Phys 2110-4 9/7/11

Note Title 9/7/2011

1-D Motion (Chap 2)

x, v, a

Constant acceleration, a

$$v = v_0 + at$$

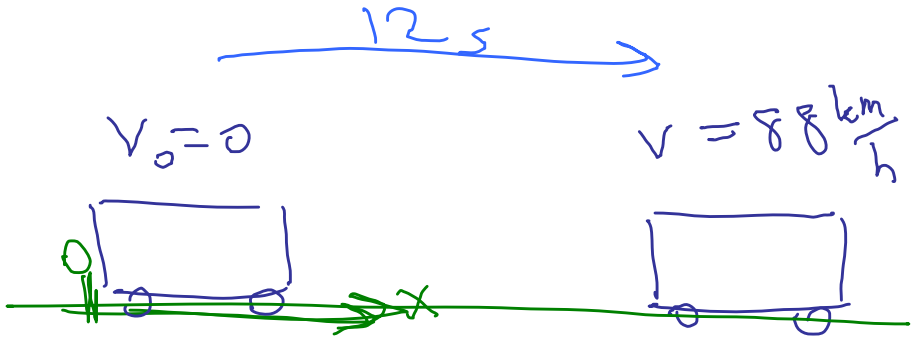
$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

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

$$x = x_0 + \frac{1}{2}(v + v_0)t$$

2.32 Starting from rest car accel's at constant rate, reaching $88 \frac{km}{h}$ in 12s. Find

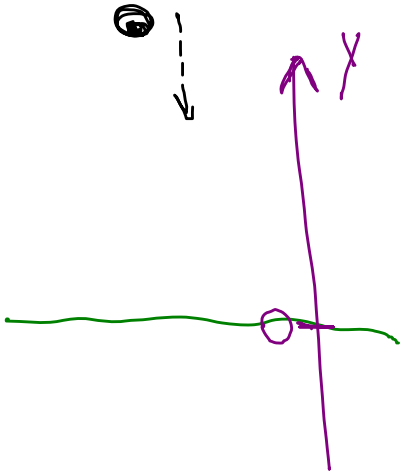
a) Acceleration b) How far it goes?



$v = 88 \frac{km}{h} \cdot \frac{1000\,m}{1\,km} \cdot \frac{1\,h}{3600\,s} = 24.4 \frac{m}{s}$

$a = \frac{v - v_0}{t} = 2.04 \frac{m}{s^2}$

b) $x = x_0 + v_0 t + \frac{1}{2} a t^2 = \frac{1}{2}(2.04 \frac{m}{s^2})(12s)^2 = 147\,m$



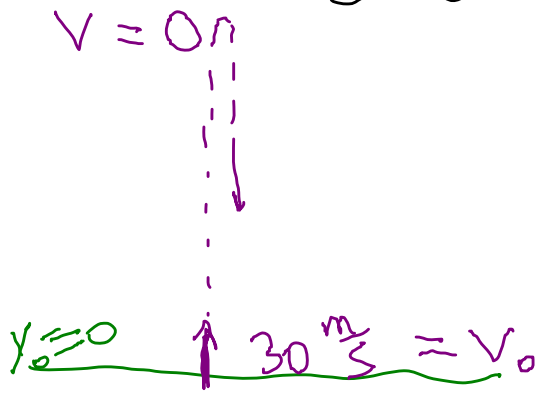
$a = -9.8\ m/s^2 = -g$

$g = 9.8\ m/s^2$ for all objects (neglecting air)

Example: Throw rock up in air (from ground) at $30\ m/s$

a) How high does it go?

b) How long is it in air?



$$v = 30\ m/s + (-9.8\ m/s^2)\,t$$

$$y = (30\ m/s)\,t + \tfrac{1}{2}(-9.8\ m/s^2)\,t^2$$

Plug in numbers

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

a) when get to max ht?

$$v = 0$$

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

$$t = \frac{30 \frac{m}{s}}{9.8 \frac{m}{s^2}} = 3.06 s$$

What is max ht?

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

$$= 45.9 m$$

b) How long is it in air?

When does $y = 0$?

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

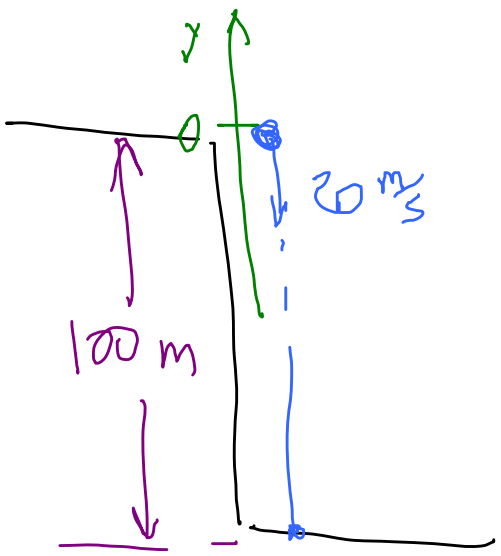
$$= t\left[\left(30\tfrac{m}{s}\right) - 4.9\tfrac{m}{s^2}t\right]$$

$t = 0$

$$t = \frac{30\frac{m}{s}}{4.9\frac{m}{s^2}} = 6.12\,s$$

Example

From top of 100 m cliff rock thrown down with speed $20\frac{m}{s}$. How long to hit ground?



When does $y = -100\,m$?

$$-100\,m = 0 + \left(-20\tfrac{m}{s}\right)t - \tfrac{1}{2}\left(9.8\tfrac{m}{s^2}\right)t^2$$

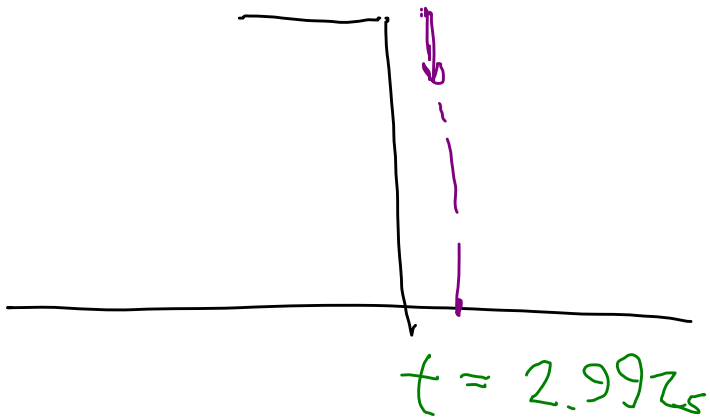
$$-100 = -20t - 4.9t^2$$

Quadr. equation

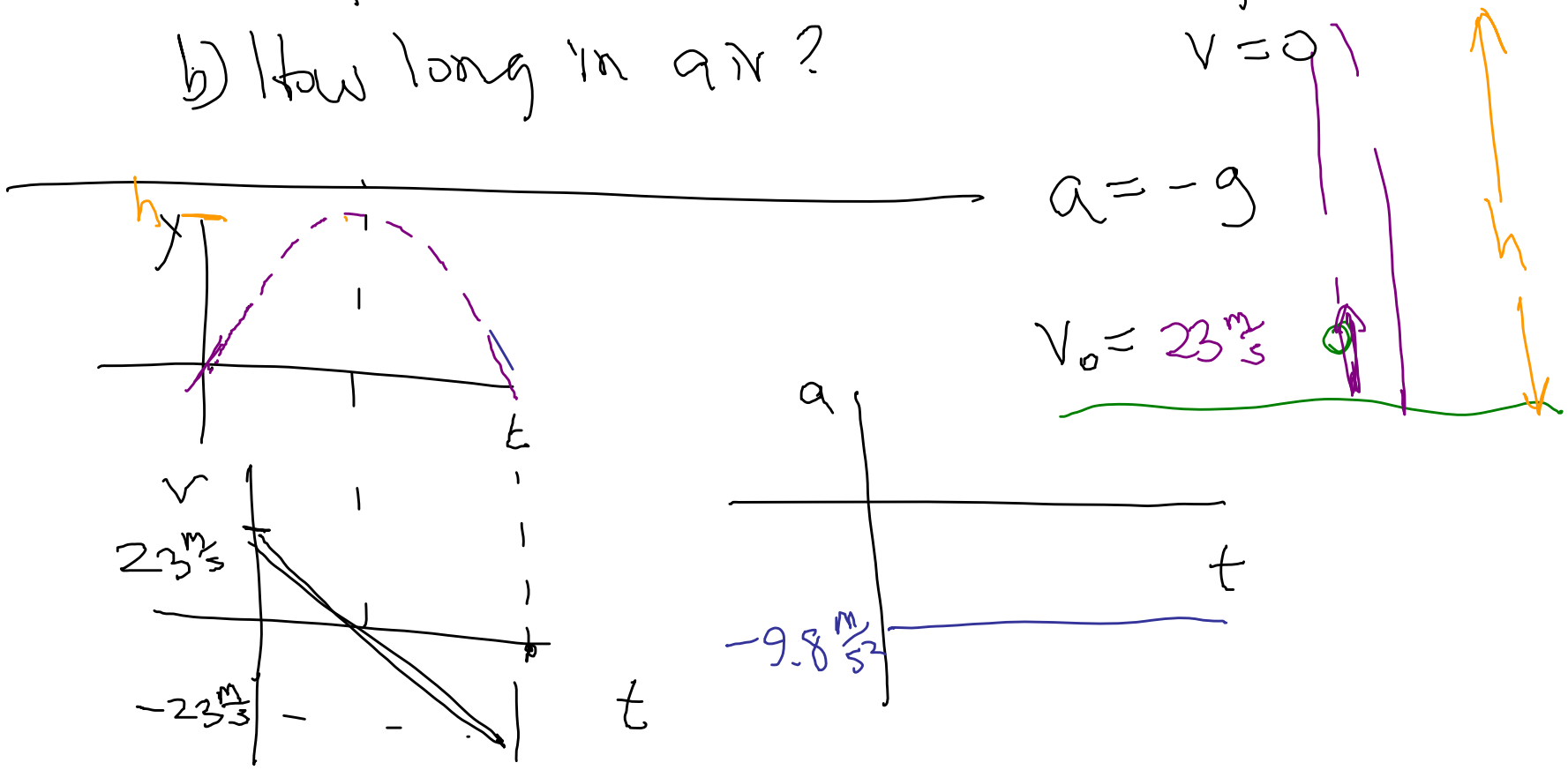
$$4.9t^2 + 20t - 100 = 0$$

$$t = \frac{-20 \pm \sqrt{400 + 4(100)(4.9)}}{9.8}$$

$$= \begin{cases} 2.92\ s \\ -6.998\ s \end{cases}$$



2.40 Foul ball leaves bat going straight up at $23 \frac{m}{s}$. a) How high does it rise?
b) How long in air?



How high?

$v = 0$ @ $y = ?$

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

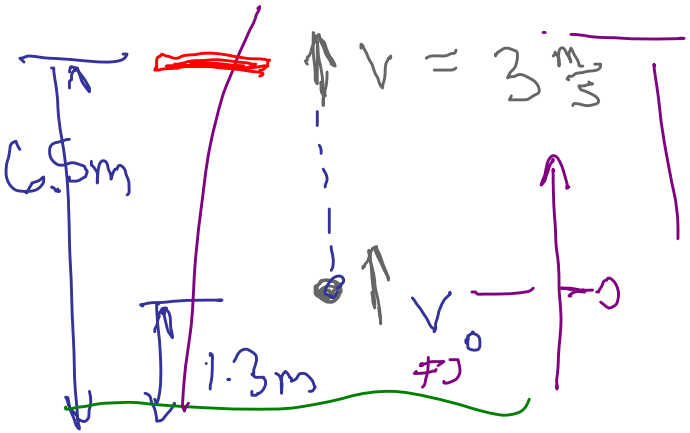
$$v^2 = v_0^2 + 2a(y - y_0)$$

0 → v ; v_0 ; a ; y → h

$$0^2 = \left(23 \tfrac{m}{s}\right)^2 + 2\left(-9.8 \tfrac{m}{s^2}\right) h$$

$$h = \frac{\left(23 \frac{m}{s}\right)^2}{2\left(9.8 \frac{m}{s^2}\right)} = \boxed{27.0\ m}$$

2.41 A Frisbee is lodged in tree 6.5 m above ground. Rock thrown from below must be going at least 3 $\frac{m}{s}$ to dislodge Frisbee. How fast must rock be thrown is hand is 1.3 m above ground?



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

$3\ \frac{m}{s}$? 5.2m

$$(3\,\tfrac{m}{s})^2 = V_0^2 + 2(-9.8\,\tfrac{m}{s^2})(5.2\,m)$$

$$\Longrightarrow V_0 = 10.5\,\tfrac{m}{s}$$

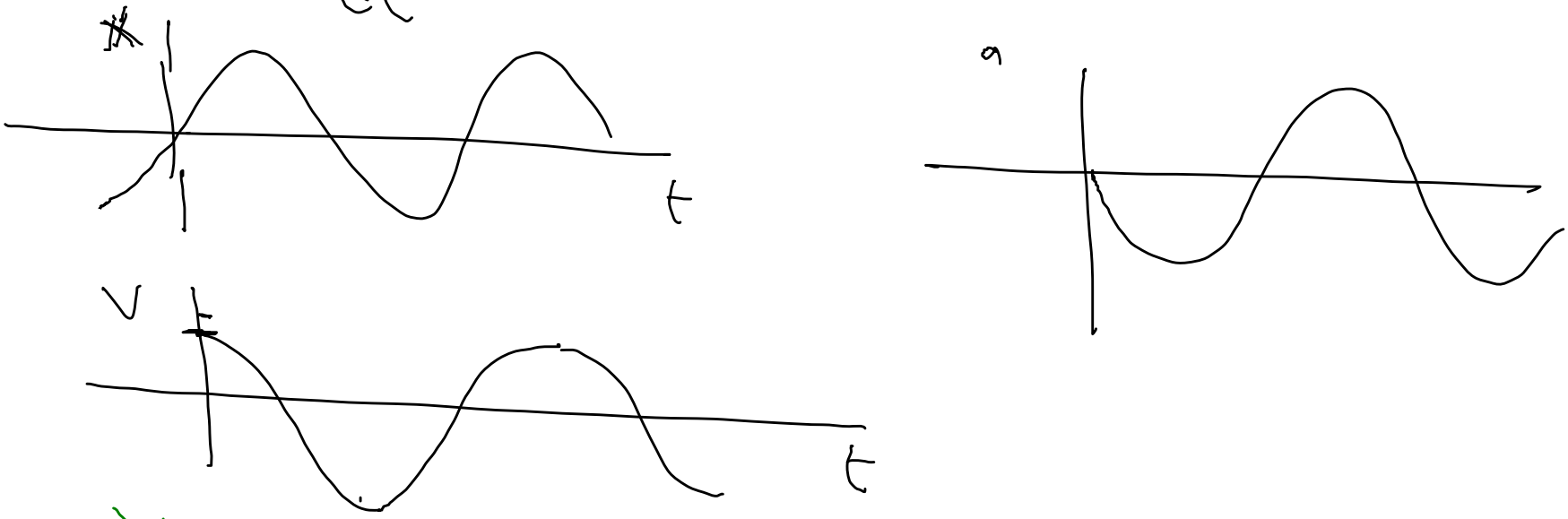
2.76 A particle's position as a fn of time is $X = X_0 \sin \omega t$

where X_0, ω are constants.

a) Find v, a b) Maximum value of v, a?

$$v = \frac{dx}{dt} = X_0 \omega \cos \omega t$$

$$a = \frac{dv}{dt} = -X_0 \omega^2 \sin \omega t$$



$$v_{max} = X_0 \omega \qquad a_{max} = X_0 \omega^2$$