2} = m$$

When is $y = 0$?

$$y = 0 + \left(30\,\tfrac{m}{s}\right)t - \tfrac{1}{2} g t^2 = 0$$

$$t\left(30\,\tfrac{m}{s} - \tfrac{1}{2}\left(9.8\,\tfrac{m}{s^2}\right)t\right) = 0$$

$t = 0 \qquad 30 = \frac{1}{2} 9.8 t \qquad \boxed{t = 6.12\,s}$



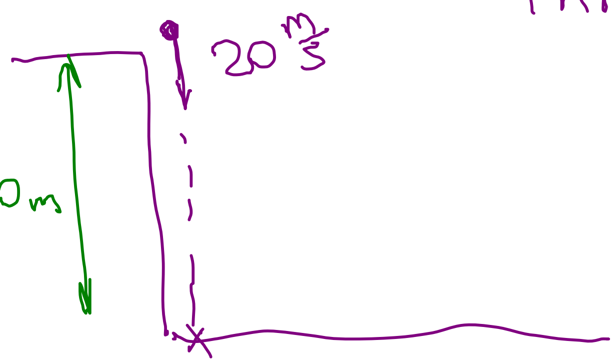
Vel at impact

$$v = v_0 + at$$

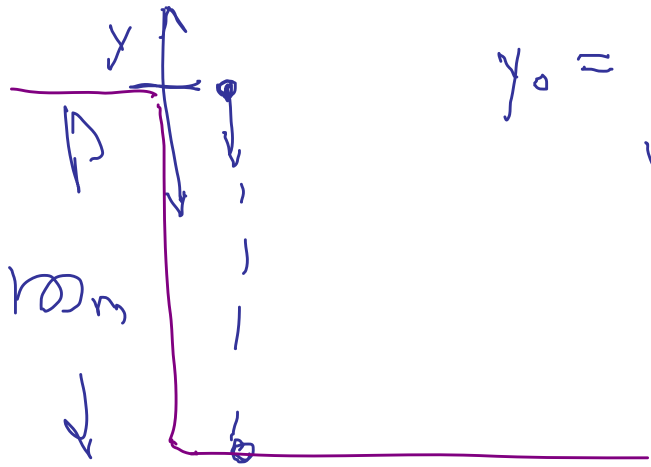
$$= 30\tfrac{m}{s} + (-9.8\tfrac{m}{s^2})(6.12\,s)$$

$$= -30\tfrac{m}{s}$$

Example



Throw rock downward at speed of $20\frac{m}{s}$. When does it hit ground?



$y_0 = 0$

When does it hit ground?

When does $y = -100\ m$

$v_0 = -20\ \frac{m}{s}$ $\qquad a = -g$

$$y = -100\ m = 0 + \left(-20\tfrac{m}{s}\right)t - \tfrac{1}{2} g t^2$$

Quadratic eqn $\qquad 4.9t^2 + 20t - 100 = 0$

$$t = \frac{-20 \pm \sqrt{400 + 4(100)(4.9)}}{9.8} \approx \begin{cases} 2.92\ s \\ -6.998\ s \end{cases}$$

6.38 Friend sits 6.5 m above you on branch. With what ~~speed~~ speed you throw apple so it just reaches her.

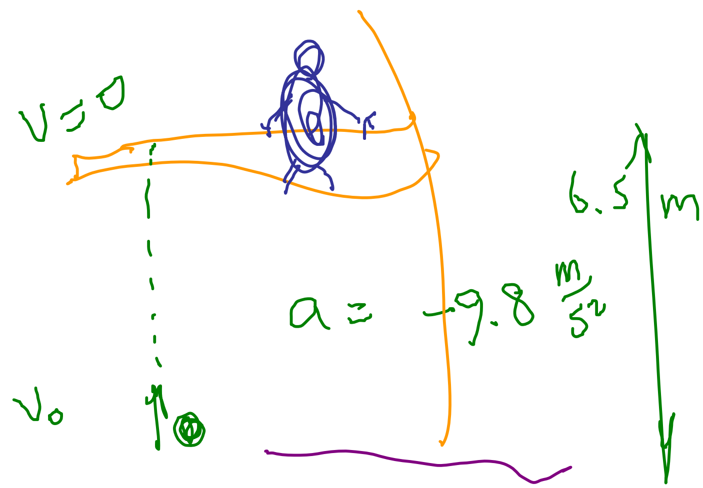
$$v^2 = v_0^2 + 2ay$$

0

$-9.8\,\frac{m}{s^2}$

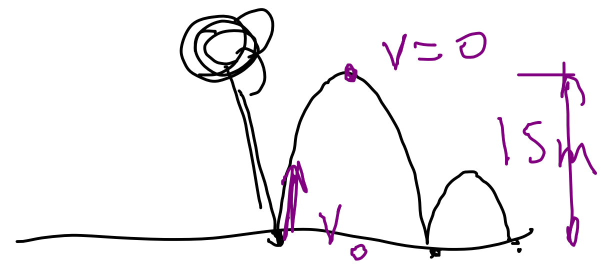
6.5 m

etc.



2.63 Mars rover. —

Bounced 15 m vertically after 1st impact.
Assume no loss of speed on bounce. Tell speed of impact.

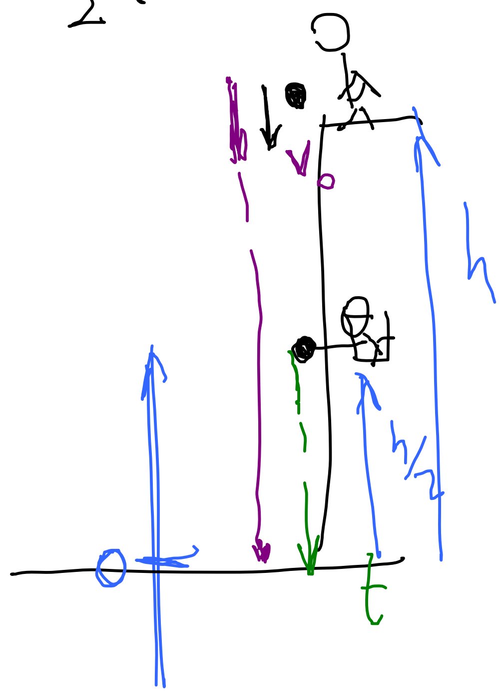


$$v^2 = v_0^2 + 2a\,y \qquad y = 15\,\text{m}$$

$v = 0$ $\quad v_0 = v_0!$ $\quad a = -3.74\,\frac{m}{s^2}$

$\longrightarrow$ $v_0 = 10.6\,\frac{m}{s}$

2.67 You are atop building of height h, Friend is poised at window at $h/2$. Drops a ball. Find speed at which you must throw ball down so that both hit at same time.



You:

$$y_1 = h + v_0 t - \frac{1}{2} g t^2 = 0$$

$$y_2 = \frac{h}{2} + 0 - \frac{1}{2} g t^2 = 0$$

at some time t

From 2^{nd} eqn, find t:

$$0 = \frac{h}{\cancel{2}} - \cancel{\frac{1}{2}} g t^2 \qquad t = \sqrt{\frac{h}{g}}$$

Put into 1^{st} eqn

$$0 = h + v_0 \sqrt{\frac{h}{g}} - \frac{1}{2} g \left(\sqrt{\frac{h}{g}}\right)^2$$

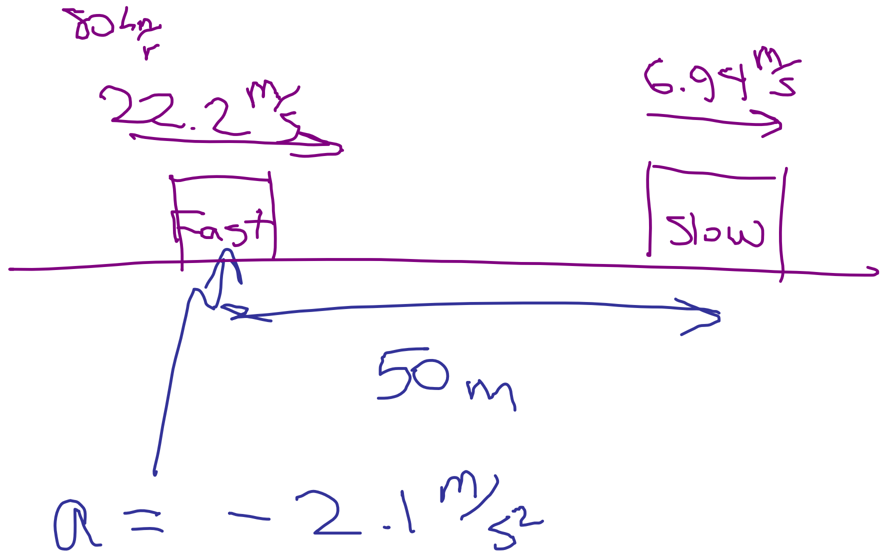
$$= h + v_0 \sqrt{\frac{h}{g}} - \frac{1}{2} \cancel{g} \frac{h}{\cancel{g}}$$

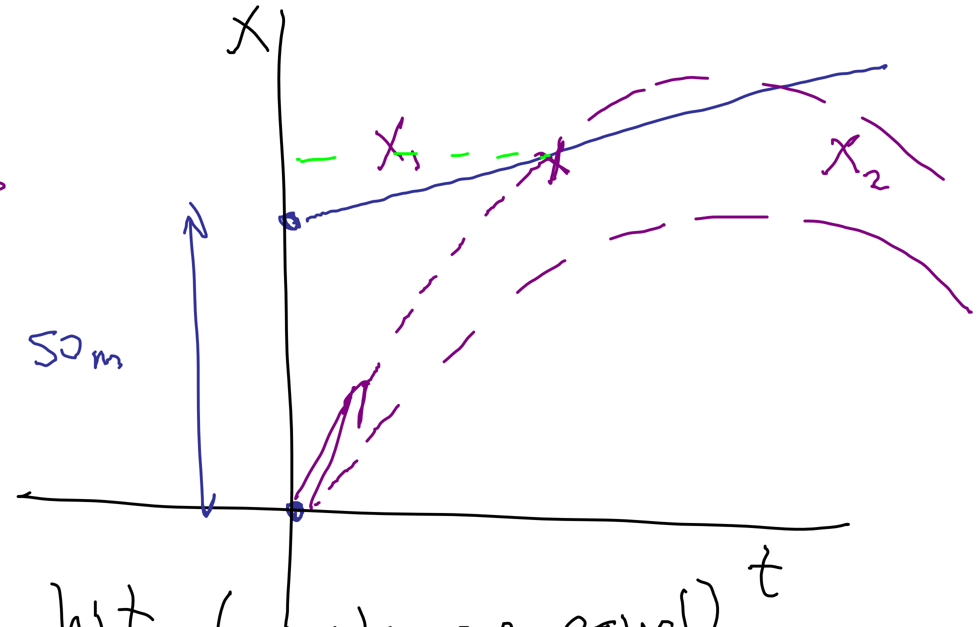
$$0 = \frac{h}{2} + v_0 \sqrt{\frac{h}{g}} \qquad v_0 = -\frac{h}{2} \sqrt{\frac{g}{h}} = -\frac{1}{2} \sqrt{\frac{g}{h}}$$

2.73 Subway accident train going at $80 \frac{km}{h}$ collided with slower train travelling in same direction at $25 \frac{km}{h}$

Find rel. speeds.

Faster train began neg'ly accelerating at $2.1 \frac{m}{s^2}$ when it was 50 m from slower train & slower train stayed at const speed.





Collision:

Solve for t when they hit (coords are equal).

When does $x_1 = x_2$?

$$x_1 = 50\,m + \left(6.94\,\tfrac{m}{s}\right)t + 0$$

$$x_2 = 0\,m + \left(22.2\,\tfrac{m}{s}\right)t - \tfrac{1}{2}\left(2.1\,\tfrac{m}{s^2}\right)t^2$$

$$22.2t - \frac{1}{2}(2.1)t^2 = 50 + 6.94t$$

$$1.05t^2 - 15.3t + 50 = 0$$

$$t = \frac{15.3 \pm \sqrt{\quad}}{2.10} = \begin{cases} 4.95\ s \\ 9.623\ s \end{cases}$$

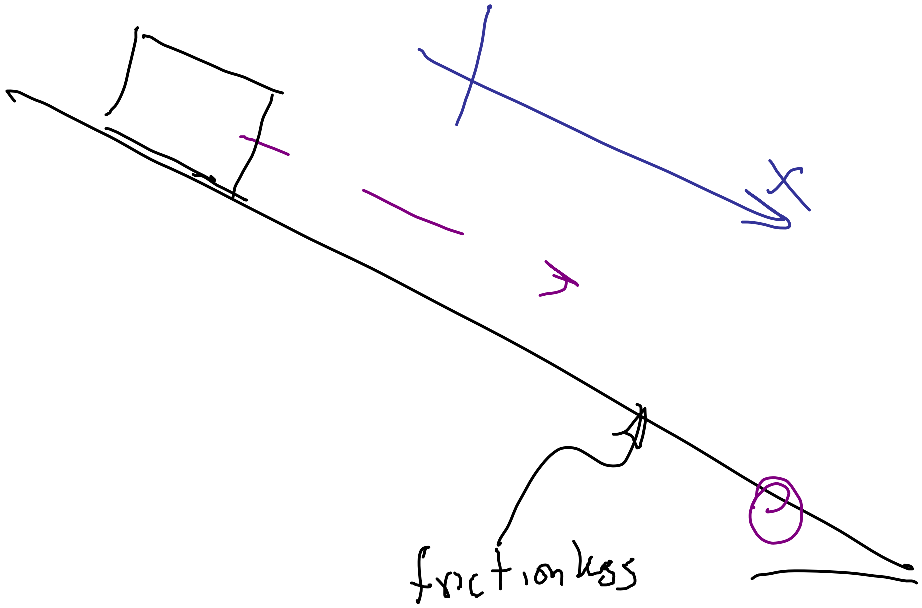
At that time

$$v_1 = \underline{6.94\ \tfrac{m}{s}}$$

$$v_2 = (22.2\ \tfrac{m}{s}) - (2.1\ \tfrac{m}{s^2})(4.95\ s) = 11.8\ \tfrac{m}{s}$$

Diff is rel velocity $4.86\ \tfrac{m}{s}$

One dim motion



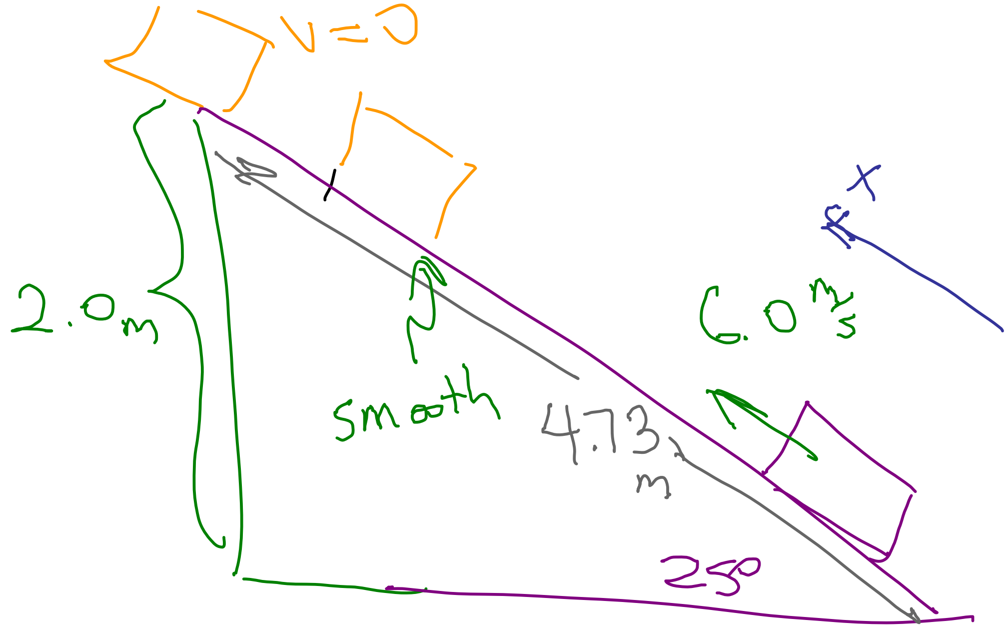
$$a_x = +g\sin\theta$$

Example

Does block reach top?

$$a_x = -g\sin\theta$$
$$= -4.14\,\frac{m}{s^2}$$

$$v^2 = v_0^2 + 2a(x - x_0)$$



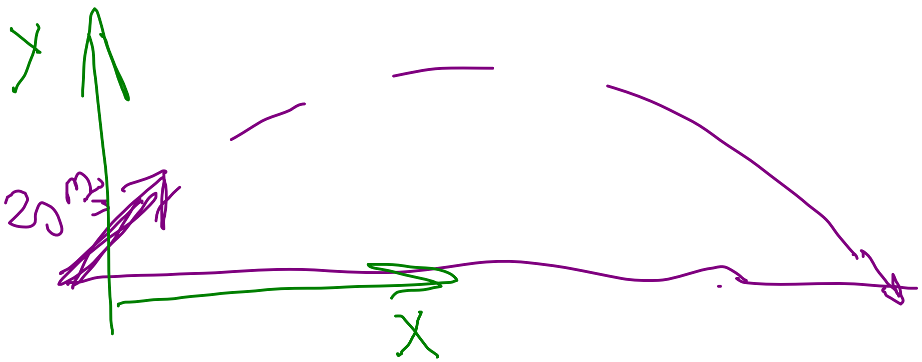
$$(x - x_0) = 4.34\ m$$

No.

Chapter 3   2-D Motion.

$x(t)$ $y(t)$

Eqns for both of these.



Vectors are for quantities which have Magnitude, direction.

So far quant no direction: Scalar