Announcements

① Come to class & take notes

* text not enough (but DO read it!)
* webpage not enough (but DO check it!)
* Eg. Estimating # of Chicago piano tuners
* cf. Problem 26 in Ch. 1

② 1st HITT Monday, Aug. 30

⇒ BRING YOUR REMOTES

(& every day afterwards)

③ Exam #1 Monday, Sept. 13 (8:20-10:20pm)

* Chapters 1-4
* room assignments soon

1-2 Punch of Physics

① Kinematics ⇒ describing motion

② Dynamics ⇒ why motion happens

Motion of What?

(A) Point Particles ⇒ position

(B) Rigid Bodies ⇒ position & orientation

(C) Continuous Media ⇒ shape parameters

Course Overview

1A Particle Kinematics ⇒ Ch 2, 3, 4

2A Particle Dynamics ⇒ Ch 5, 6, 7, 8, 9, 13, 15

1B Rigid Body Kinematics ⇒ Ch 10.1-7, 11.1-3

2B Rigid Body Dynamics ⇒ Ch 10.8-10, 11.4-12, 12.1-6

1C Media Kinematics ⇒ Ch 16.1-7

2C Media Dynamics ⇒ Ch 16.8-13, 17, 12.7

Position, Displacement, Distance

① Position (at time t) = $x(t)$

* measured relative to "origin" at $x = 0$

* dimension of length
* $x(t)$ can be + or − (so can t!)

② Displacement (from t_1 to t_2): $\Delta x \equiv x_2 - x_1$

* dimension of length
* Δx can be + or −

③ Distance (from t_1 to t_2): $\Delta D \equiv |\Delta x|$

* dimension of length
* $\Delta D \geq 0$

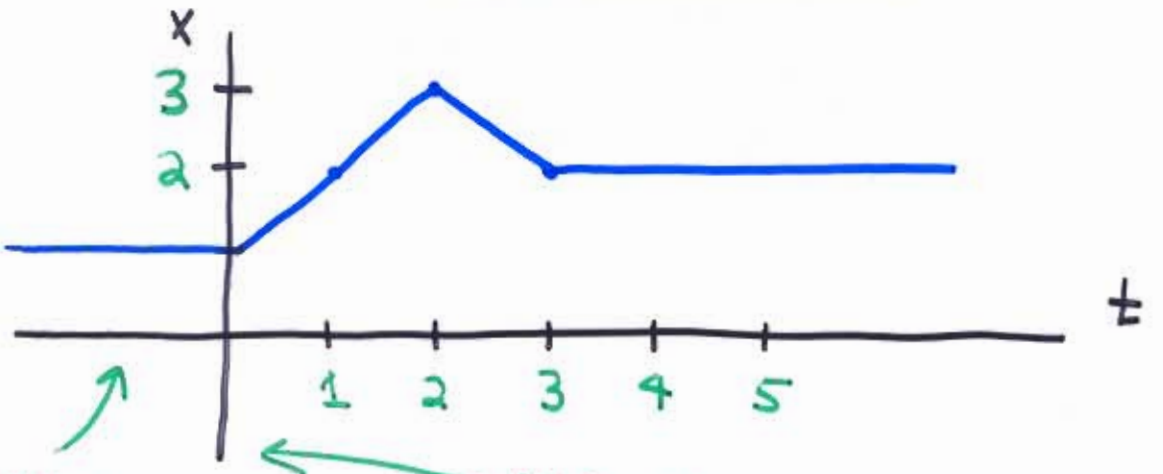
Total Displacement

$$\Delta x_{tot} = \sum \Delta x = x_{final} - x_{initial}$$

Total Distance

$$\Delta D_{tot} = \sum |\Delta x|$$

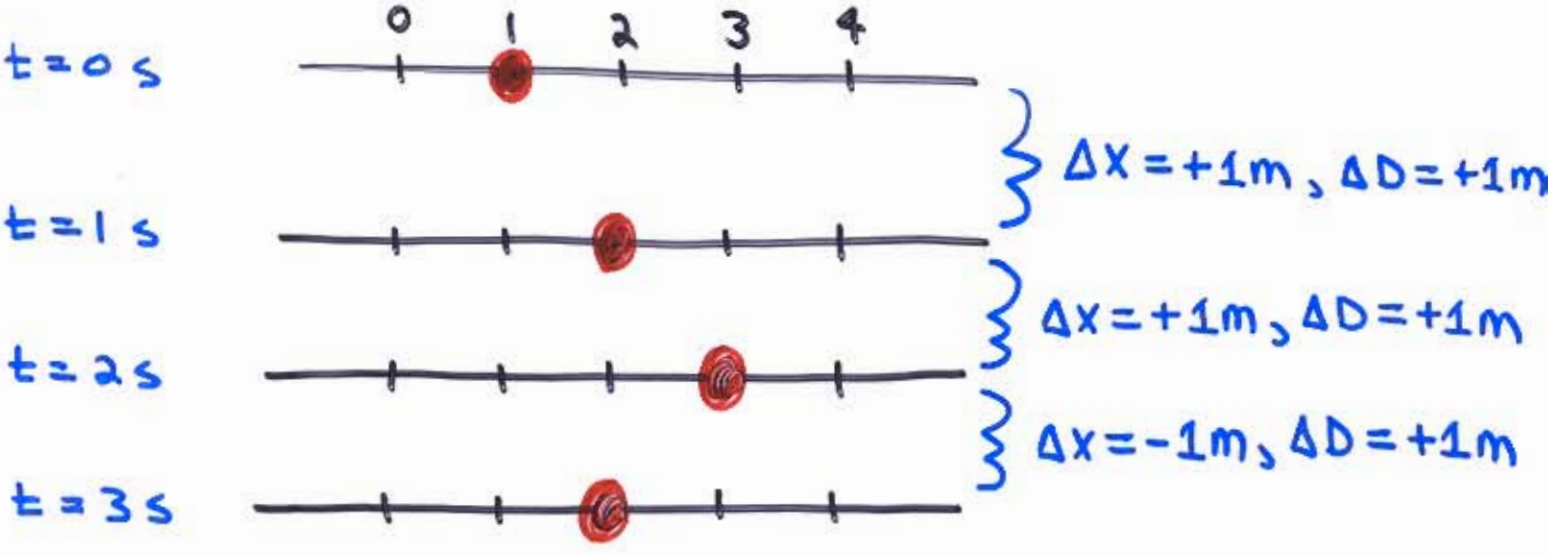
Example



NB $t<0$ is allowed

NB $x<0$ is allowed

SNAPSHOTS



* $\Delta x_{tot} = \sum \Delta x = (1+1-1)\,m = +1\,m$

* $\Delta D_{tot} = \sum |\Delta x| = (1+1+1)\,m = +3\,m$

Velocity & Speed

① Average velocity (from t_1 to t_2)

$$v_{avg} \equiv \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

* dimensions of length/time
* can be + or −

② Average speed (from t_1 to t_2)

$$s_{avg} \equiv \frac{\Delta D}{\Delta t}$$

* dim ~ length/time
* $s_{avg} \geq 0$

③ Instantaneous velocity (at time t)

$$v(t) \equiv \frac{dx}{dt}$$

* dim ~ length/time
* can be + or −
* NB $x(t) = x_0 + \int_0^t dt' v(t')$

④ Instantaneous speed (at time t)

$$s(t) \equiv |v(t)|$$

* dim ~ length/time
* $s \geq 0$
* NB your speedometer reads this

Acceleration

① Average acceleration (from t_1 to t_2)

$$a_{avg} \equiv \frac{\Delta V}{\Delta t} = \frac{V_2 - V_1}{t_2 - t_1}$$

* dim ~ length/time^2

* can be + or −

② Instantaneous acceleration (at time t)

$$a(t) \equiv \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

* dim ~ length/time^2

* can be + or −

Calculus

① $$V(t) = V_0 + \int_0^t dt' \, a(t')$$

② $$X(t) = X_0 + V_0 t + \int_0^t dt' \int_0^{t'} dt'' \, a(t'')$$

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Const. Acc. $a(t) = a_0$

(1) $v(t) = v_0 + a_0 t$ (2-11)

(2) $x(t) = x_0 + v_0 t + \frac{1}{2} a_0 t^2$ (2-15)

Algebra

(A) Eliminate $t = \frac{v - v_0}{a_0}$

$$\Rightarrow v^2 = v_0^2 + 2a(x - x_0) \quad (2\text{-}16)$$

(B) Eliminate $a_0 = \frac{v - v_0}{t}$

$$\Rightarrow x - x_0 = \frac{1}{2}(v + v_0)\, t \quad (2\text{-}17)$$

(C) Eliminate $v_0 = v - a_0 t$

$$\Rightarrow x - x_0 = vt - \frac{1}{2} a_0 t^2 \quad (2\text{-}18)$$

DO NOT MEMORIZE THESE FORMULAE !