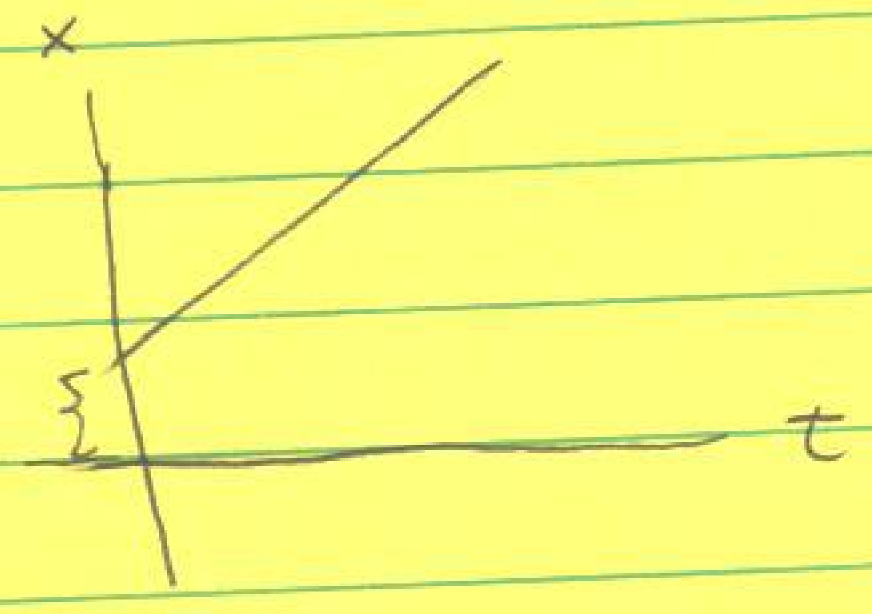
(1)

Last Time:

Motion With Constant Velocity:



$1\,m = x_0$

say $v = 5\,m/s$

$$x = x_0 + v\,t$$

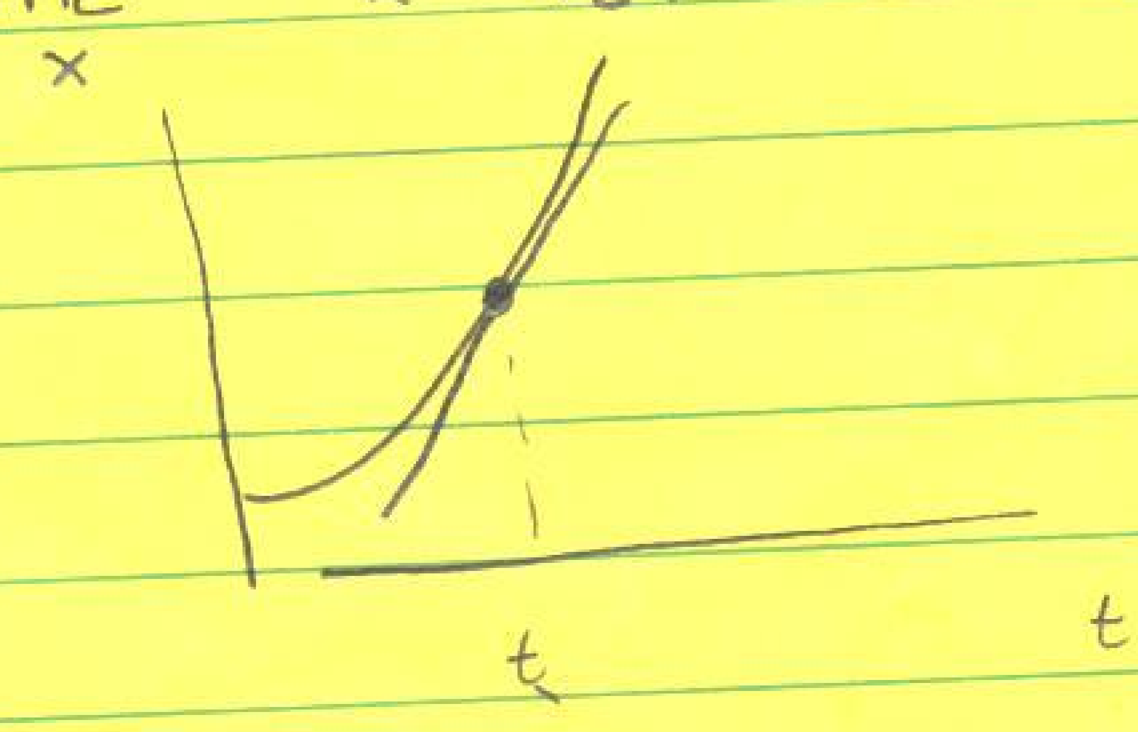
the slope of the line

Two Notions of Velocity:

1) $V = \dfrac{\Delta x}{\Delta t}$

2) The slope of the x vs. t line $x = x_0 + vt$

- More generally the slope of the x vs. t curve



$$V(t) = \frac{dx}{dt}$$

(2)

x vs. t

- GI Joe drives his fighter plane going ea
mach 1 for one hour realizes he
must refuel, Turns around and
flies at a more reasonable $\frac{1}{4}$ mach
until he reaches a fuell depot 200 km
West of where he started. What time does
he arrive?

Problem: Draw his position and
velocity as a function of
time. Label all relevant
points on your graph

- How fast must Joe travel to reach the turnaroun
point in 30 minutes?

- Derek, Trying to entertain his
class, runs 3m to the left for twos
seconds, and the runs to the
right at 5.2m/s. When does he reach
the wall which is 10.6m to the right

Problem: Draw Derek position vs. time
and Dereks velocity vs. time
label all relevant

(3) Const. Acceleration:

$$a = \frac{\text{Change in velocity}}{\text{Change in time}}$$

$$a = \frac{\Delta V}{\Delta t}$$

Typical Values

$$a \sim \frac{60-0 \text{ mph}}{4 s} \sim \frac{20 m/s}{4 s} \sim 5 m/s^2 \sim \frac{1}{2} g$$

$$1 g \sim \text{roughly} = 9.8 m/s \,/s = 9.8 m/s^2$$

$30 g \sim$ max a human body can with stand

Analogy:

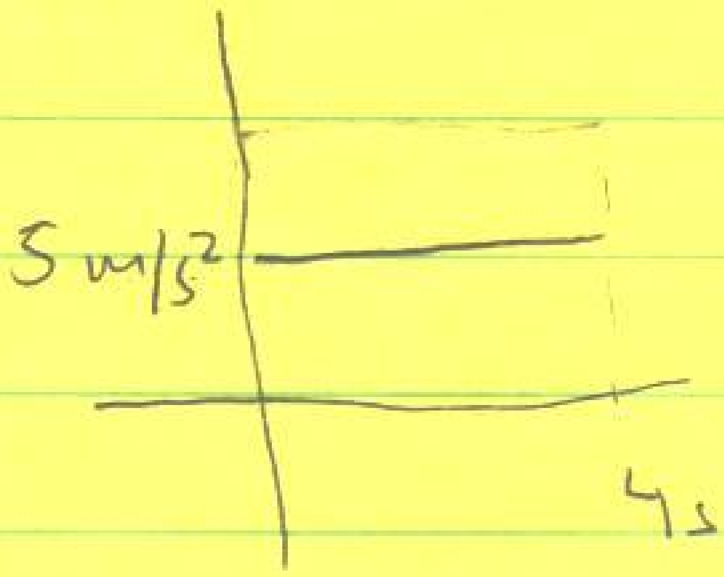
Const a	Const v
$a = \frac{\Delta V}{\Delta t} = \frac{dv}{dt}$	$V = \frac{dx}{dt}$
$V = V_0 + at$	$x = x_0 + vt$
a = slope of the V vs. t curve	V = Slope of the x vs. t curve

Ex I

A porsche goes from 0-60 in 4s draw his velocity vs. time draw his acceleration vs. time

Label all relevant points

$at = 5 m/s^2 \cdot 4s$

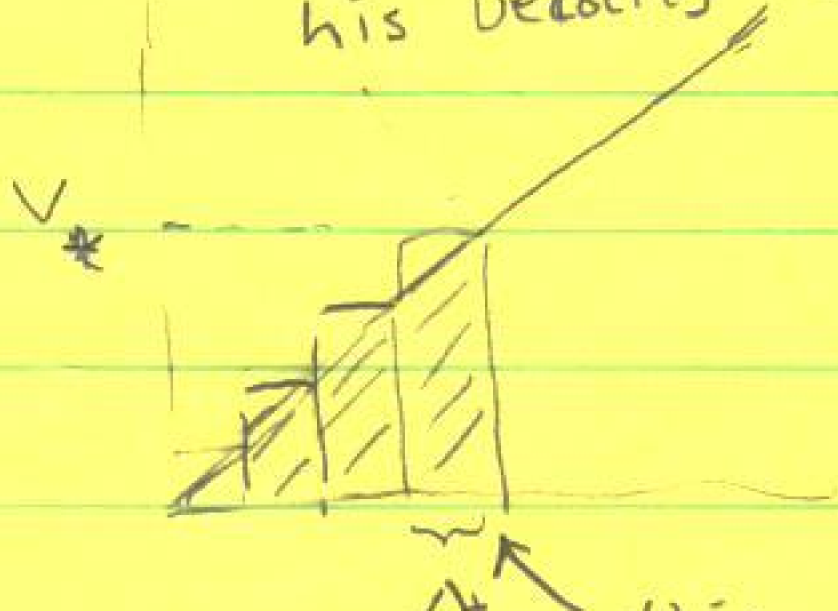


$$a = \frac{\Delta V}{\Delta t} = \frac{20 m/s}{4s} = \frac{5 m/s}{s}$$

How far did the porsche travel?

- Hes getting faster all the time

his velocity at this time

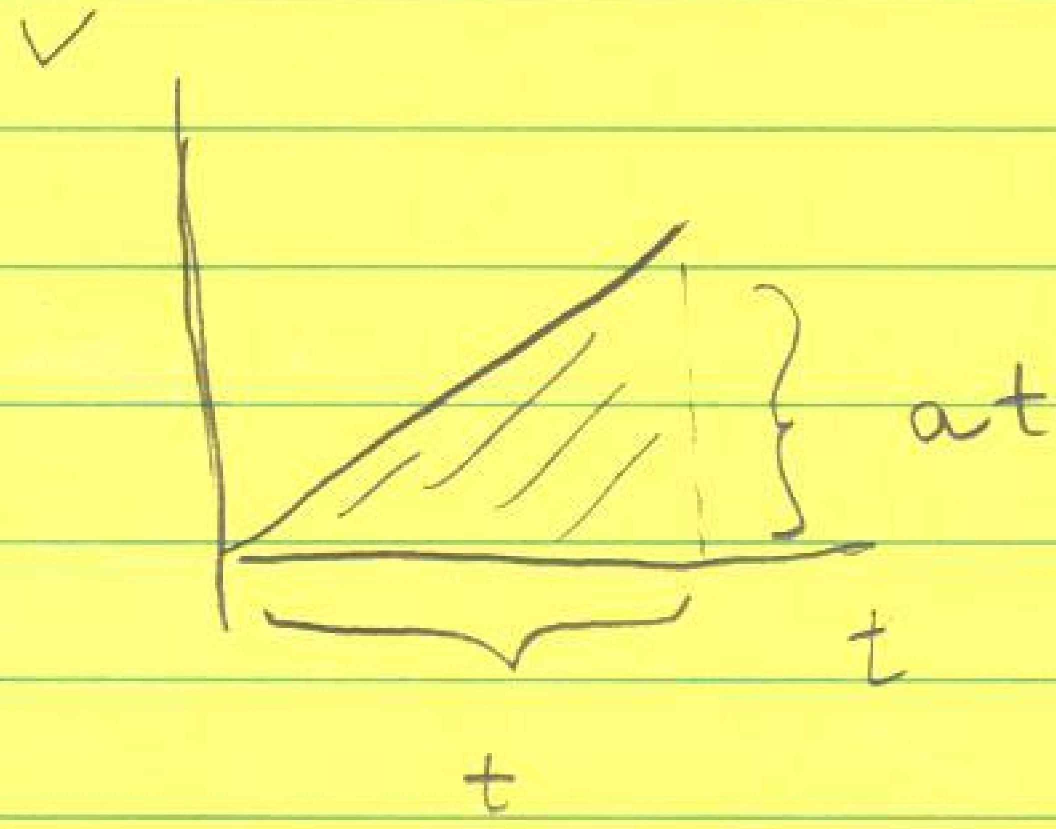


this time t_*

Distance he moved at this $= V_* \Delta t$

= area of the rectangle

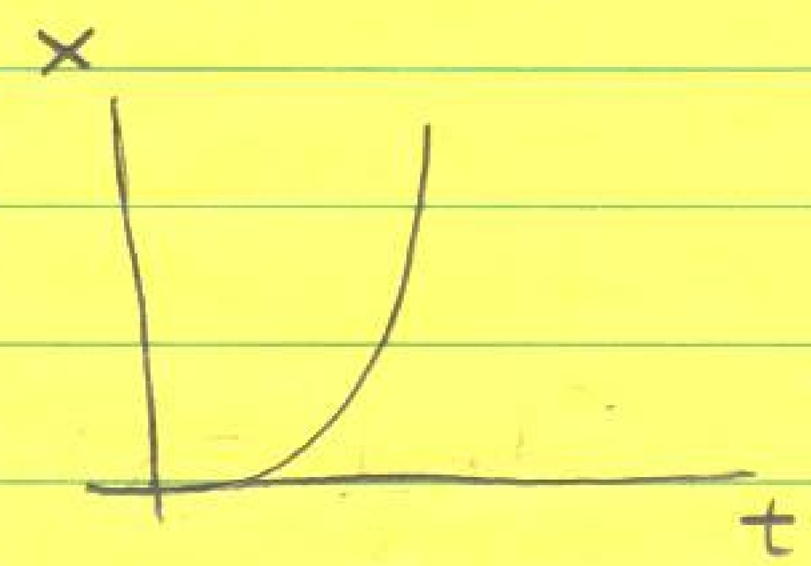
Distance he moved = the area under the v vs. t curve



distance he moved $= \frac{1}{2}\,\overbrace{\text{base}}^{t} \times \overbrace{\text{height}}^{at} = \frac{1}{2}at^2$

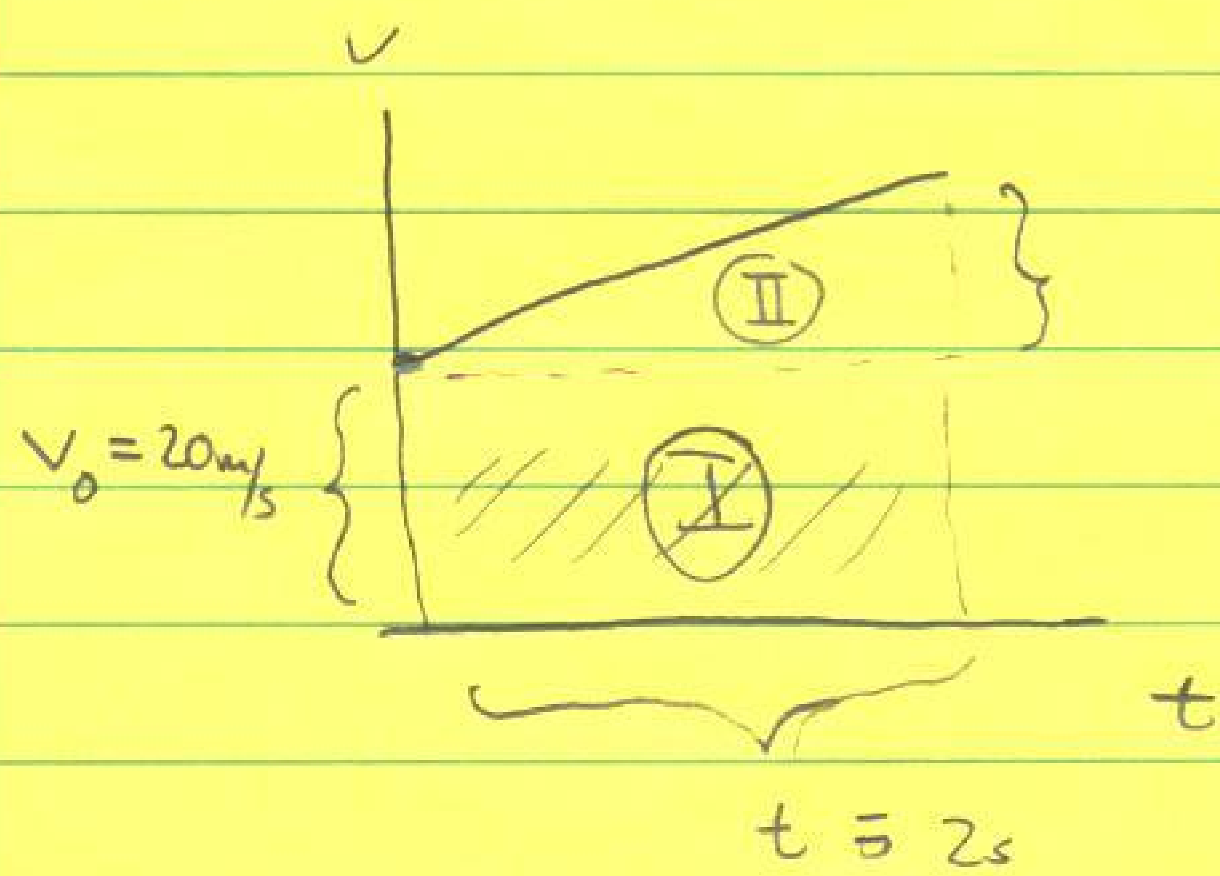
$= 2.4\,\text{m/s}^2\, t^2$

Position vs. time



More generally suppose a porsche starts with speed $V_0 =$ "20 m/s" per second and then accelerates with "$a = \frac{1}{2}g$" for 2s $= 5\,\text{m/s}^2$

Plot his velocity vs. time and his acceleration vs. time



$\Delta v = a\,t = 5\,\text{m/s}^2 \cdot 2s = 10\,\text{m/s}$

(6)

How far did he travel?

Δx = area under v vs. t curve

$$(\text{Area})_{I} = v_0 t = 20\,m/s \cdot 2s = 40m$$

$$(\text{Area})_{II} = \frac{1}{2} \underbrace{\text{base}}_{t} \times \underbrace{\text{height}}_{at} = \frac{1}{2} at^2$$

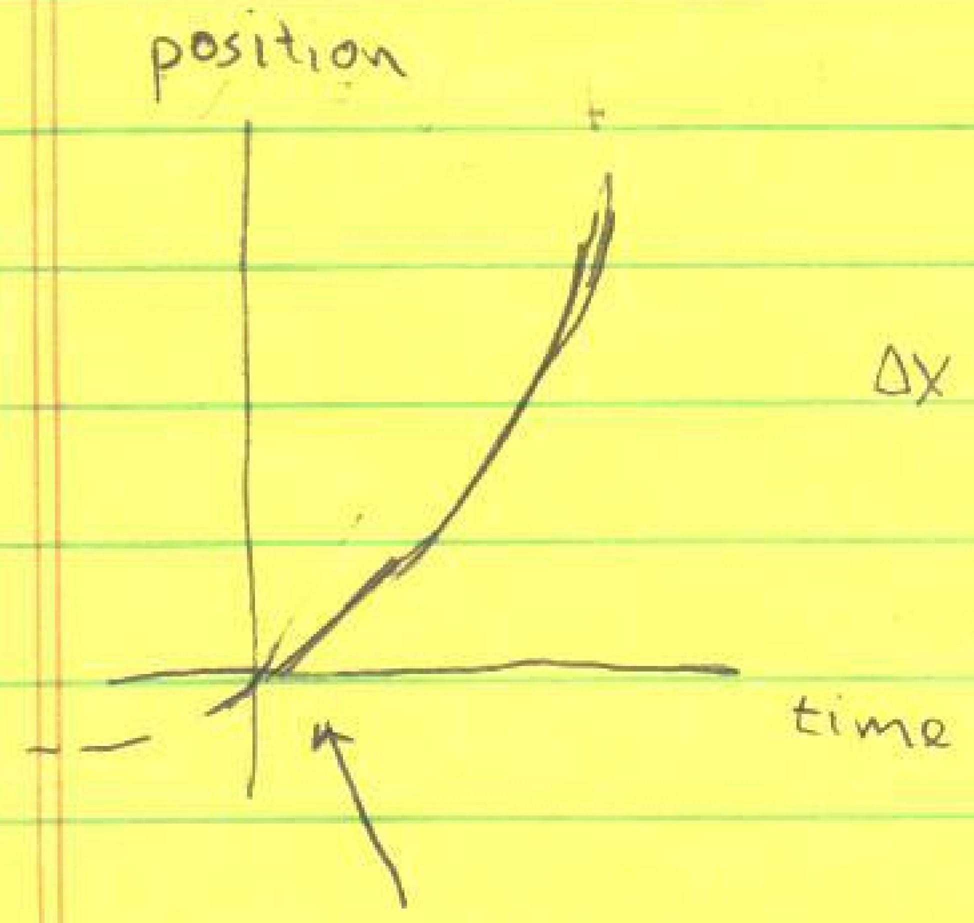
$$= \frac{1}{2} 5 \cdot 2^2 = 10$$

$$\Delta x = v_0 t + \frac{1}{2} at^2$$

$$\Delta x = 40m + 10m = 50m$$

Does this number make sense?

Graph



$$\Delta x = 20t + 12.5t^2$$

7

Summary Equations of Constant Acceleration

$$a = \frac{\Delta V}{\Delta t}$$

V vs. t $\quad V = V_0 + a \cdot t \implies \frac{dv}{dt} = a$

X vs. t $\quad x = x_0 + V_0 t + \frac{1}{2} a t^2 \implies \begin{cases} \frac{dx}{dt} = V = V_0 + at \\ \frac{d^2x}{dt^2} = \frac{dv}{dt} = a \end{cases}$

t

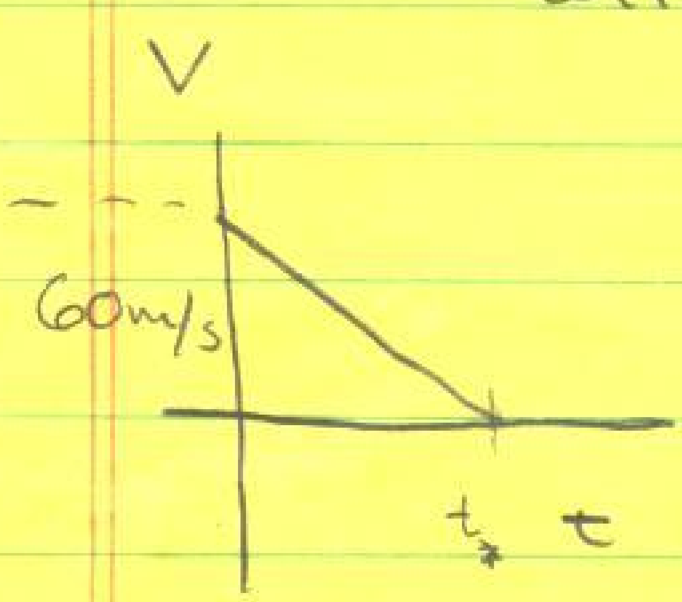
V vs. x $\quad \frac{1}{2} V_1^2 = \frac{1}{2} V_0^2 + a(x_1 - x_0)$ ← we'll see how to use it shortly

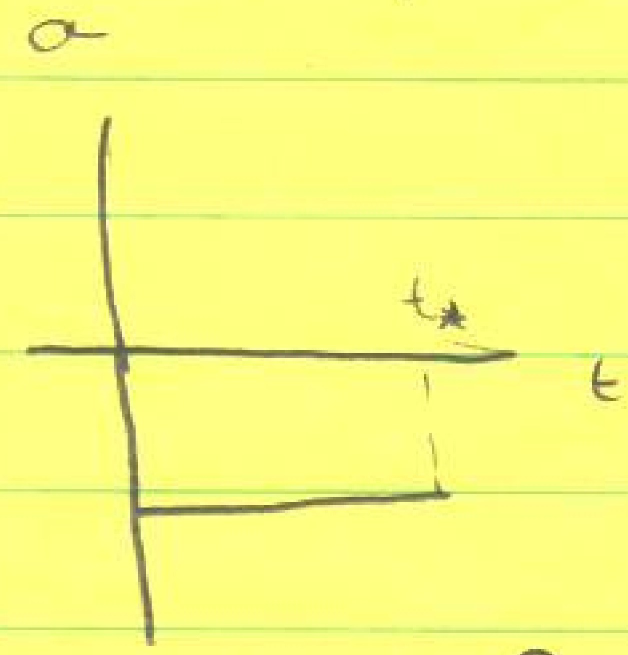
$$\frac{dv}{dt}$$

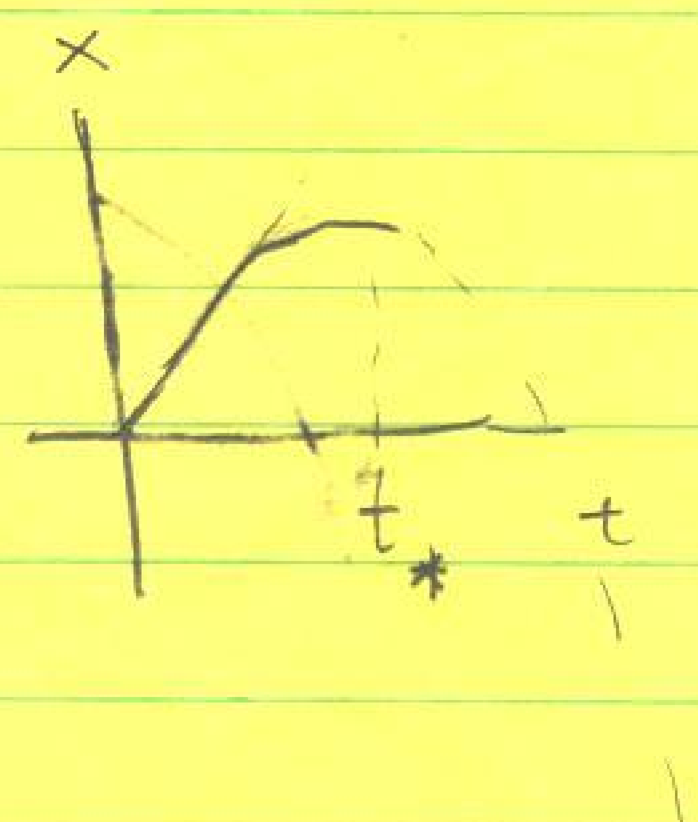
8

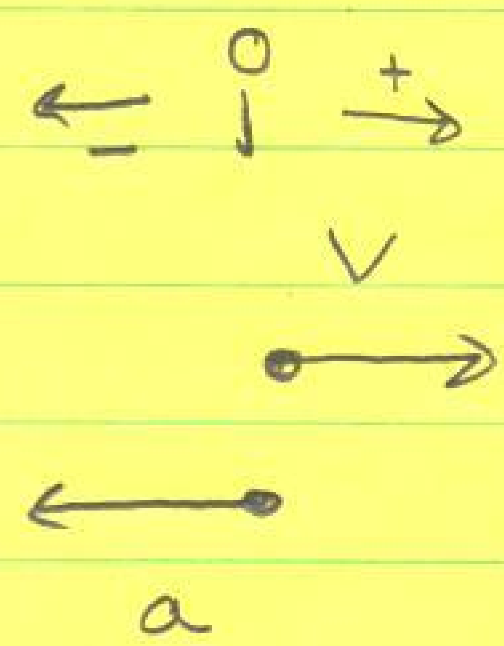
Problem a fighter plane going 60m/s lands on an aircraft carrier and undergoes decelerates at 3gs. What is his stopping distance and time

Plot his ① velocity vs. time ② acceleration vs. time ③ position vs. time. Label all relevant points









Solution:

Stopping Time $t \ (v = 0)$

$$V_f = V_0 + at_*$$

$$0 = 60\,m/s + (-3g)\,t_*$$

$$-60\,m/s = -3 \times 10\,m/s^2\ t_*$$

$$\boxed{2s = t_*}$$

(9)

Stopping distance: x when $t = t_*$

$$x_f = \cancel{x_0}^{\,0} + v_0 t + \frac{1}{2} a t^2$$

$$x_f = v_0 t_* + \frac{1}{2} a t_*^2$$

$$= 60\,m/s \cdot 2s + \frac{1}{2}(-3g) \cdot (2s)^2 \qquad (1g = 10\,m/$$

$$x_f = 60\,m/s \cdot 2s - 15\,m/s^2 \cdot 4s^2$$

$$x_f = 60\,m$$

Alternate solution use the x vs. v equation

Stopping distance x $(v = 0)$

$$V_f^2 = V_i^2 + 2a(x_f - \cancel{x_i}^{\,0})$$

$$0 = (60\,m/s)^2 + 2 \cdot (-3 \times 10\,\frac{m}{s^2}) \cdot x_f$$

$$-3600\,\frac{m^2}{s^2} = -60\,\frac{m}{s^2} \cdot x$$

$$60\,m = x$$