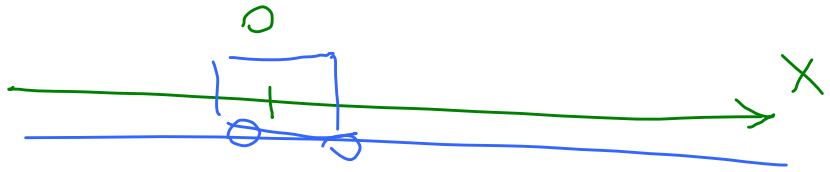
Phys 2110-4 1/25/13

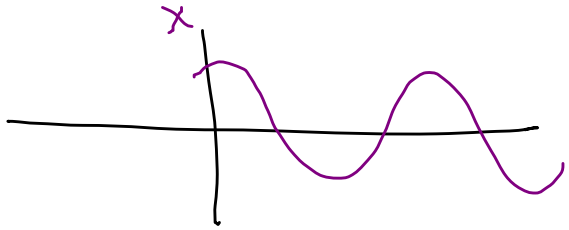
Note Title 1/25/2013

Motion in 1-D.



$x(t)$, $v(t)$, $a(t)$

$= x'(t)$ $= v'(t)$



Specialized to the case $a = \text{const.}$

$$v = v_0 + at$$

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

Can derive

X_0 = init pos

V_0 = init vel.

a = accel.

$$V^2 = V_0^2 + 2a(X - X_0)$$

Does not contain time t

Also

$$X = X_0 + \frac{1}{2}(V + V_0)t$$

Does not contain a

p. 20

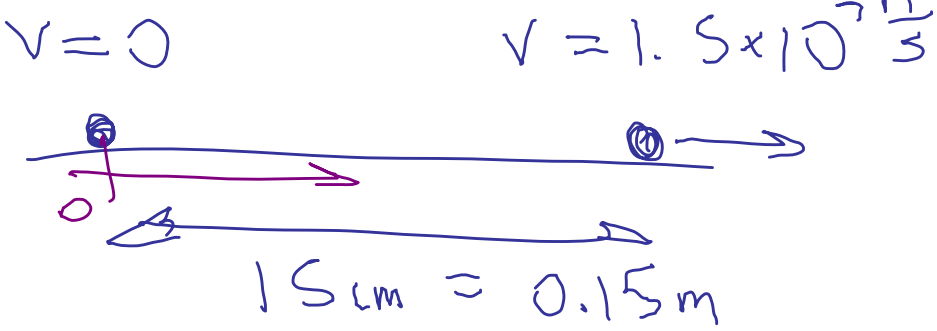
2.30 An X-ray tube acc's electrons over a dist 15 cm, final speed is $1.5 \times 10^7 \frac{m}{s}$ what are:

a) (Constant) accel

b) The time they spent acc'ing

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

$v_0 = 0$



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

$1.5\times10^7 \frac{m}{s}$ $\quad 0 \quad 0.15\,m$

$$a = \frac{v^2 - v_0^2}{2(x - x_0)} = \frac{\left(1.5\times10^7 \frac{m}{s}\right)^2 - 0}{2(0.15\,m)} \quad \frac{m^2/s^2}{m} = \frac{m}{s^2}$$

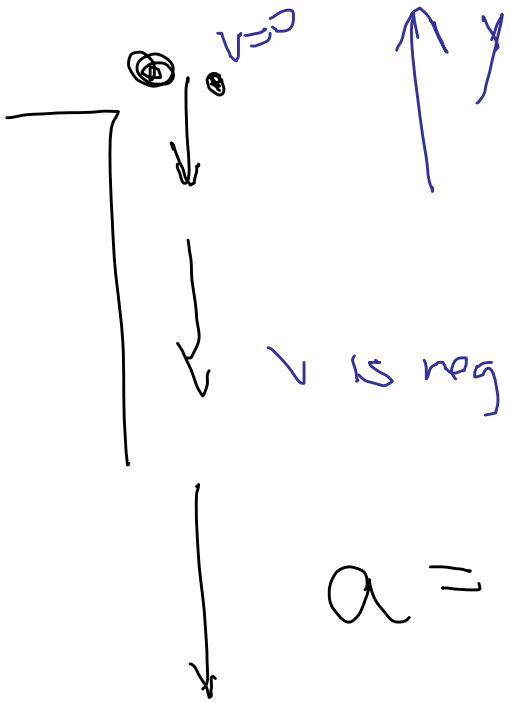
$$= \boxed{7.5\times10^{14} \frac{m}{s^2}}$$

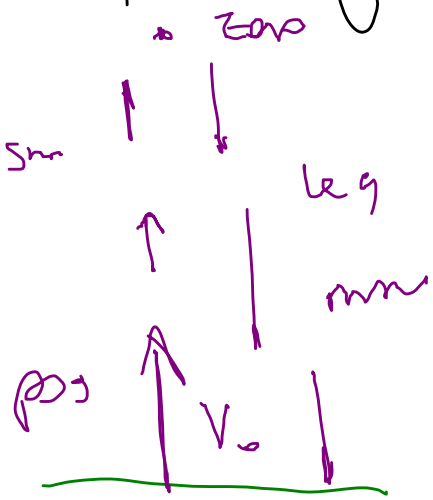
b) $v = v_0 + at$

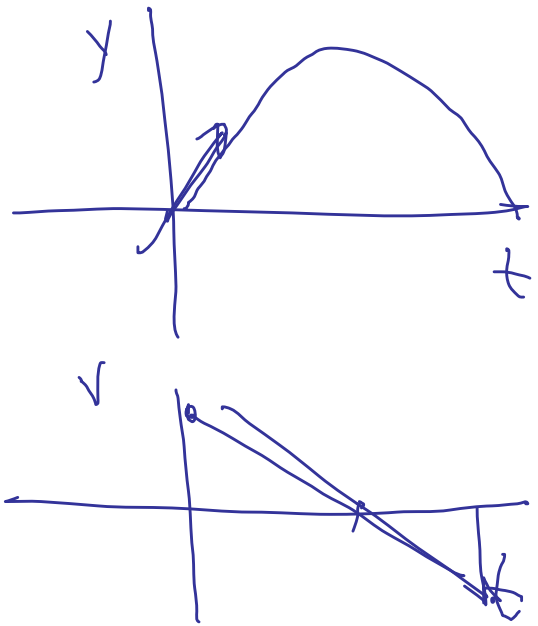
$$t = \frac{v - v_0}{a} = \frac{1.5\times10^7 \frac{m}{s}}{7.5\times10^{14} \frac{m}{s^2}}$$

$$= \boxed{2\times10^{-8}\,s}$$

Most famous example of constant a

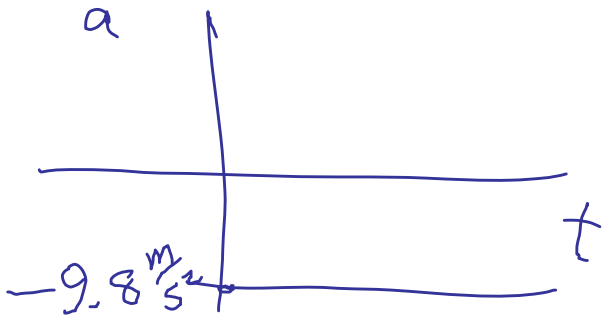






Near surface of earth neglect air

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

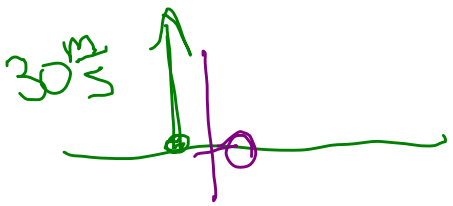


Shorthand

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

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

Example:



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

$= (30 \frac{m}{s}) t - \frac{1}{2} (9.8 \frac{m}{s^2}) t^2$

$v = 30 \frac{m}{s} - 9.8 \frac{m}{s^2} t$ $\quad v = v_0 + at$

t	y	v
0 s	0	$30 \frac{m}{s}$
1 s	25.1 m	$20.2 \frac{m}{s}$
2 s	40.4 m	$10.4 \frac{m}{s}$
3 s	45.9 m	$0.600 \frac{m}{s}$
4 s	41.6 m	$-9.20 \frac{m}{s}$

Guess get to max ht

~ 3 s

max ht ~ 45.9 m

What is max ht

$v = 0$ $\quad v = v_0 + at$

$0 = 30 \frac{m}{s} - (9.8 \frac{m}{s^2})t$

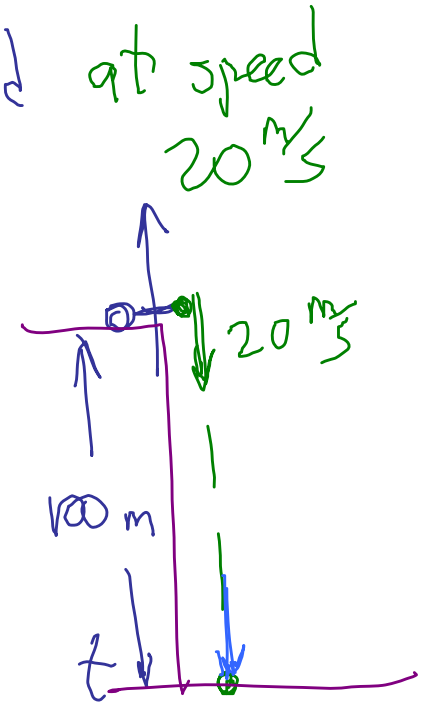
$t = 3.06$ s

$y = 0 + (30 \frac{m}{s})(3.06 s) - \frac{1}{2}(9.8 \frac{m}{s^2})(3.06 s)^2$

$= 45.9$ m

Example

Rock is hurled downward at speed $20\ m/s$ from top of 100 m cliff.



a) How long to hit ground?

b) What is velocity at impact?

$$v^2 = v_0^2 + 2a(y - y_0)$$

$v_0 = (-20\ m/s)$ $\quad a = -9.8\ m/s^2$ $\quad y_0 = 100\ m$

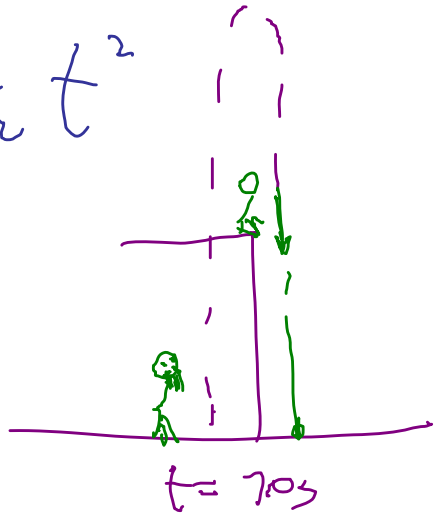
Solve for v: $\quad v^2 = 2.36 \times 10^3\ m^2/s^2 \quad v = -48.6\ m/s$

Time to hit ground:

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

$$-100\,m = 0 + \left(-20 \tfrac{m}{s}\right) t - 4.9 \tfrac{m}{s^2} t^2$$

Solve for t:



$$-100 = -20t - 4.9t^2$$

$$4.9t^2 + 20t - 100 = 0$$

$$t = \frac{-20 \pm \sqrt{20^2 + 4(4.9)(100)}}{2(4.9)} = \begin{cases} 2.92\,s \\ -6.918\,s \end{cases}$$

2.38 Your friend is sitting 6.5m above → you on a tree branch. How fast you throw ball so that is just reaches her.

$$v^2 = v_0^2 + 2a(y - y_0)$$

v: 0 ; v_0 ; a: $-9.8\ m/s^2$; $y - y_0$: $6.5m$

Solve for v_0 $\quad v_0 = 11\ m/s$