Today's topics

- Graphing.
  - Basic terms and concepts
  - Displacement
  - Velocity
  - Acceleration
  - Instantaneous versus average $v$ and $a$. 

Do yourself a favor!

- Prof Sarah's fail-safe learning plan
  - Try the homework yourself.
  - Get together and solve the problems or similar ones suggested in lecture.
  - Try the homework again.
    (you'll learn better, and anyways, work must be your own!)

- Use Facebook to start/find a study group!
  [Link to Facebook group](https://www.facebook.com/groups/36633047095349/)

Clickers will be used in class almost every day after this!

- If one day you forget your clicker, please write clicker answers on a piece of paper.
- If you have a borderline grade I will look at these (otherwise I will not)!
Common Graphing Lingo

y-axis: Vertical axis
Dependent variable
The thing you measure.
"The value of this variable depends on the other variable."

x-axis: Horizontal axis
Independent variable
"We can change this variable to see how it effects the other."

Horizontal axis = Time (s)

"How position changes as a function of time"

\[ y = y_0 + at \]

"How position changes as a function of time"

\[ y = B \]

"How position changes as a function of time"

\[ y = B - v_0 \cdot t \]
"How position changes as a function of time"

![Graph showing position as a function of time with labeled axes and markers indicating constant and no velocity.]

1. constant $+v$
2. no $v$
3. constant $-v$

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**Calculating Average Velocity**

(On an $x$ vs $t$ plot)

![Graph showing a line with a slope labeled as the average velocity.]

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$  
Slope of a line drawn between two points on $x$ vs $t$ curve: average velocity

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**Calculating Average Velocity**

(On an $x$ vs $t$ plot)

![Graph showing a line with a slope labeled as the average velocity.]

$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{4m - 1m}{4s - 1s} = \frac{3m}{3s} = 1 \text{ m/s}$

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**Calculating Average Velocity**

(On an $x$ vs $t$ plot)

What's the car doing?

A. Approaches wall slowly, then reverses rapidly.
B. Goes slowly away from wall, then returns fast.
C. Speeds away from wall, then returns slowly.
D. Speeds toward the wall, then backs away slowly.
E. Runs straight into wall then backs up.
Calculating Average Velocity
(on an x vs t plot)

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Instantaneous vs. Average Velocity

Average velocity: velocity averaged over a time interval.

“Average velocity between 3 and 10 seconds”
= slope of line between these points on the curve

Instantaneous velocity: velocity at one “instant”

A train car moves along a long straight track. The graph shows the position as a function of time for this train. The graph shows that the train:

A. speeds up all the time.
B. slows down all the time.
C. speeds up part of the time and slows down part of the time.
D. moves at a constant velocity.
Calculating Average Acceleration
(on a \( v \) vs \( t \) plot)

\[
\frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}
\]

Slope of line between two points on the \( v \) vs \( t \) curve:

average acceleration

Calculating Average Acceleration
(on \( v \) vs \( t \) plot)

Slope of line tangential to one point on the curve:

instantaneous acceleration

Velocity vs. Time

\( / \) = velocity more and more positive [constant +\( a \)]

\( - \) = constant velocity [no \( a \)]

\( \backslash \) = velocity more and more negative [constant -\( a \)]

Acceleration vs. Time

In this class, acceleration will always be horizontal line segments (constant accel over set periods)
You can’t infer the sign of v or x just by knowing the sign of acceleration (it might act with or against the movement)! But you CAN know sign of acceleration from velocity and position information.

Finally... Motion Vector Diagrams!

Draw two horizontal lines on your paper...

walking
running
PRACTICE building your intuition! All of these sets are valid. Why?

An object is speeding up uniformly in the positive direction. Which of the following represents this motion?

A. $a^x$ B. $a^y$
C. $a^x$ D. $a^y$

An object is speeding up uniformly in the negative direction. Which of the following represents this motion?

A. $a^x$ B. $a^y$
C. $a^x$ D. $a^y$

This object moves along the x-direction with constant acceleration. Starting with 1, the dots 1, 2, 3, ... show the position of the object at equal time intervals $\Delta t$.

Which of the following v-t graphs best matches the motion shown in the motion diagram?

A. B. C. D. E.
<table>
<thead>
<tr>
<th>Type of graph</th>
<th>Slope gives</th>
<th>Change of physical direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position vs Time</td>
<td>Velocity</td>
<td>At maximum or minimum</td>
</tr>
<tr>
<td>Velocity vs Time</td>
<td>Acceleration</td>
<td>When curve crosses axis</td>
</tr>
<tr>
<td>Acceleration vs Time</td>
<td>---</td>
<td>Can’t determine</td>
</tr>
</tbody>
</table>

Integration (calculus) lets you find the area under a curve, but we won’t be doing that.