College Physics I: 1511
Mechanics & Thermodynamics

Professor Jasper Halekas
Van Allen Lecture Room 1
MWF 8:30-9:20 Lecture

Announcements

- First homework available on Wiley Plus
- Due 11:00 pm next Thursday 9/1/16

Clicker Practice

- First, open the web page (https://rwpoll.com or https://account.turningtechnologies.com) or the app
  - Enter the session ID on the board
- Wait until I open polling (green arrow changes to red square on my screen)
- Enter A, B, C, D, or E
  - Can change answer as long as polling still open
- After I close polling, we will see a histogram of the results

Background Questions

- Where are you from?

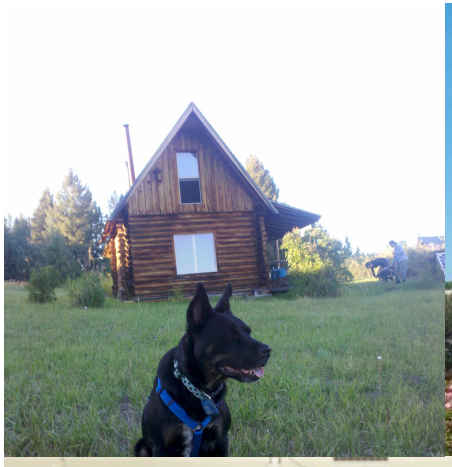
A. Iowa
B. Other state in U.S.
C. Outside of U.S.
D. Another galaxy

Background Questions

- Have you studied physics before?

A. Never
B. Homeschool/self-study
C. In high school
D. In college

About Me



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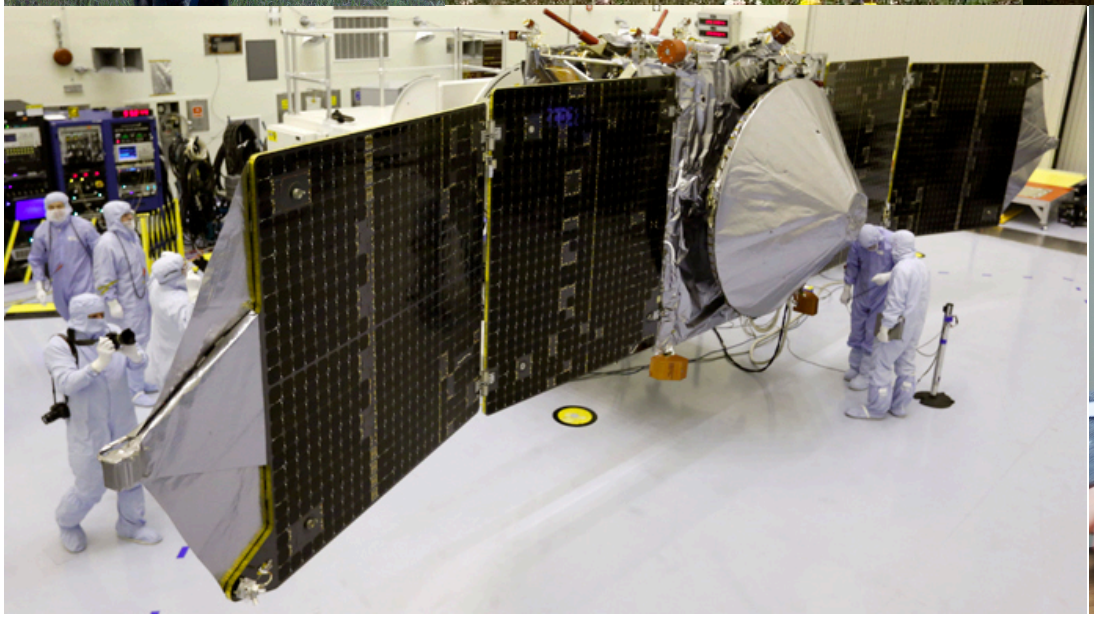
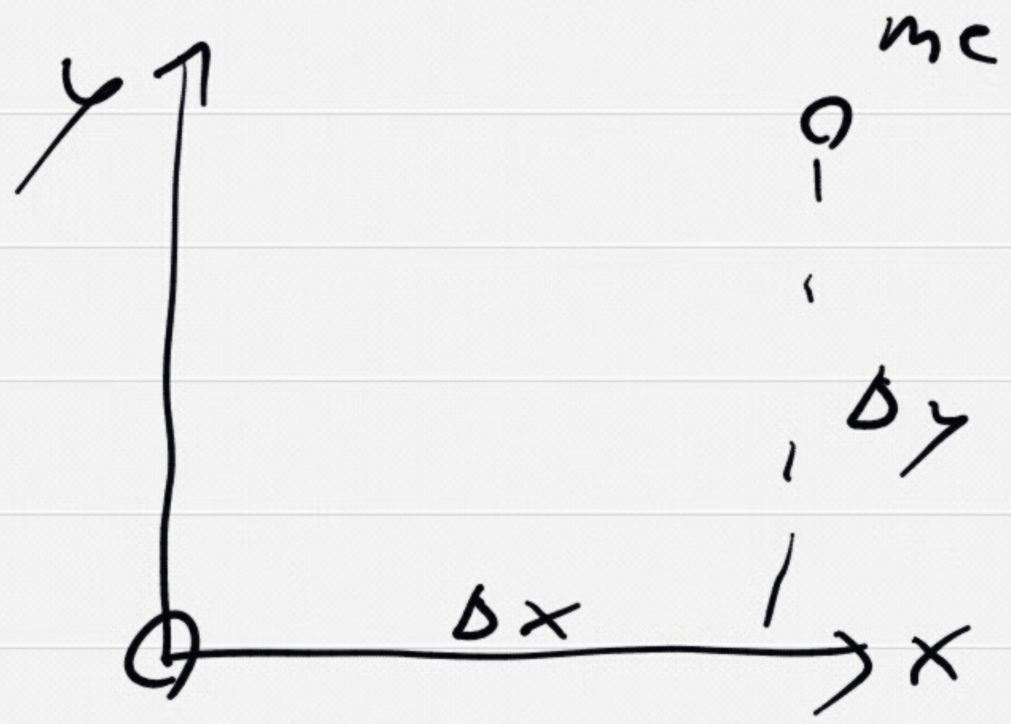


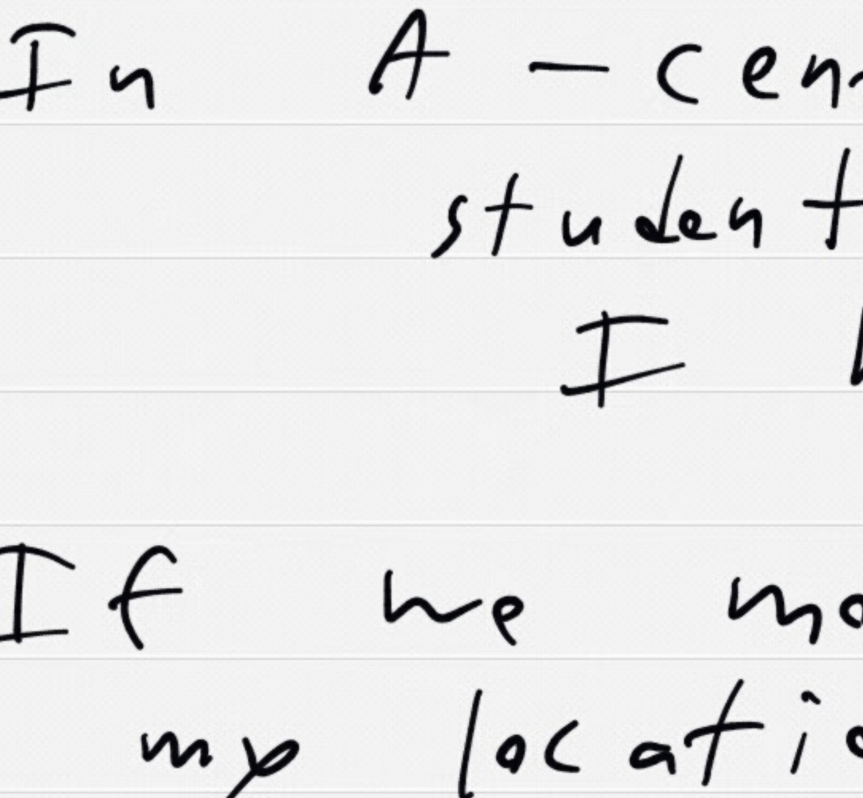
Position vs. Displacement

Technically position is defined w/ respect to a specific set of coordinates.



In A-centered coordinates
student A has $x=0, y=0$
I have $x=\Delta x, y=\Delta y$

If we move coordinates to my location:



student A @ $x' = -\Delta x$
$y' = -\Delta y$

me @ $x' = 0$
$y' = 0$

$\vec{A}$ = "displacement" of me from student A

— same in all coordinate systems!

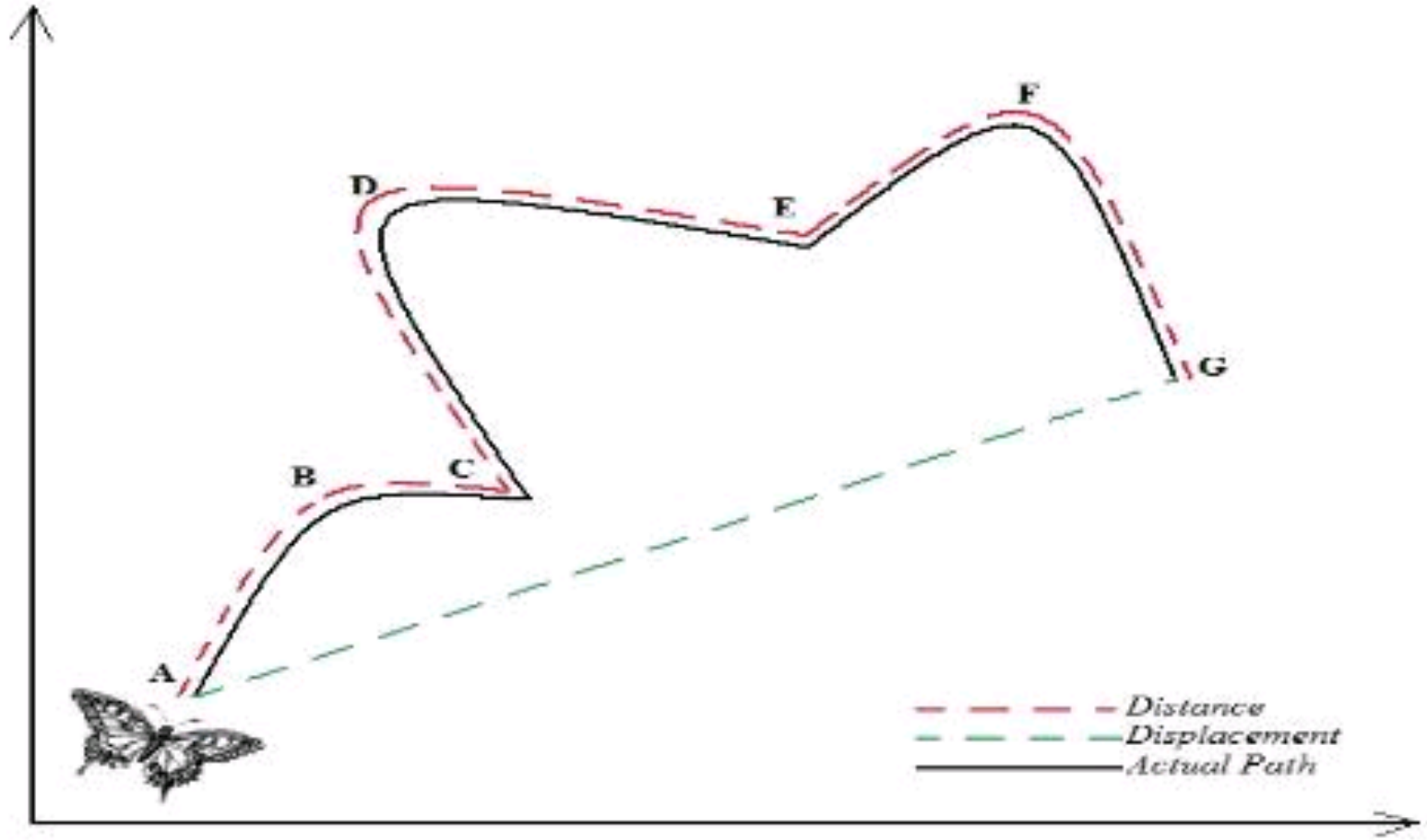
— Displacement = relative position or change in position

— Always a vector

Definition: Position/Displacement

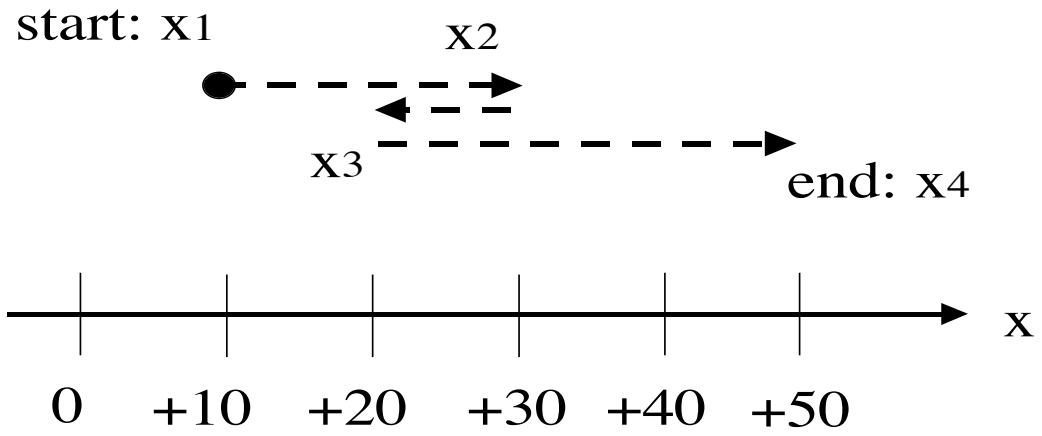
- The position of an object is the distance from the origin of a given set of coordinates (coordinate-dependent)
  - SI unit m
- The displacement is a vector that points from an object's initial position to its final position (coordinate-independent)
- Both of these are different from distance traveled!

Displacement Vs. Distance



Concept Check

2-0



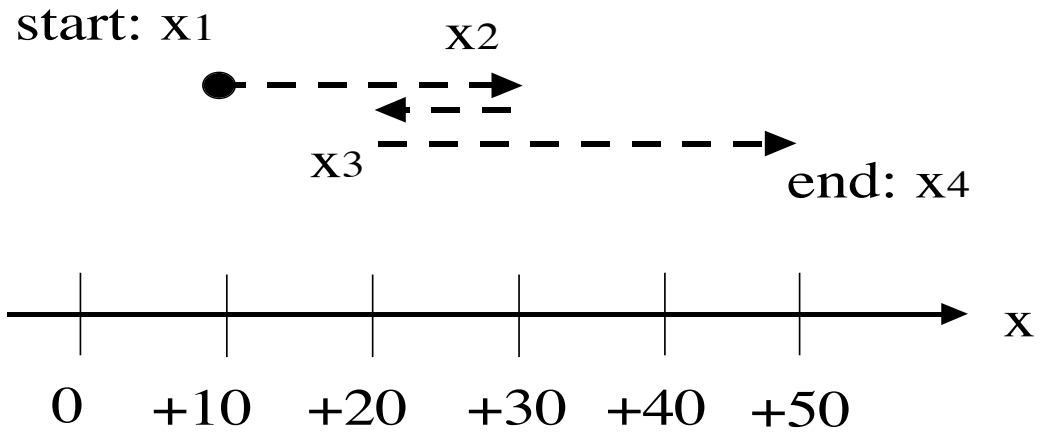
Steve is pacing back and forth in lecture. He starts at x =+10 (measured in cm from the edge of the bench), moves right to x=+30, moves back left to +20, then finally moves right to +50, as shown.

What is the *distance* travelled, and the *displacement?*

A: +40, and +40 (cm)
B: +60, and +40 (cm)
C: +40, and +60 (cm)
D: +60, and +60 (cm)
E: Something else, none of the above.

Concept Check

2-0



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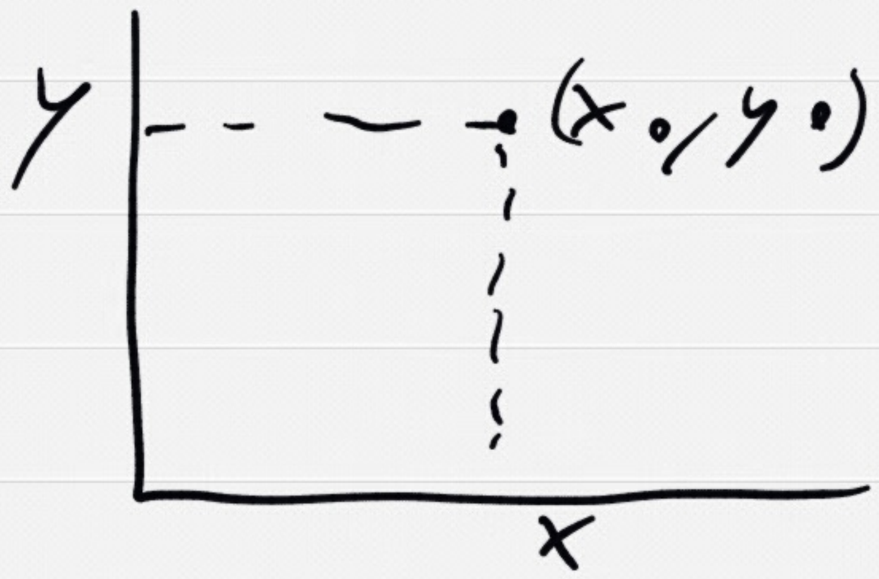
Position



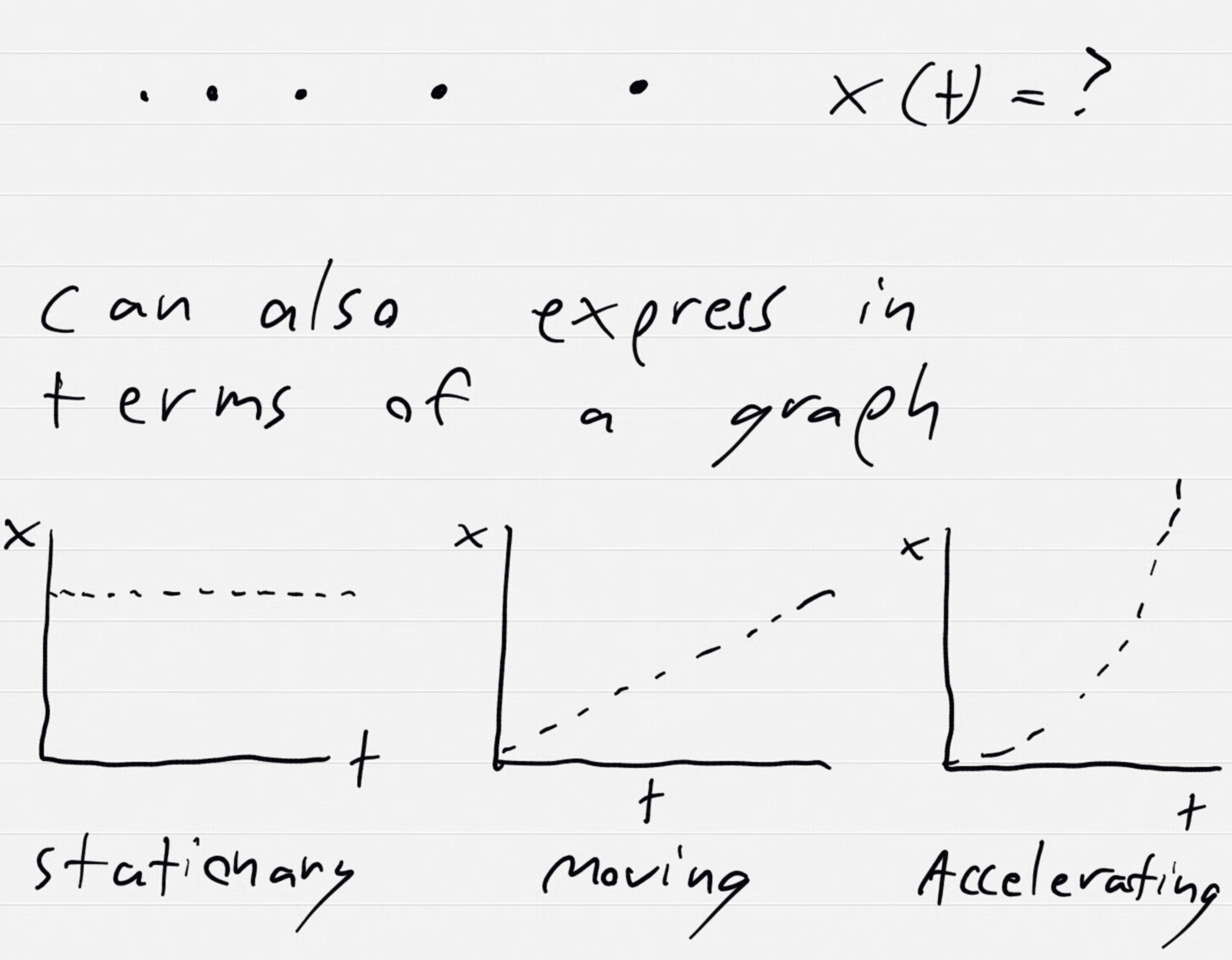
start w/ 1-d:

- $x(t) = x_0$

. . . . . $x(t) = ?$

. . . . $x(t) = ?$

can also express in terms of a graph



Average Velocity $= \Delta x / \Delta t$ in 1-d

$$\langle v \rangle = \frac{x - x_0}{t - t_0}$$

$$= \frac{\text{displacement}}{\text{time}}$$

- usually put $t_0 = 0$

then $\langle v \rangle = (x - x_0)/t$

Can rewrite $\langle v \rangle t = x - x_0$

or $x(t) = x_0 + \langle v \rangle t$

x_0: constant

$\langle v \rangle t$: increasing with time

Say we start at $x = 4$ m
and move at $v = -2$ m/s
where are we at $t = 3$ s?

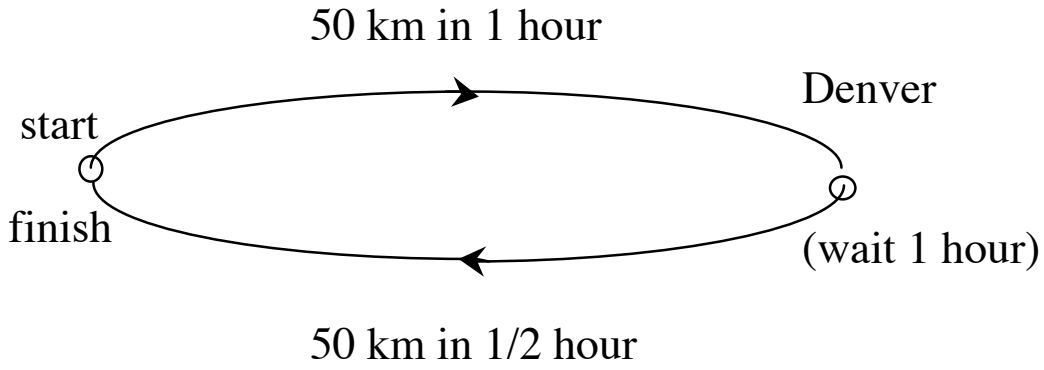
$$x(3) = 4 - 2 \cdot 3$$
$$= 4 - 6$$
$$= -2 \text{ m}$$

Definition: Velocity

- Velocity = displacement/elapsed time
  - SI unit m/s
  - In 1-d average velocity $\langle v \rangle = (x-x_0)/(t-t_0)$
- Velocity is not the same as speed
  - Speed = distance/time
  - Notice that velocity has a sign (a direction)!

Concept Check

2-4 A person starts in Iowa City, drives to Cedar Rapids (50 km away) in 1 hour, stays in Cedar Rapids 1 hour, then speeds back to Iowa City in 30 minutes.



What is the *average speed* of the round trip?

A: 25 km/hr
B: 67 km/hr
C: 40 km/hr
D: 75 km/hr
E: none of these

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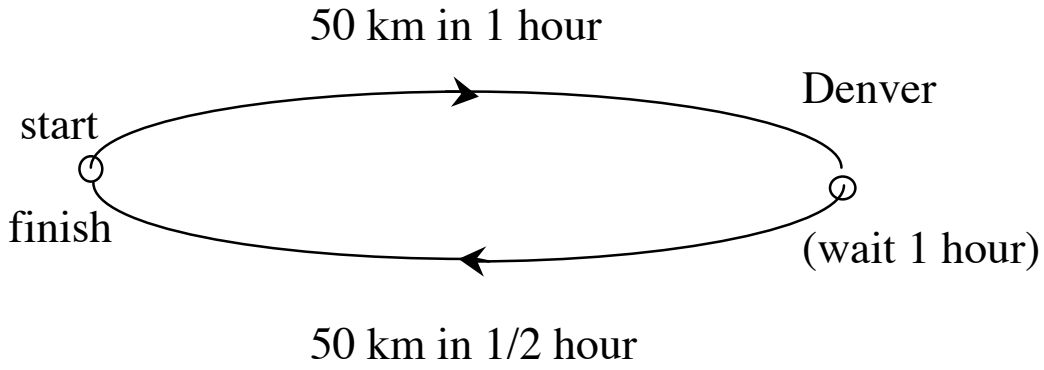

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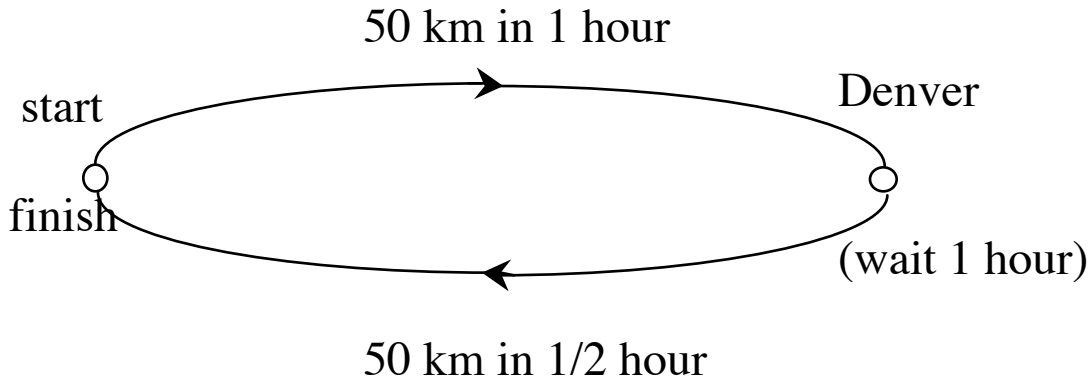

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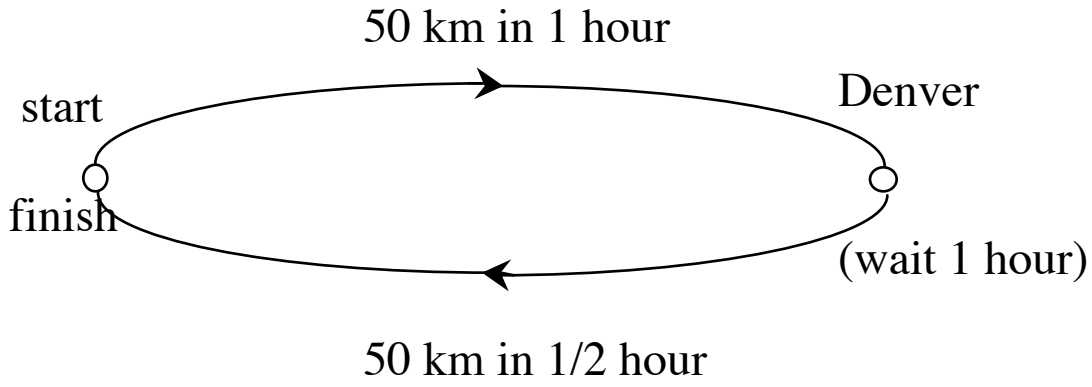

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If moving w/ constant velocity / we travel same distance in every time interval:

. . . . . .

$x(t+\Delta t) = x(t) + v((t+\Delta t) - t)$

or $x(t+\Delta t) = x(t) + v \cdot \Delta t$

what about this case?

. . . . .

- Traveling different amounts each interval
- Velocity not constant
- We are accelerating!

$a = (v - v_0)/(t - t_0)$

We will only treat constant acceleration

so $a = \langle a \rangle$

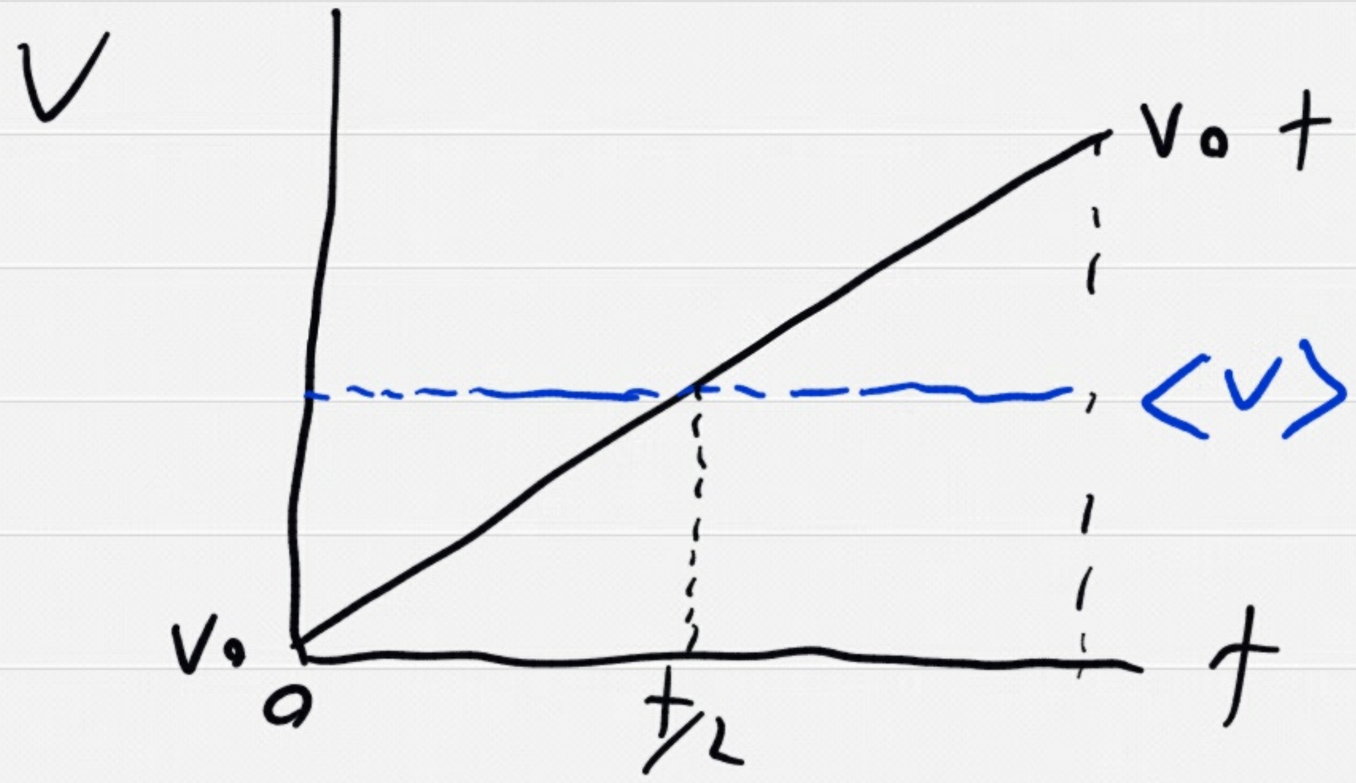
Definition: Acceleration

- Acceleration is rate of change of velocity or the "velocity of the velocity"
  - SI unit m/s^2
- Average acceleration $\langle a \rangle = (v-v_o)/(t-t_o)$

$$a = (V - V_0)/t \qquad \text{for } t_0 = 0$$

$$\Rightarrow at = V - V_0$$

$$\Rightarrow V(t) = V_0 + at$$



what is average velocity?

$$\langle V \rangle = \frac{V_0 + (V_0 + at)}{2}$$

$$= (2V_0 + at)/2$$

$$= V_0 + \tfrac{1}{2}at$$

$$= V(t/2)$$

= velocity at mid point

$$x(t) = x_0 + \langle v \rangle t$$

$$x(t) = x_0 + (V_0 + \tfrac{1}{2}at) \cdot t$$

$$= \boxed{x_0 + V_0 t + \tfrac{1}{2}at^2}$$