– Concept Map   Lect Sept 5

– Problems with Website? / Downloads of .docs?

– e-Mail roster

– Workshop signings

https://spider.pas.rochester.edu/signup/PHY113-F02/

Last time:

→ Went thru syllabus + discussed how to approach course

PATH of 3 steps to post-physics Nirvana

→ Questions?

→ Spent a few minutes talking about the Scientific Philosophy of Physics and some of the things that ~~make~~ drive it to be what it is.

Precise Measurement / quantification
→ mathematics ... Number
→ System of units

Systeme Internationale

	Mass	Length	Time
MKS	kg	M	S
CGS	g	CM	S
British Engineering System / English	Slug	~~inch~~ foot	S

Tennis Ball $O \longrightarrow$

Introduce vectors and Scalars

Will not do Significant figures
Estimation

Should know how to do

Vectors, Dimensional Analysis, conversions
will do as we go!

Lets START studying the world around us
Sit on the quad for 2 hours
What do you see?

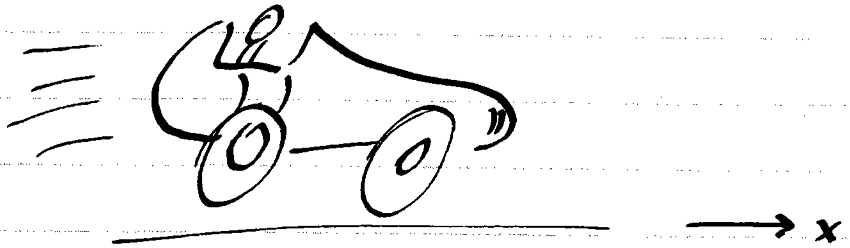
Motion ... change ... what causes change

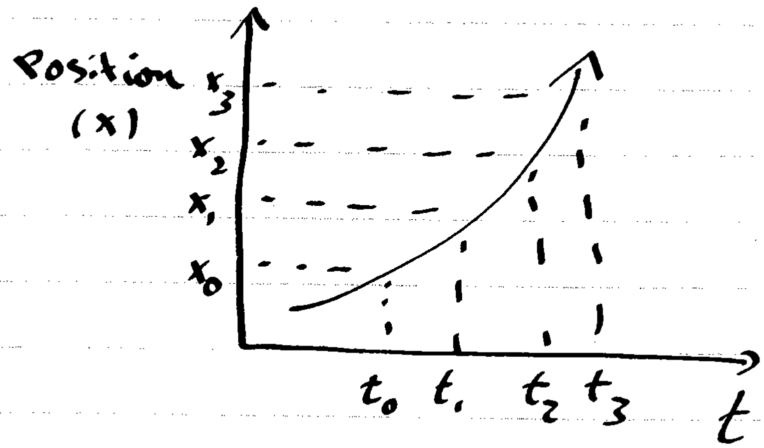
Let us begin by studying Motion
one dimension for simplicity

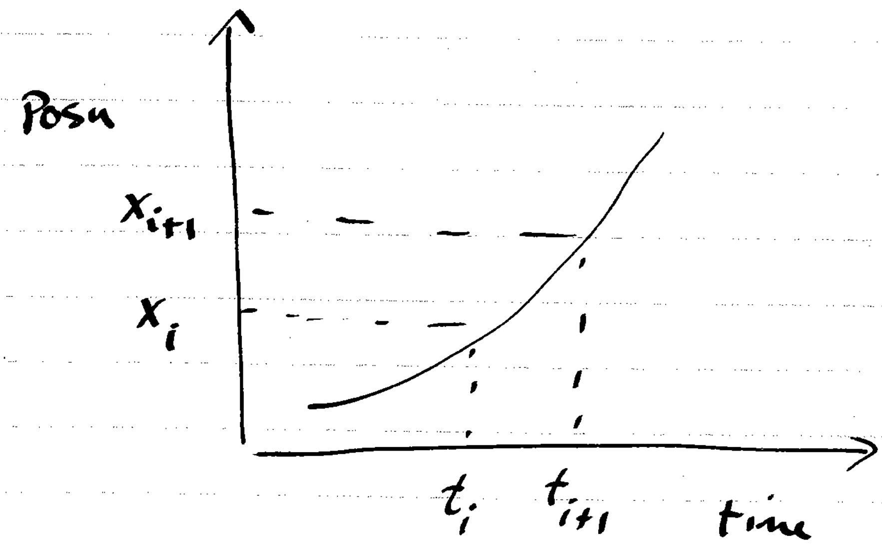
One dimensional Kinematics

9/6/01

1 dimensional Motion (1d kinematics)







Ave. <u>Speed</u> over interval is $\dfrac{X_{i+1} - X_i}{\cancel{X_{i+1} - X_i} \quad t_{i+1} - t_i} = \dfrac{\Delta X}{\Delta t}$ m/s

<u>units</u>

Ave Velocity is $\frac{\Delta x}{\Delta t}$ $\frac{m}{s}$ in $+x$ direction

Speed has magnitude only

Velocity has magnitude + direction

1 d Motion ... direction determined w/ sign

Suppose you want the instantaneous velocity at time t_i

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

$t_{i+1} \to t_i$ ⟶ standard definition of derivative

~~Suppose we look at a drag race~~

what does this look like Motion

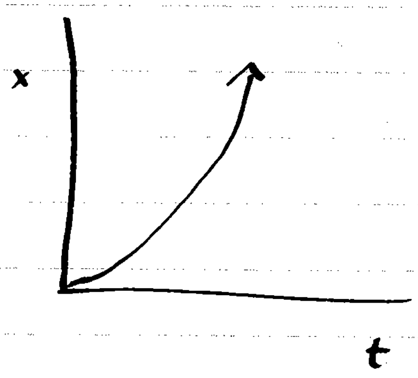


Table A-4 **Properties of Derivatives and Derivatives of Particular Functions**

Linearity

1. The derivative of a constant times a function equals the constant times the derivative of the function:

$$\frac{d}{dt}[Cf(t)] = C\frac{df(t)}{dt}$$

2. The derivative of a sum of functions equals the sum of the derivatives of the functions:

$$\frac{d}{dt}[f(t) + g(t)] = \frac{df(t)}{dt} + \frac{dg(t)}{dt}$$

Chain rule

3. If f is a function of x and x is in turn a function of t, the derivative of f with respect to t equals the product of the derivative of f with respect to x and the derivative of x with respect to t:

$$\frac{d}{dt}f(x) = \frac{df}{dx}\frac{dx}{dt}$$

Derivative of a product

4. The derivative of a product of functions $f(t)g(t)$ equals the first function times the derivative of the second plus the second function times the derivative of the first:

$$\frac{d}{dt}[f(t)g(t)] = f(t)\frac{dg(t)}{dt} + \frac{df(t)}{dt}g(t)$$

Reciprocal derivative

5. The derivative of t with respect to x is the reciprocal of the derivative of x with respect to t, assuming that neither derivative is zero:

$$\frac{dx}{dt} = \left(\frac{dt}{dx}\right)^{-1} \quad \text{if} \quad \frac{dt}{dx} \neq 0$$

Derivatives of particular functions

6. $\frac{dC}{dt} = 0$ where C is a constant

7. $\frac{d(t^n)}{dt} = nt^{n-1}$

8. $\frac{d}{dt}\sin \omega t = \omega \cos \omega t$

9. $\frac{d}{dt}\cos \omega t = -\omega \sin \omega t$

10. $\frac{d}{dt}e^{bt} = be^{bt}$

11. $\frac{d}{dt}\ln bt = \frac{1}{t}$

Table A-5 **Integration Formulas†**

1. $\int A\,dt = At$

2. $\int At\,dt = \frac{1}{2}At^2$

3. $\int At^n\,dt = A\frac{t^{n+1}}{n+1} \qquad n \neq -1$

4. $\int At^{-1}\,dt = A\ln t$

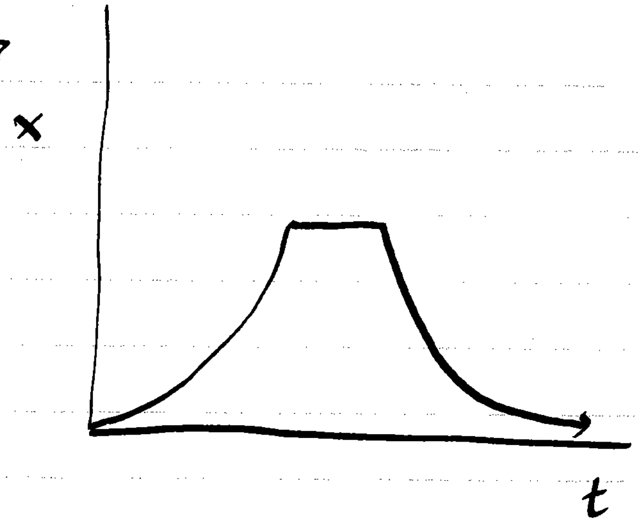
5. $\int e^{bt}\,dt = \frac{1}{b}e^{bt}$

6. $\int \cos \omega t\,dt = \frac{1}{\omega}\sin \omega t$

7. $\int \sin \omega t\,dt = -\frac{1}{\omega}\cos \omega t$

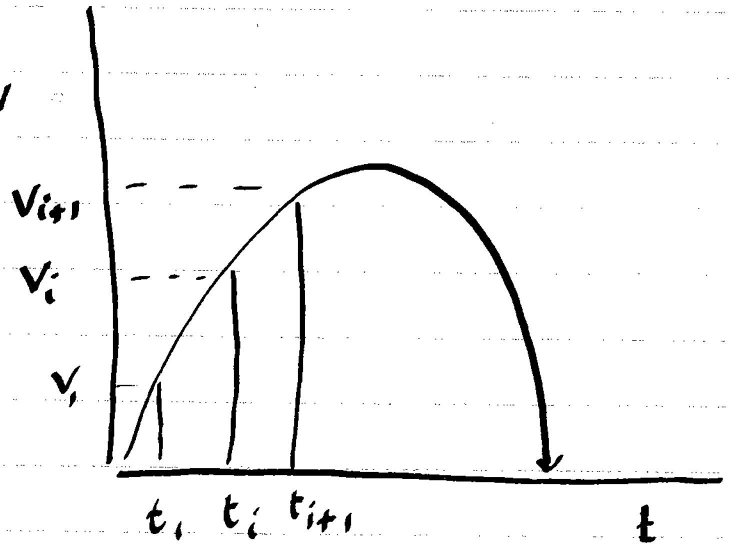
†In these formulas, A, b, and ω are constants. An arbitrary constant C can be added to the right side of each equation.

How about this?



Think of a drag racer

What about v-t



$$\text{Ave. Acceleration} = \frac{V_{i+1} - V_i}{t_{i+1} - t_i} = \frac{\Delta v}{\Delta t} \text{ in } \frac{m/s}{s} = m/s^2$$

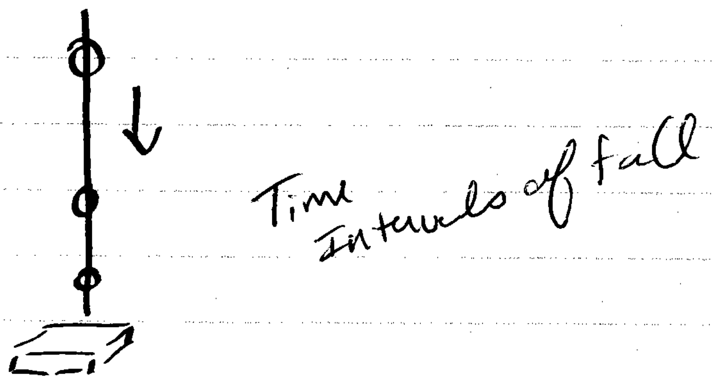
$$\text{inst. Accel.} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

Acceleration has magnitude and direction

$$a = \frac{dv}{dt} = \frac{d\left(\frac{dx}{dt}\right)}{dt} = \frac{d^2x}{dt^2}$$

deceleration vs. acceleration in negative direction

demo Mb-12

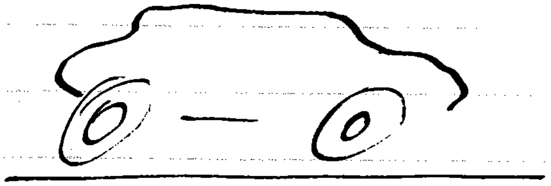


x ~ Position	m	ft	mi
v ~ velocity	m/s	ft/s	mi/hr
a ~ acceleration	m/s^2	ft/s^2	mi/hr^2
t ~ time	s	s	hr

These are the kinematic variables. If you know these ... you know all there is to know about particle motion

Example

Sister w/ learner's permit
and obnoxious brother with radar device



$x(t) = At^2 - Bt^3$

what bothers you abt this eqn?
perhaps A, B are bothersome
CONSTANTS ... written as a ~~variable~~ Symbol

What are units on A + B

if x in m A is in m/s^2 B in m/s^3

Dimensional Analysis!

~~let A = 10~~
lets say $x(t)$ is in feet for now
and

$A = 10\ ft/s^2$

$B = 1\ ft/s^2$

bothered by feet
change to meters

$$1 \text{ foot} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{1 \text{ m}}{100 \text{ cm}} = 0.3 \text{ m}$$

factor label method

$$A \frac{ft}{s^2} = 10 \frac{ft}{s^2} \times \frac{0.3 \text{ m}}{1 \text{ ft}} = 3 \text{ m/s}^2$$

$$B \frac{ft}{s^3} = 1 \frac{ft}{s^3} \times \frac{0.3 \text{ m}}{1 \text{ ft}} = 0.3 \text{ m/s}^3$$

Find average velocity, ~~[illegible]~~ and Accel over 4 s interval (from $t=0$)

Find inst. posn., vel., Accel at $t=0, 1, 2, 3, 4$

Posn.

$$x(t) = 3t^2 - \cancel{0.3}\,t^3$$

t (s)	x (m)
0	0
1	2.7
2	9.6
3	~~9.6~~ 18.9
4	~~18~~ 28.8

Ave. velocity

$\bar{v}$ over 1st 4 seconds

$$= \frac{28.8}{4} = 7.2 \text{ m/s}$$

in +x direction