Phys 2110-4 1/28/13

Note Title 1/28/2013

1-Dim motion

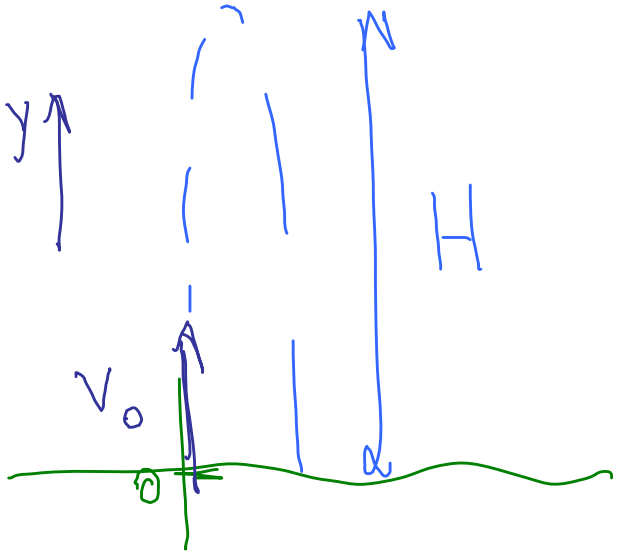
constant acceleration $a = \text{const}$

$$v = v_0 + at$$

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

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

$$\vdots$$



Time in flight

$$a = -g \qquad g = 9.8 \frac{m}{s^2}$$

$$y = y_0 + v_0 t + \frac{1}{2} a t^2$$

$a = -g$

$y_0 = 0$

What is t when $y = 0$?

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

$$= t\left(v_0 - \frac{g}{2} t\right)$$

Two answers

$t = \boxed{0}$ No news

$v_0 - \frac{g}{2} t = 0$

$t = \boxed{\frac{2v_0}{g}}$ News!

$$\boxed{T = \frac{2v_0}{g}}$$

When does it get to max ht?

When does $v = 0$?

$v = v_0 - gt$

$0 = v_0 - gt$

$$t_{up} = \frac{v_0}{g}$$

No air resistance

What is max ht?

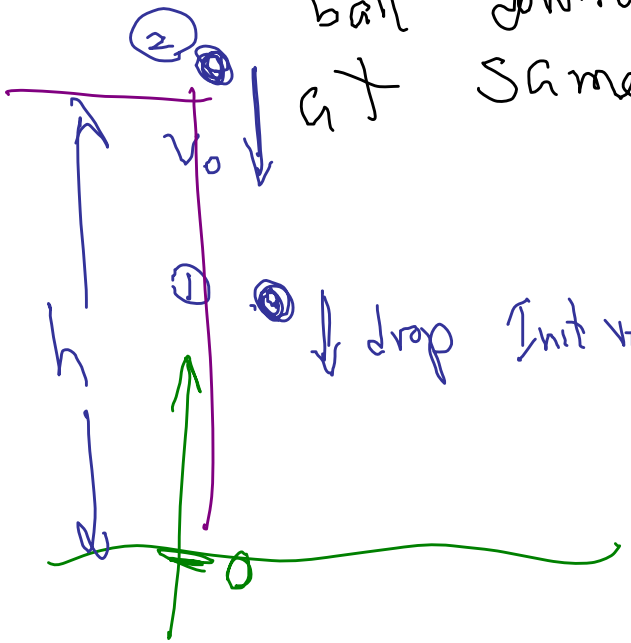
Value of y at $t_{up} = \frac{v_0}{g}$

$v^2 = v_0^2 + 2ax = v_0^2 + 2(-g)H$

$0 = v_0^2 - 2gH$

$$H = \frac{v_0^2}{2g}$$

2.67 You're atop building height h a friend is poised to drop ball from window height $h/2$. Find an expression for speed at which should simultaneously throw ball downward so that the two hit ground at same time.



Eqn of motion for each

① Hits ground when $y = 0$

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

②

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

From first eqn $0 = \frac{h}{2} - \frac{1}{2}gt^2$

(solve) $t = \sqrt{h/g}$

$0 = \frac{h}{2} - \frac{1}{2}gt^2$ (1)

$0 = h + v_0 t - \frac{1}{2}gt^2$ (2)

Subtract (1) from (2)

$\frac{h}{2} + v_0 t = 0$

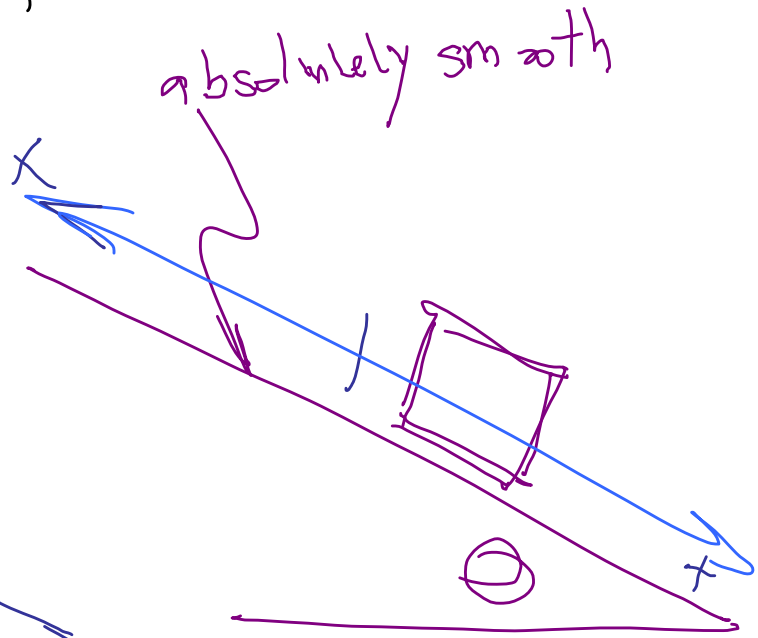
$v_0 = -\frac{h}{2}\frac{1}{t}$

$= -\frac{h}{2}\sqrt{\frac{g}{h}}$

$= \boxed{-\frac{1}{2}\sqrt{hg}}$

Speed $\frac{1}{2}\sqrt{hg}$

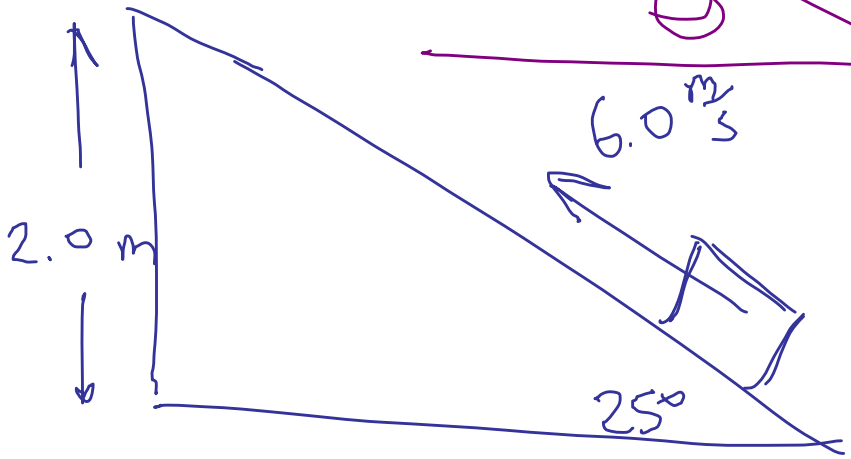
Example Block on a frictionless slope, θ



$\Rightarrow$ Accel of block is $g\sin\theta$ down the slope

Does block get the top?

$\Rightarrow$ what was x when $v = 0$?



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

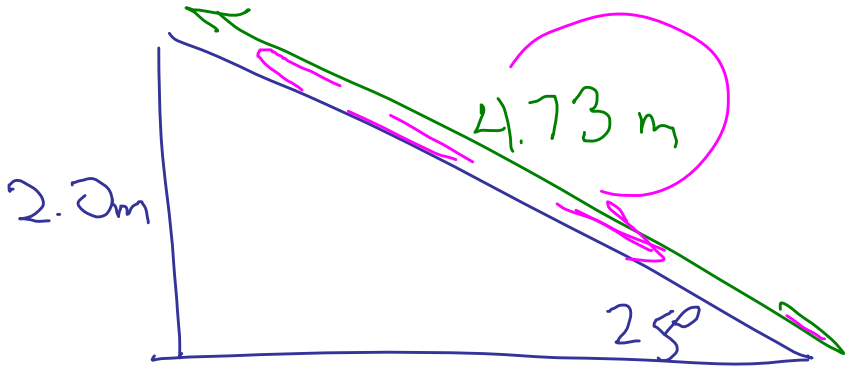
$$a = -9.8 \frac{m}{s^2} \sin 25$$

$$= -4.14 \frac{m}{s^2}$$

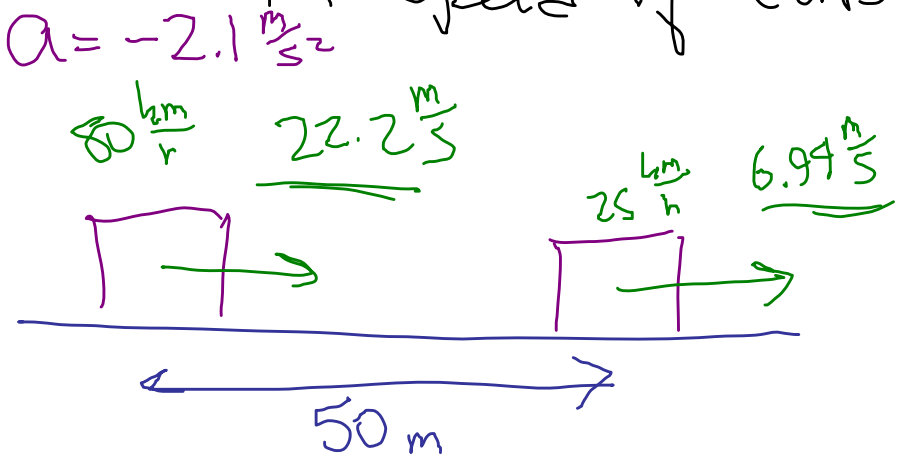
$$0 = \left(6.0 \frac{m}{s}\right)^2 + 2\left(-4.14 \frac{m}{s^2}\right)(x - x_0)$$

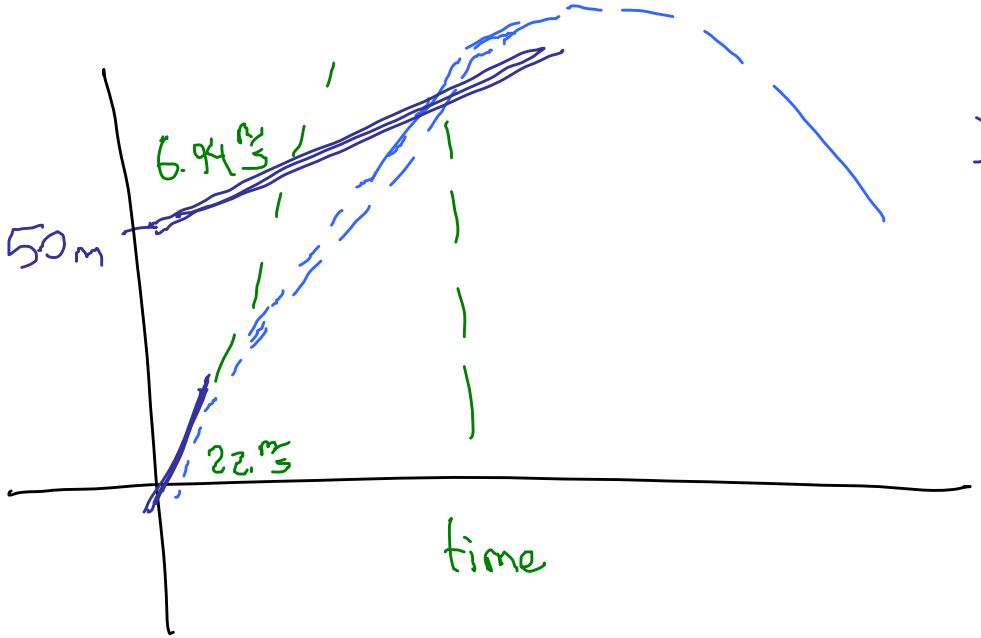
$$(x - x_0) = 4.34$$

Nope, doesn't get to top.



2.73 A train going at 80 $\frac{km}{h}$ collides w slower train traveling at 25 $\frac{km}{h}$ Faster train decelerated at 2.1 $\frac{m}{s^2}$ when it was 50 m from train, slower train continued at constant speed. Yo find rel speed of cars when they collided.





$$x_{slow}(t) = 50_m + 6.94\frac{m}{s}t$$

$$x_{fast}(t) = 0_m + \left(22.2\frac{m}{s}\right)t - \frac{1}{2}\left(2.1\frac{m}{s^2}\right)t^2$$

At what time do they hit.

Set them equal solve for t

$$50 + 6.94t = 22.2t - 1.05t^2$$

$$t = \frac{15.3 \pm \sqrt{(15.3)^2 - 4(1.05)(50)}}{2.10} =$$

$$t = 4.95$$

$$v_{slow} = 6.94\frac{m}{s}$$

$$v_{fast} = v_0 + at = 11.8\frac{m}{s}$$

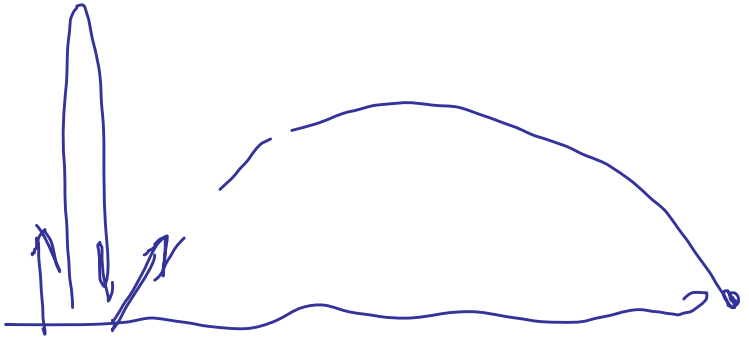
Diff $4.86\frac{m}{s}$

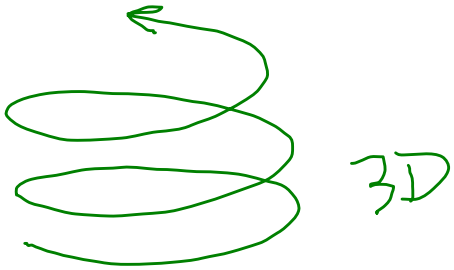
4.95 s

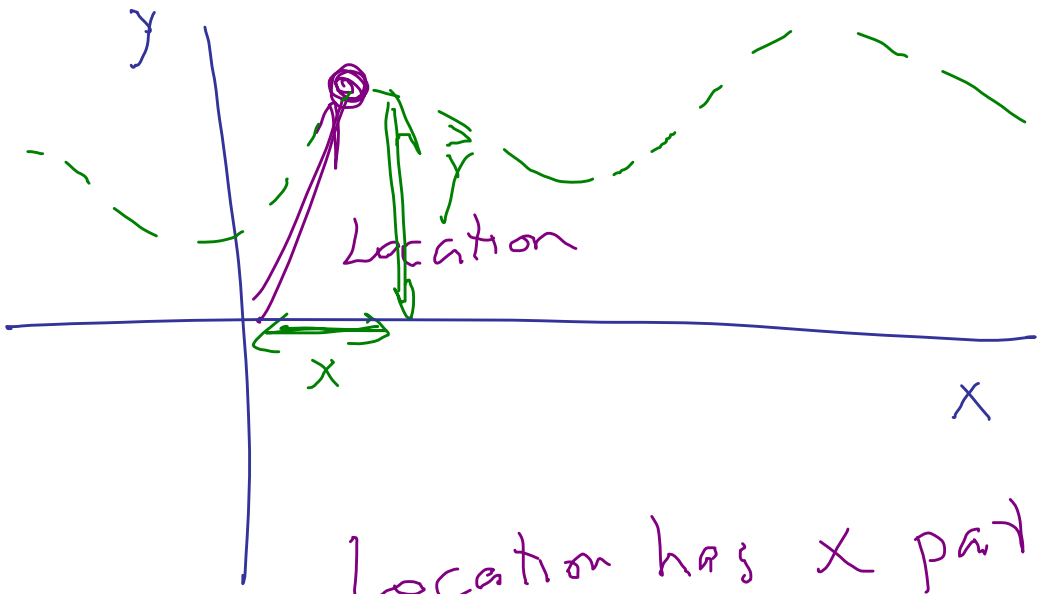
9.62 s

Two Dimension Motion

(3-D motion?)

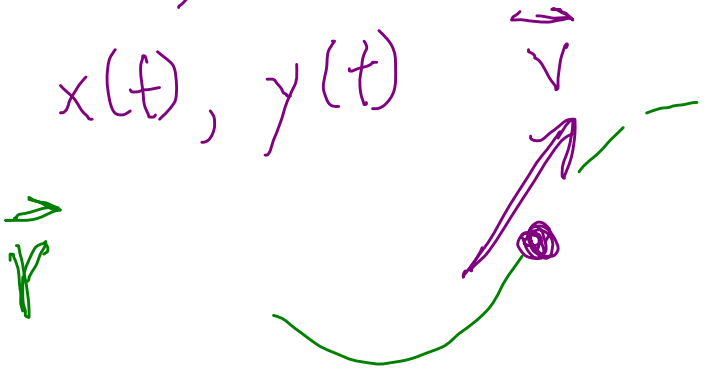






$x(t)$

$x(t), y(t)$



Location has x part
y part

Vectors

Vectors

Physics some quantities are numbers:

Scalars

- T temperature
- Kinetic Energy $KE = \frac{1}{2}mv^2$
- :

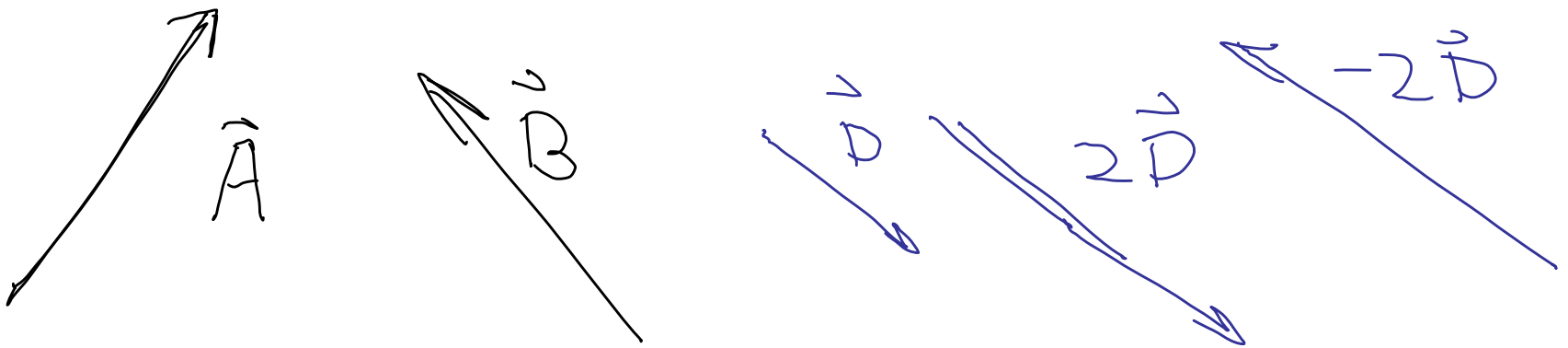
Some quantities have direction & magnitude:

Vectors

- $\vec{r}$ location, displacement
- $\vec{v}$ velocity
- $\vec{a}$ acceleration
- $\vec{p}$ momentum
- $\vec{E}$, $\vec{B}$, ...

Math. of vectors

Vectors are represented on page by arrows



Vectors can be multiplied by scalar.