Phys 2110-4 1/23/13

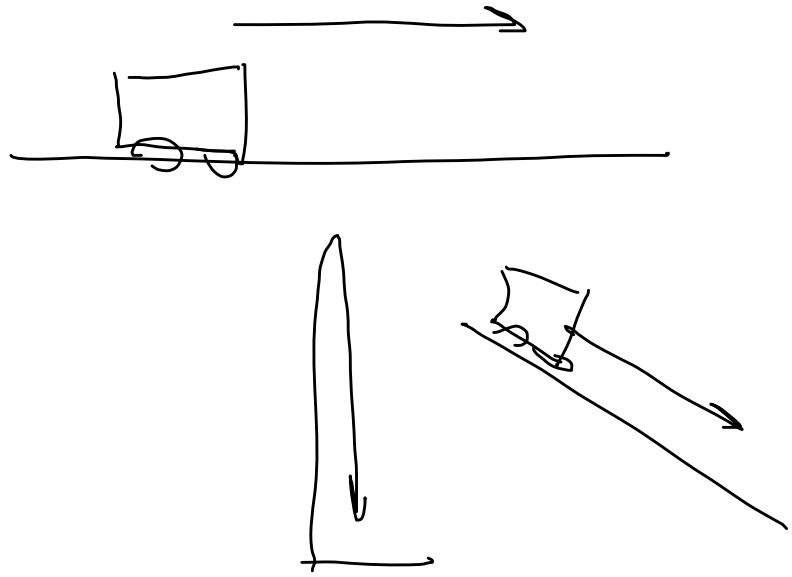
Note Title 1/23/2013

Motion in one dimension

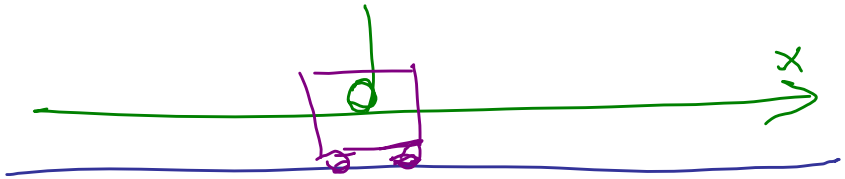
Kinematics

Dynamics

Math of motion.

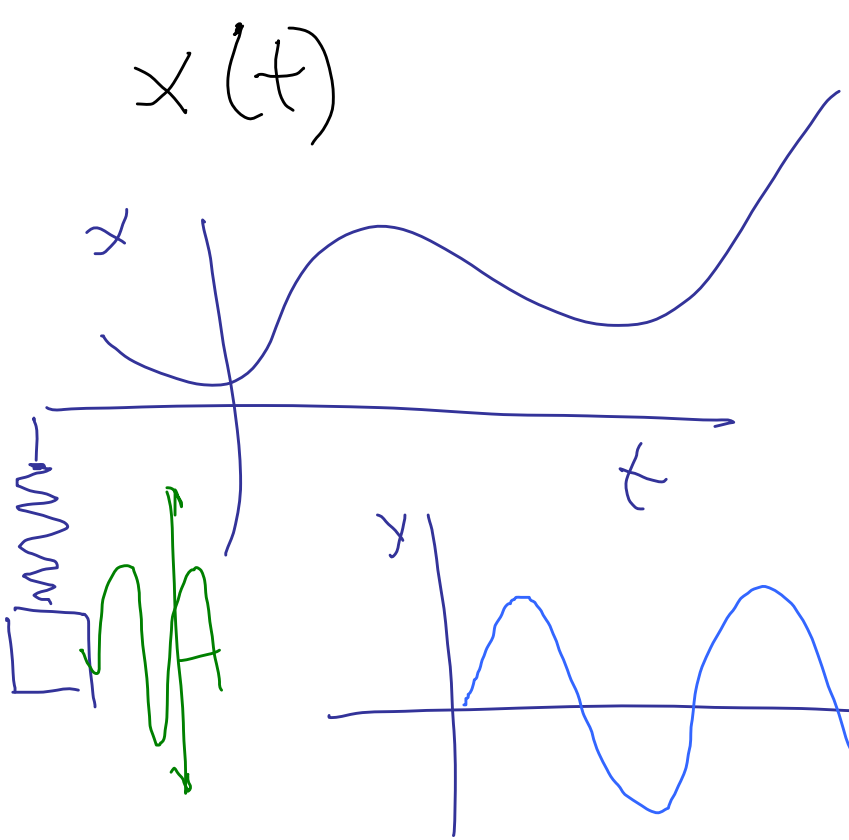


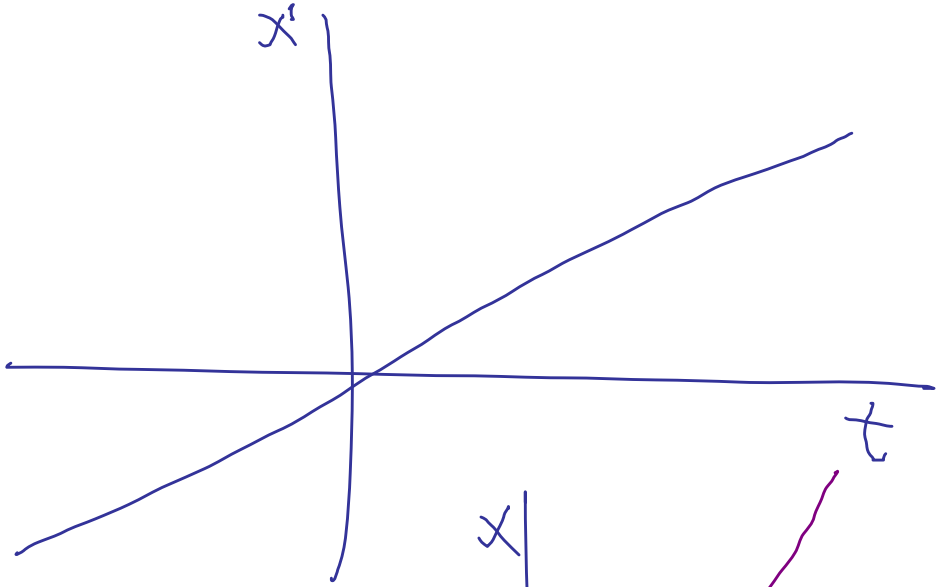
Coord system, x

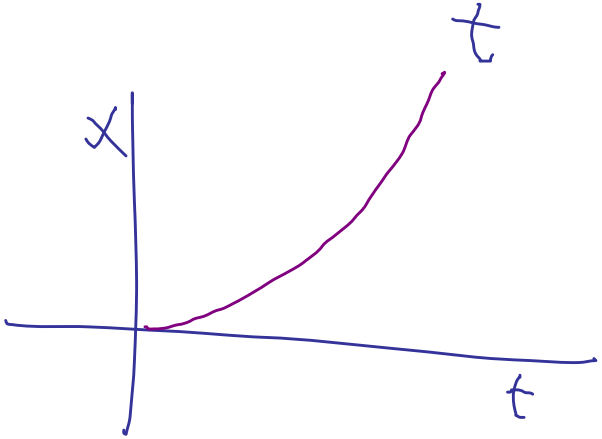


x changes w/ time

$x(t)$







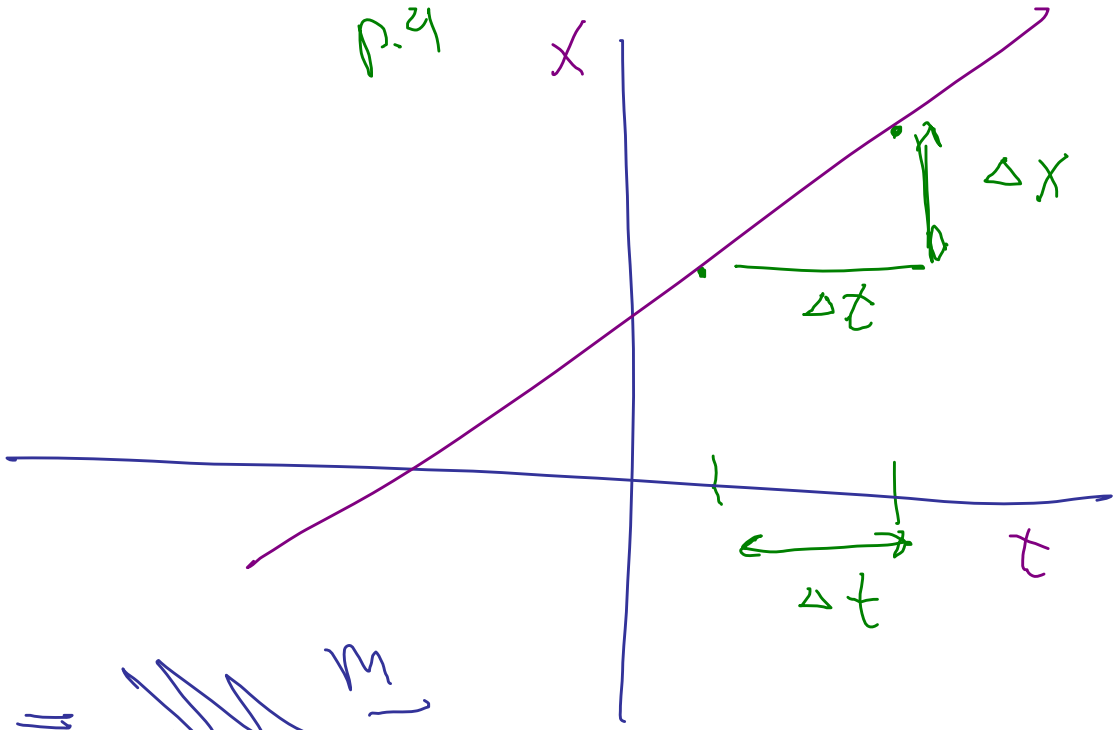
"How fast is something going"

Calculate

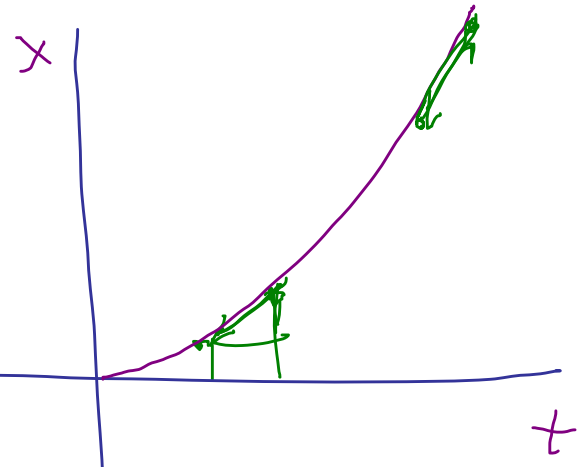
$$\frac{\Delta x}{\Delta t} = \bar{v}$$

avg velocity

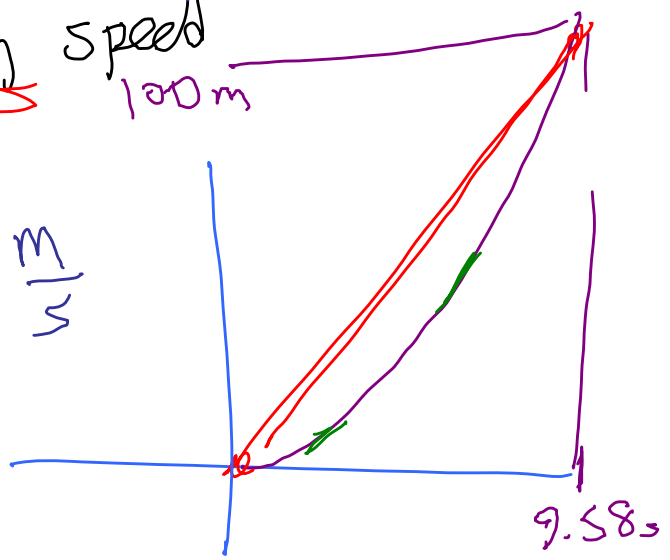
Units? $\frac{\Delta x}{\Delta t}$ $\frac{m}{s}$ = $\frac{m}{s}$



Avg velocity depends on time interval.

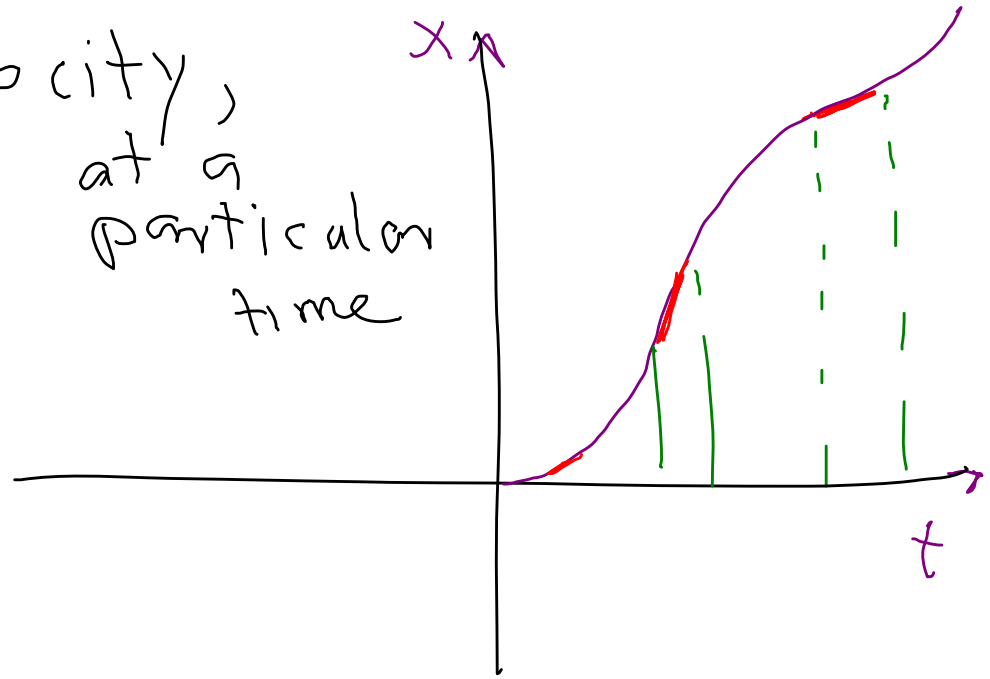


2.12 In 2009 Usain Bolt set world record in 100m in time 9.58s. Find avg speed



$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{100\,m}{9.58\,m} = 10.4\,\frac{m}{s}$$

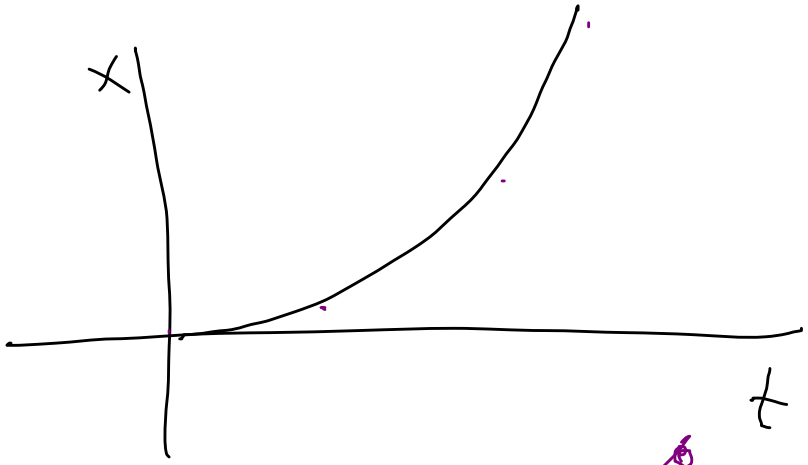
Instantaneous velocity, at a particular time

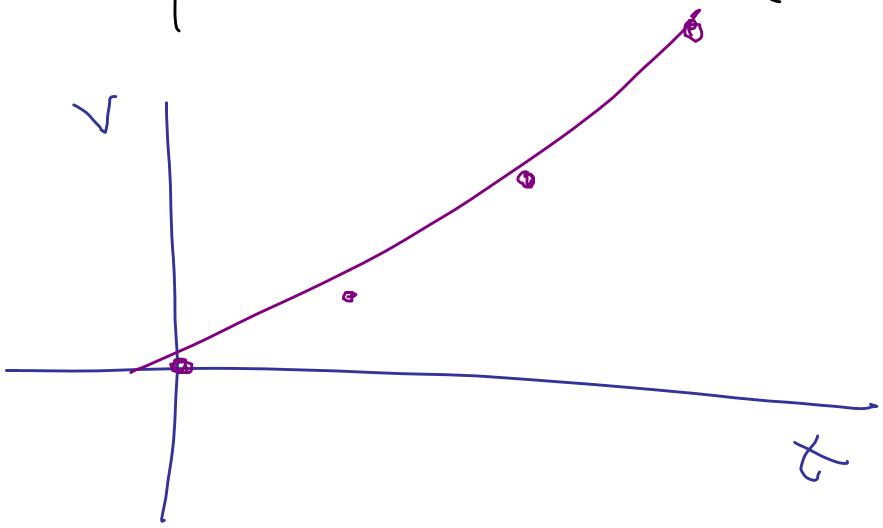


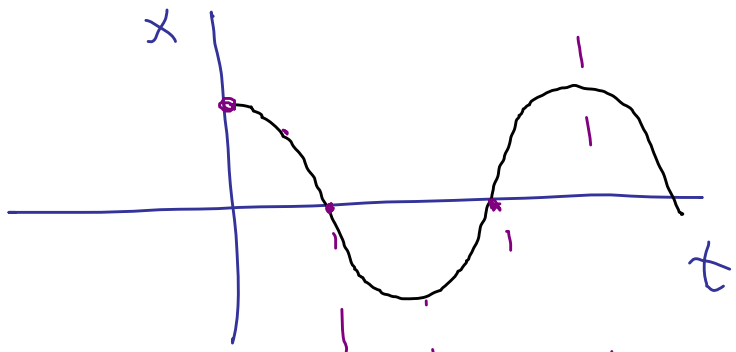
$$v = \frac{\Delta x}{\Delta t} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$

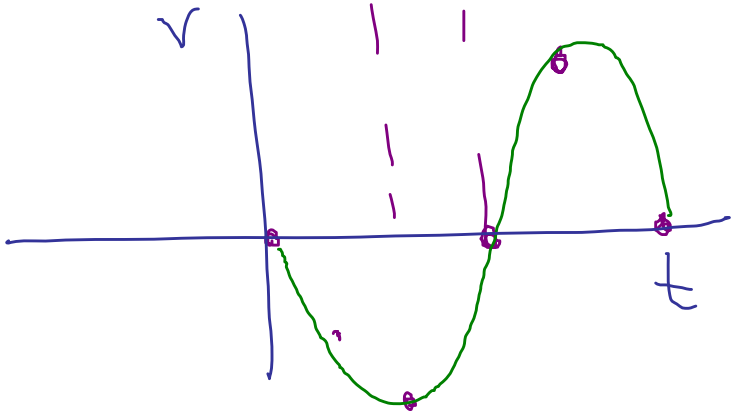
where Δt is reeeeally small

$x(t)$ $\qquad v = \frac{dx}{dt} = x'(t)$

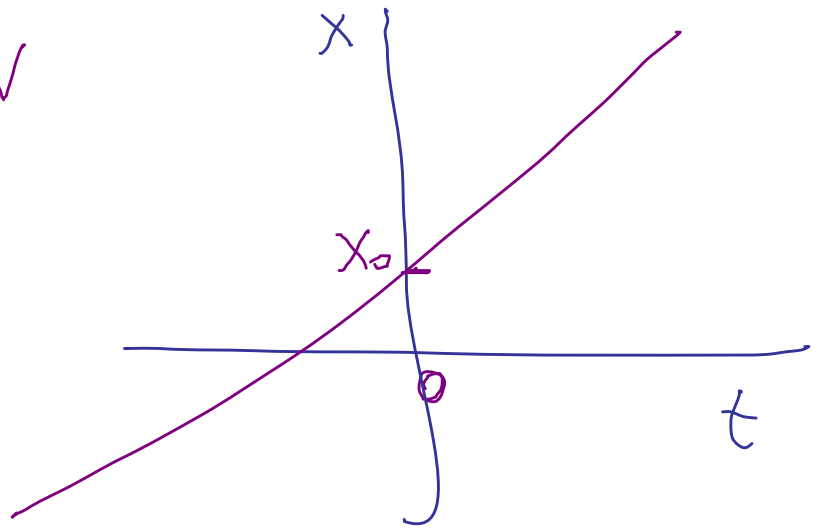

x
t


v
t


x
t


v
t

Suppose $\frac{dx}{dt} = \text{const} = v$



$$x = vt + x_0$$

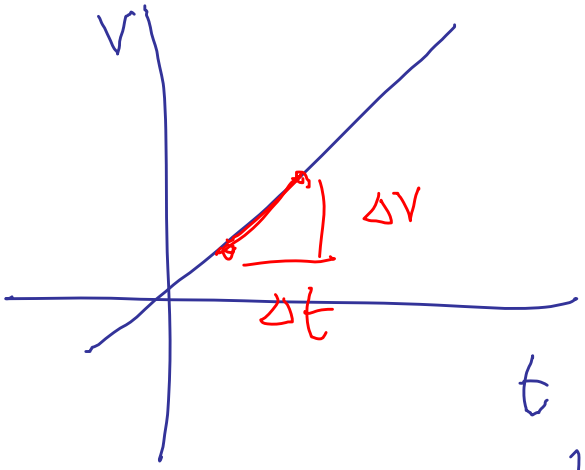
$$x = x_0 + vt$$

x_0 initial location. (m)

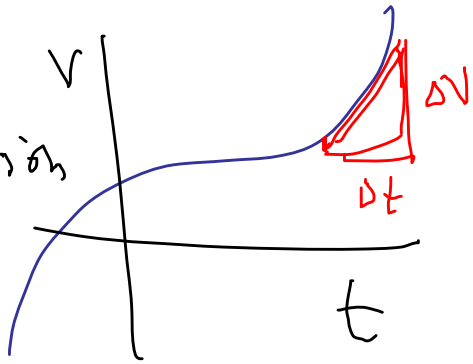
v_0 m/s $t = 5$

Consider when v changes

Accelerates.



How fast is v changing?



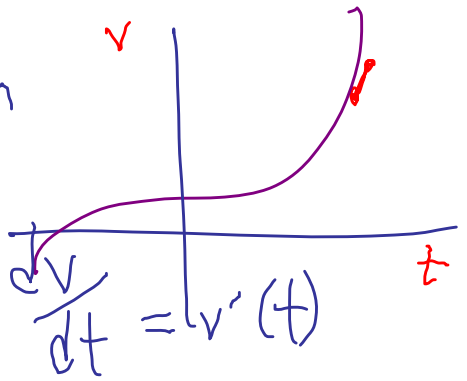
average acceleration

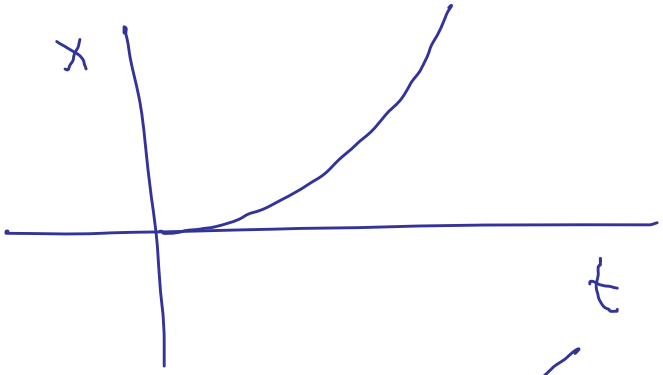
$$\bar{a} = \frac{\Delta v}{\Delta t} \qquad \frac{m/s}{s} = \frac{m}{s^2}$$

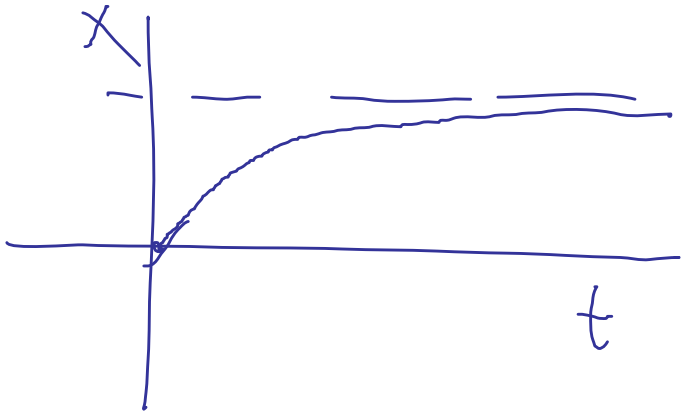
Want instantaneous acceleration

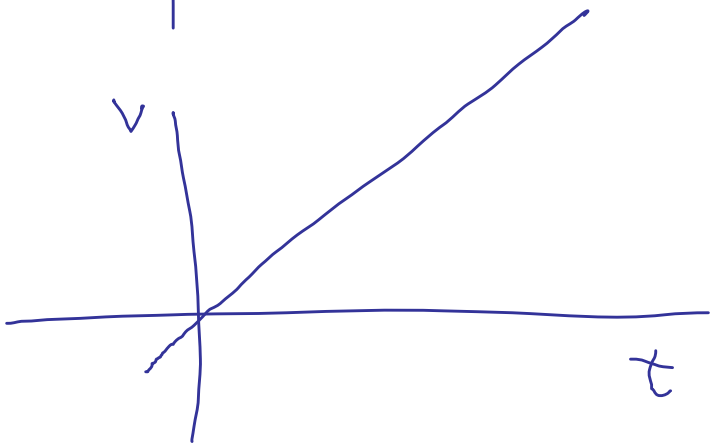
$$a = \frac{\Delta v}{\Delta t} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt} = v'(t)$$

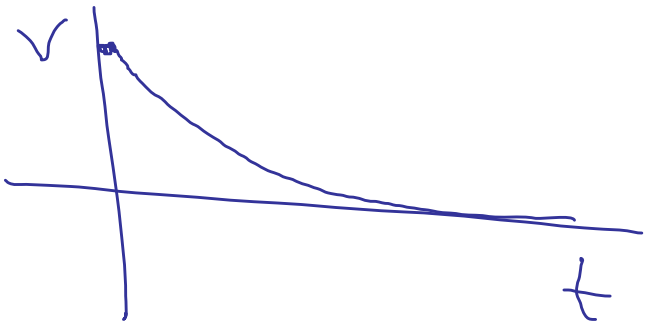
at recall on

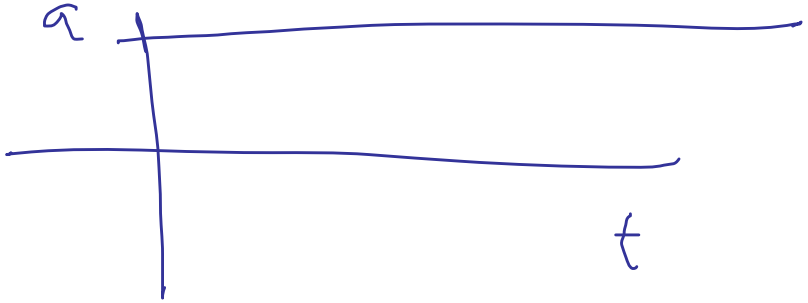


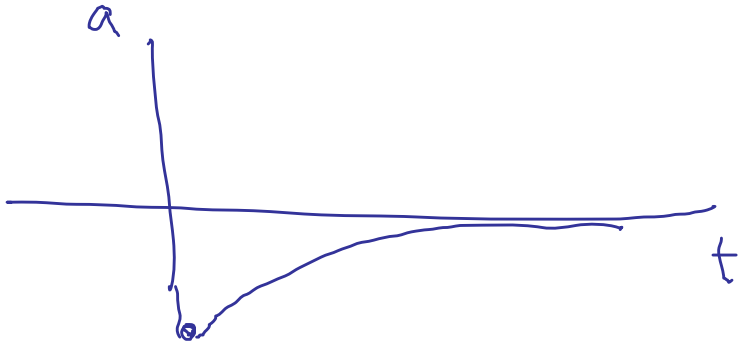

x
t

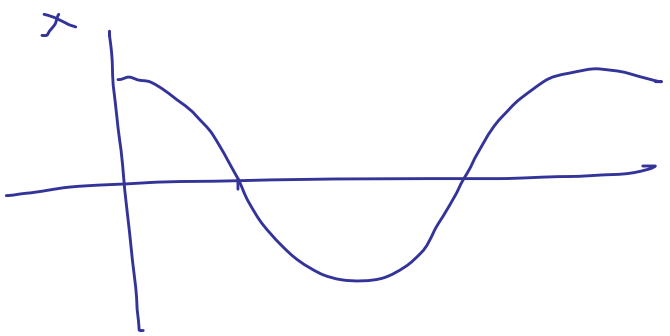

x
t

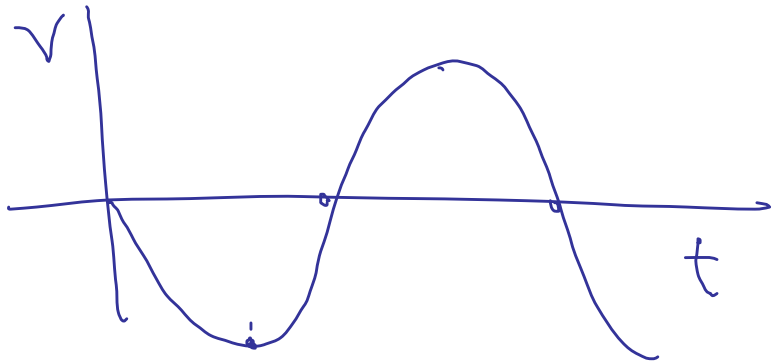

v
t

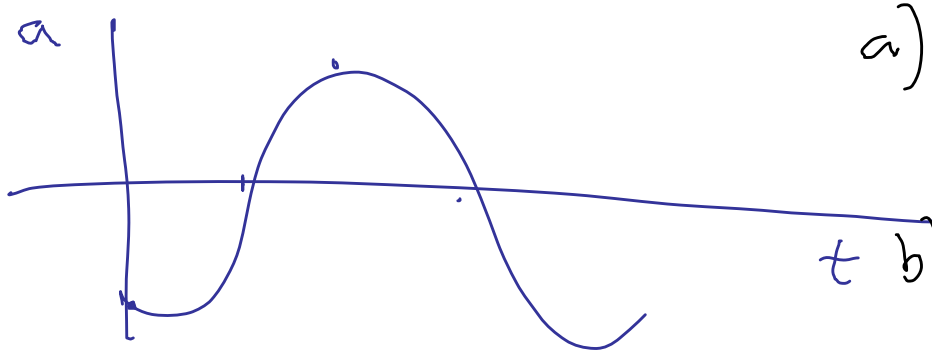

v
t


a
t


a
t







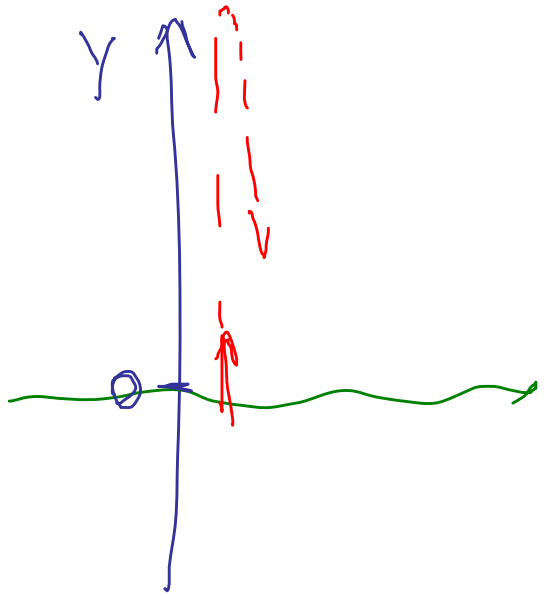
2.21 A model rocket launched str. up altitude y

$$y = bt - ct^2$$

$b = 82 \frac{m}{s}$ $c = 4.9 \frac{m}{s^2}$

a) Find general expr. for $v(t)$

b) When is velocity zero?



$$y = bt - ct^2$$

a) $$v = \frac{dy}{dt} = b - 2ct$$

At $t = 0$ $\quad v = 82 \frac{m}{s}$

$b = 82 \frac{m}{s}$

$c = 4.9 \frac{m}{s}$

b) When is $v = 0$

$$v = b - 2ct = 0$$

$$t = \frac{b}{2c} = \frac{82 \frac{m}{s}}{4.9 \frac{m}{s^2}} = 8.4\ s$$

c) What was alt. when $v = 0$ (Max ht)

Plug in

$$y = bt - ct^2$$

$$= \left(82\frac{m}{s}\right)(8.4\,s) - \left(4.9\frac{m}{s^2}\right)(8.4\,s)^2$$

$$= 343\ m$$

Special case $a = \text{const}$

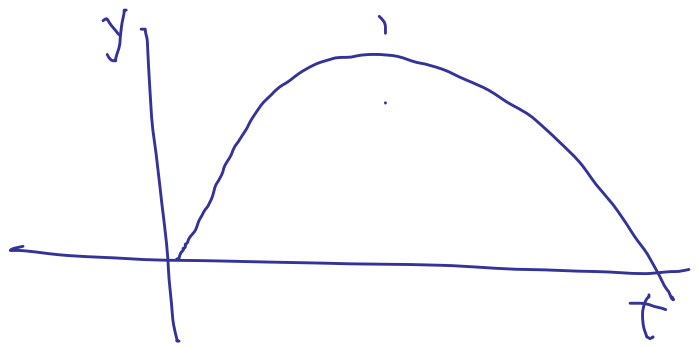
Gravity

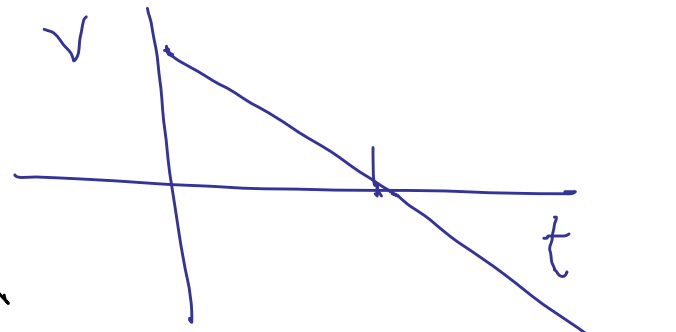
$x(t)$ $x(t)$

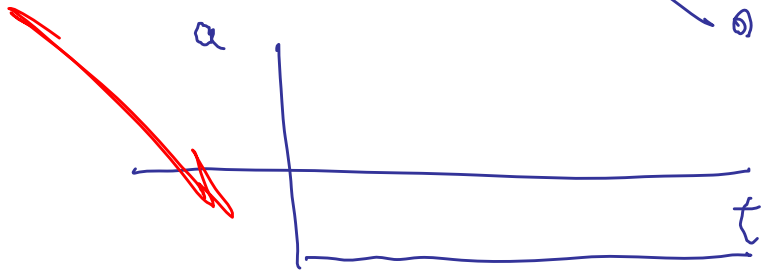
$v(t)$ $x'(t)$

$a(t)$ $x''(t)$

~~$b(t)$ $x'''(t)$~~







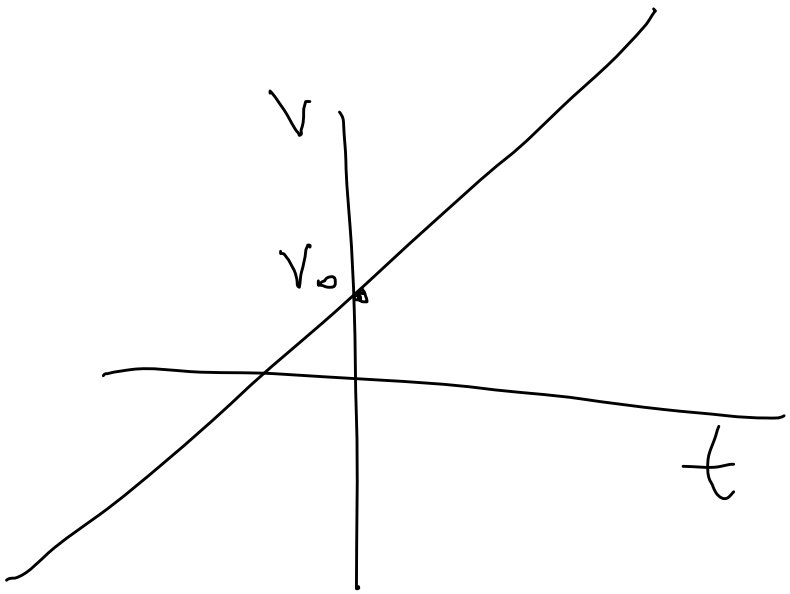
$a = const = \frac{dv}{dt}$

v is a linear function

$v = C_1 t + C_2$

$v = at + v_0$

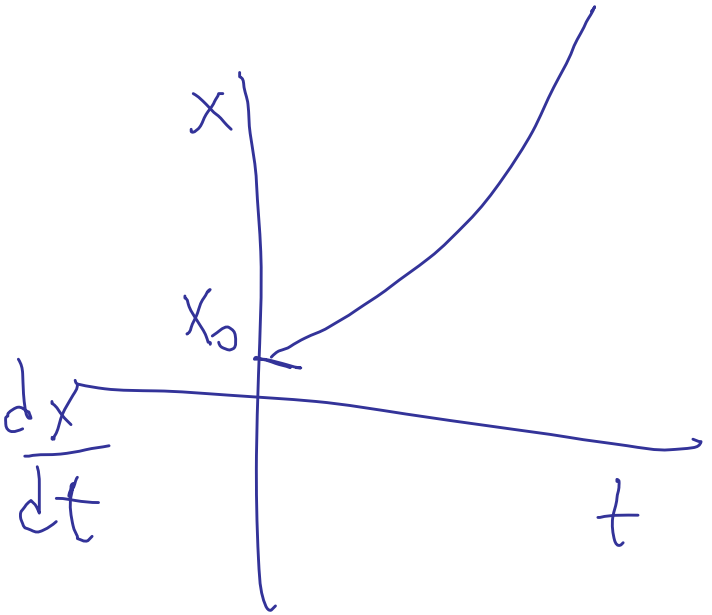
$$\boxed{v = v_0 + at}$$



Find $x(t)$

$$v = v_0 + at$$

$$v = \frac{dx}{dt}$$



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

what is x at $t = 0$?

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