Physics 113 - September 6, 2012

- P.S. 1 due ... hand in here after class

  or

  Put in "homework locker" across hall from Main entrance to B+L 106 lecture hall

  Will be picked up Friday morning

- Workshops start next week

- Labs start next week (Section A)

Review of last class

in 1-d motion direction given by Algebraic sign

Kinematic variables

x (or y or z) $\equiv$ position

$v \equiv$ velocity

$a \equiv$ Acceleration

$t \equiv$ time

Have $x(t)$, $v(t)$, $a(t)$ — Not Independent

Average Speed $= \frac{\Delta x}{\Delta t}$ — Distance Traveled

Average velocity $= \frac{\Delta x}{\Delta t}$ — Displacement over time interval

$\bar{v}$

$\boxed{\text{in limit } \Delta t \to 0}$

Average Velocity

instantaneous Velocity

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

Also known as "velocity"

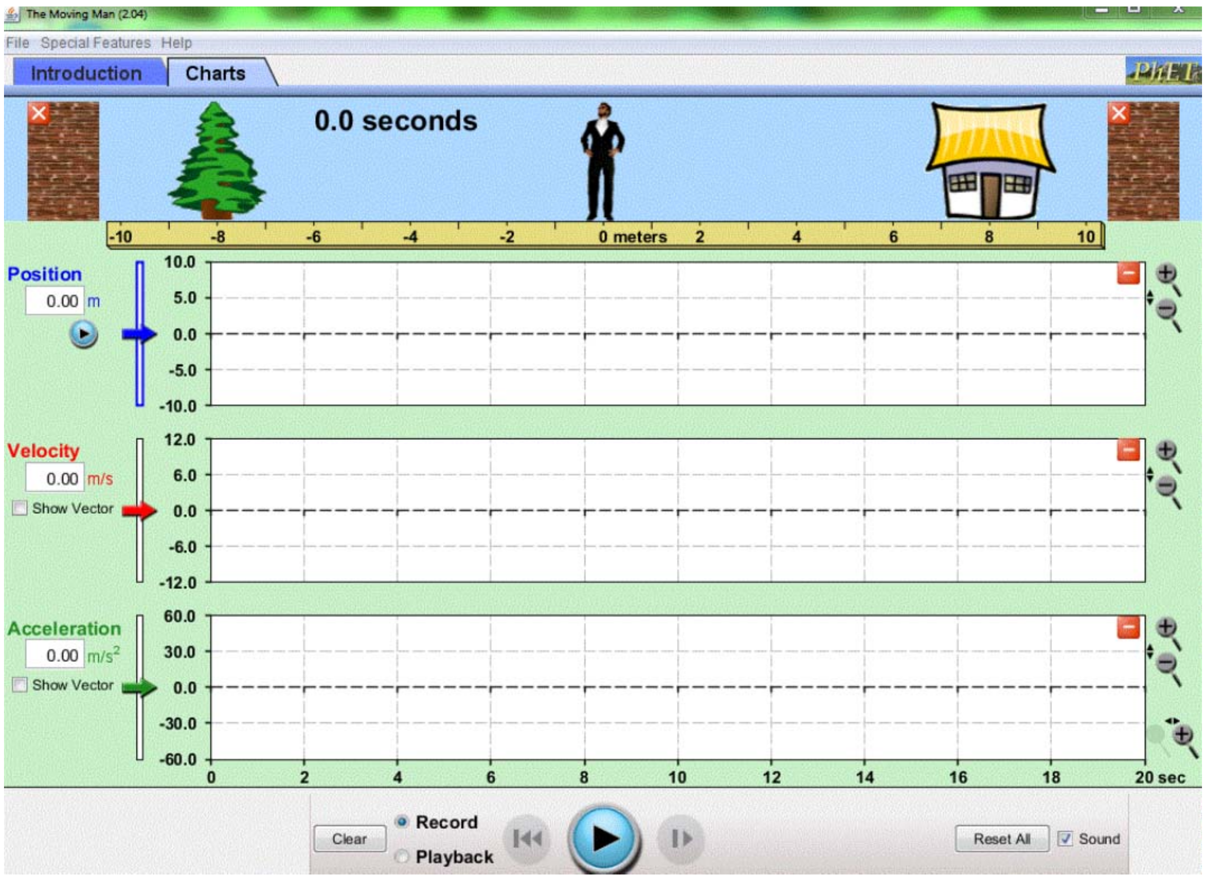
Similarly,

$$\text{Average Acceleration} = \frac{\Delta v}{\Delta t}$$

instantaneous Acceleration or acceleration $= \dfrac{dv}{dt}$

$$= \frac{d}{dt}\frac{dx}{dt} = \frac{d^2x}{dt^2}$$

http://phet.colorado.edu/en/simulation/moving-man

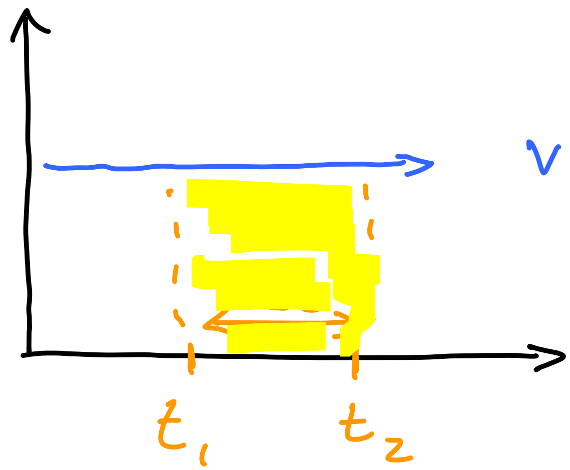


Also do Motion sensor demo

-10 6 -1

$$\frac{\Delta x}{\Delta t} = V_{Ave}$$

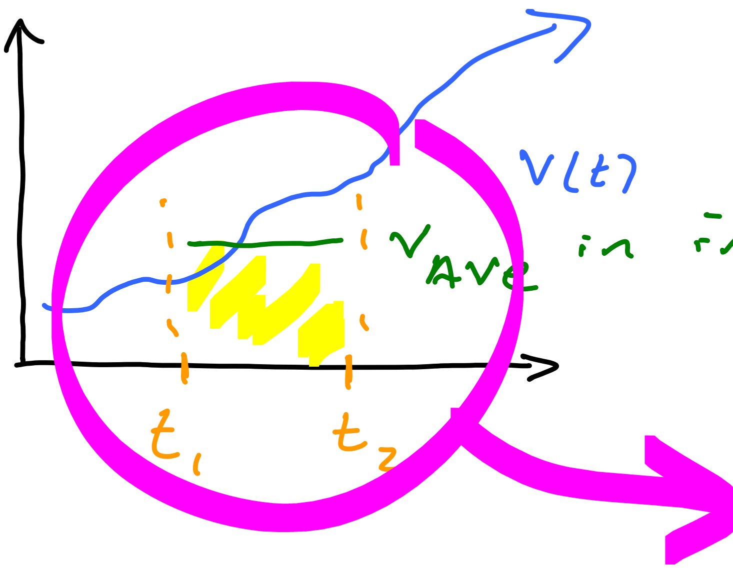
$V(t) = \text{constant}$



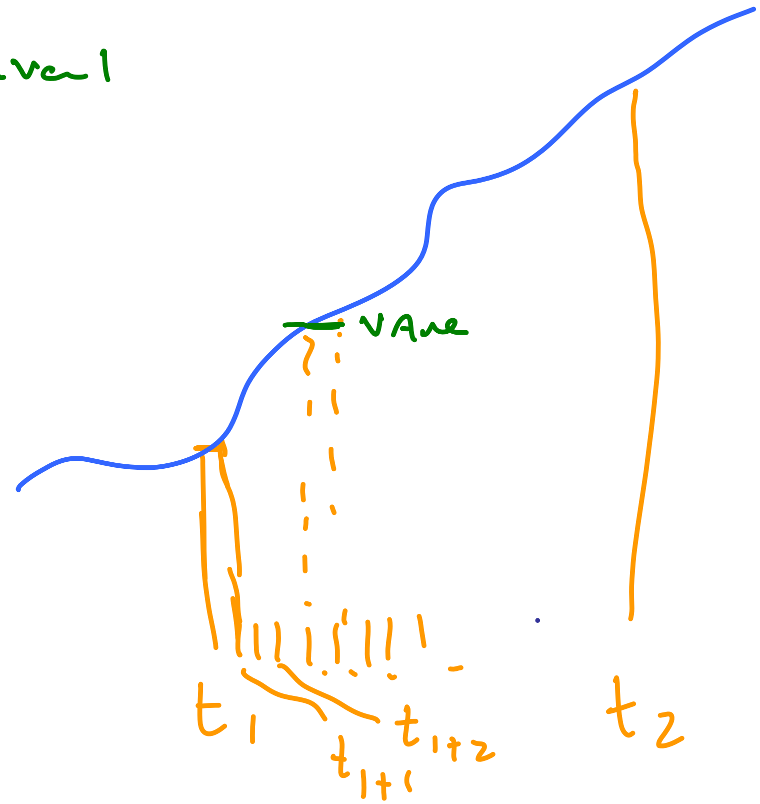
$V(t)$ . . . also V_{ave}

$$\Delta x = V_{Ave} \Delta t$$

Area



$$\Delta x = v_{Ave} \Delta t$$



$$\Delta x = \sum_i v_{Ave,i} \Delta t_i$$

go to limit $\Delta t \to 0$

$$\Delta x = \lim_{\Delta t \to 0} \sum V_{ave,i} \Delta t_i$$

$$\equiv \quad \Delta x = \int_{t_1}^{t_2} v\,dt$$

$$\Delta t \to dt$$

$$V_{ave} \to V$$

if $\quad g = \int f\,dt \quad$ then $\quad f = \dfrac{dg}{dt}$

$$\boxed{x_2 - x_1 = \int_{t_1}^{t_2} v\,dt}$$

general

$$\longrightarrow \quad x - x_0 = \int_{t_0}^{t} v\,dt$$

$$\frac{\Delta v}{\Delta t} = a_{ave} \equiv \text{Average Acceleration}$$

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

$$v - v_0 = \int_{v_0}^{v} dv = \int_{t_0}^{t} a\,dt$$

True in general

Special case

$a = \text{CONSTANT}$

$$V - V_0 = \int_{t_0}^{t} a\,dt = a\int_{t_0}^{t} dt = a\,t\Big|_{t_0}^{t} = a(t - t_0)$$

$$V - V_0 = a(t - t_0)$$

let $t_0 = 0$

$$\boxed{V = V_0 + at}$$

V, a, t

NO X

$$x - x_0 = \int_{t_0}^{t} v\,dt$$

$$x - x_0 = \int_{t_0}^{t} (v_0 + at)\,dt$$

$$x - x_0 = \underbrace{\int_{t_0}^{t} v_0\,dt}_{} + \underbrace{\int_{t_0}^{t} at\,dt}$$

$$x - x_0 = v_0(t - t_0) + a\underbrace{\int_{t_0}^{t} t\,dt}$$

$$\left.\frac{t^2}{2}\right|_{t_0}^{t}$$

$$x - x_0 = v_0(t - t_0) + a\left(\frac{t^2}{2} - \frac{t_0^2}{2}\right)$$

$t_0 = 0$

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

x, t, a

NO V

$$V_{Ave} = \frac{\Delta x}{\Delta t} \longrightarrow \Delta x = V_{ave}\,\Delta t$$

a is constant $\rightarrow$ V changes at constant rate

$$V_{Ave} = \frac{V + V_0}{2}$$

$$x - x_0 = \frac{V + V_0}{2}(t - \cancel{t_0}^{\,0})$$

$$\boxed{x = x_0 + \left(\frac{V + V_0}{2}\right) t}$$

No a

x, V, t

$V = V_0 + at$ $\xrightarrow[\text{Solve for } t]{}$ $\dfrac{V - V_0}{a} = t$

$$x = x_0 + \left(\frac{V + V_0}{2}\right)\left(\frac{V - V_0}{a}\right)$$

$V^2 - V_0^2$

$$x = x_0 + \frac{V^2 - V_0^2}{2a}$$

$$\boxed{V^2 = V_0^2 + 2a(x - x_0)}$$

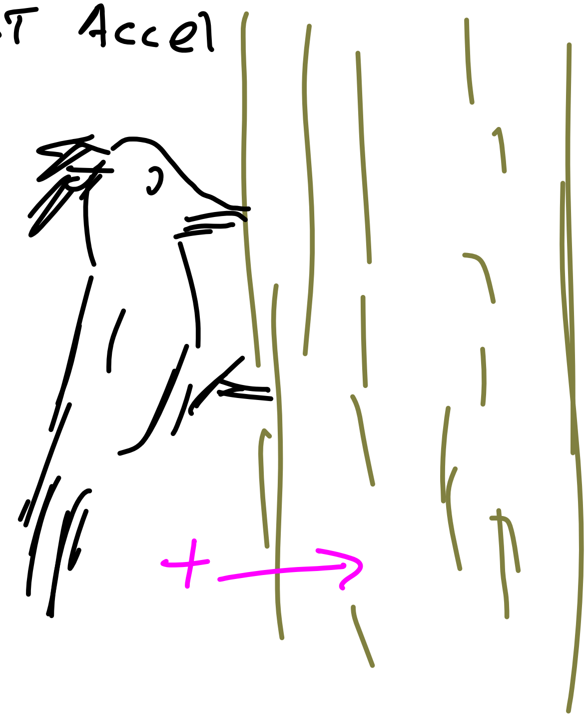
V, a, X

No time

Assume const Accel

$V_0 = 0.6 \ m/s$

Comes to a stop in 2 mm



(a) What is the acceleration of head in units of $\underset{9.8 \ m/s^2}{\underline{\underline{g}}}$.

Know V_0, $x - x_0$, $V = 0$

Want is a

$$\underbrace{V^2}_{0} = \underbrace{V_0^2}_{0.6^2} + 2a\underbrace{(x - x_0)}_{.002}$$

$$a = -90 \ m/s^2$$

$$\frac{|-90|}{98} \sim 9 \text{ g's}$$

(b) how much time does it take head to stop

$$V = V_0 + at$$

$0 \quad .6 \text{ m/s} \quad -90 \text{ m/s}^2$

$$t = \frac{-.6}{-90} = 6.7 \text{ milliseconds}$$

.0067

Tendon's Stretch ... brain come to a stop in 4.5 mm

$$V^2 = V_0^2 + 2a(x - x_0)$$

$$a = -40 \text{ m/s}^2$$

or 4g

After class, one of you came up and told me the woodpecker's "tendon" that I spoke of is actually part of the tongue ... is that fun or what?