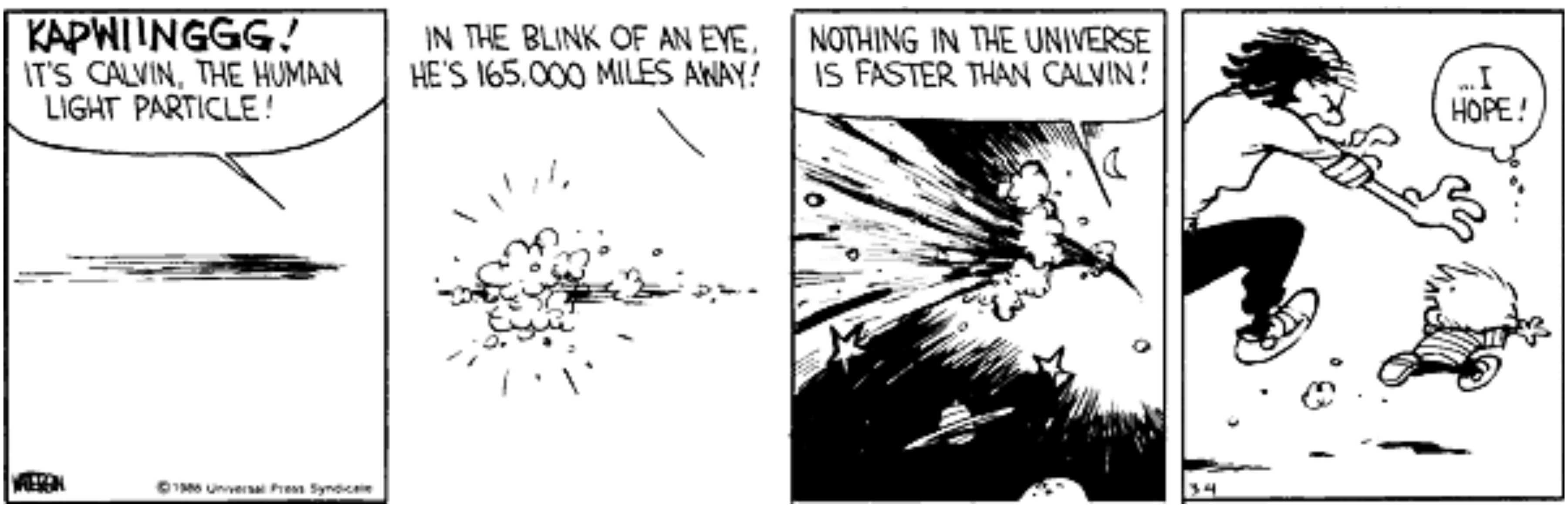
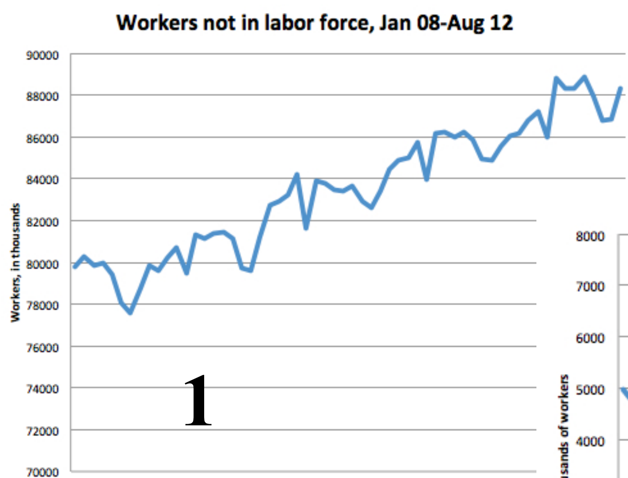
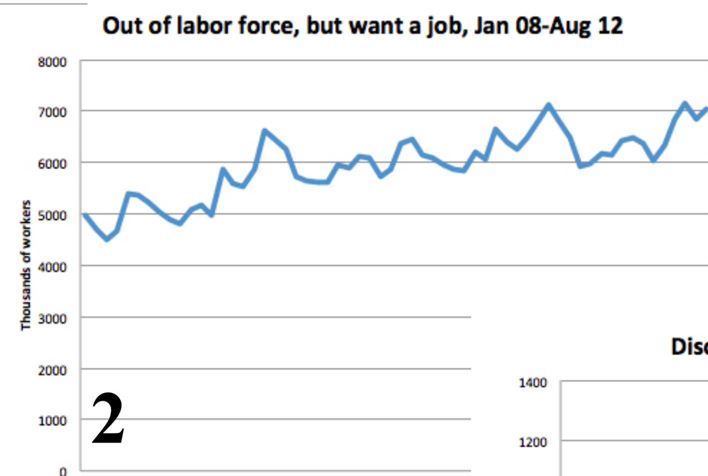
- **Theme Music:** **Elton John**
  Rocket Man
- **Cartoon:** **Bill Waterson**
  Calvin & Hobbes



From Ezra Klein's "Wonkblog"





Which graph shows
the biggest percentage
change from 1/08 to 8/12?

Foothold ideas: Velocity

- Average velocity is defined by

$$\langle \vec{v} \rangle = \frac{\Delta \vec{r}}{\Delta t} = \frac{\text{vector displacement}}{\text{time it took to do it}}$$

Note: an average velocity goes with a <u>time interval</u>.

- Instantaneous velocity is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{v} = \frac{d\vec{r}}{dt}$$

Note: an instantaneous velocity goes with a <u>specific time</u>.

Multiple Representations

- We choose different ways of representing things depending on what we want to do.

- Adding multiple sensory modes adds to our sense of an object’s reality.

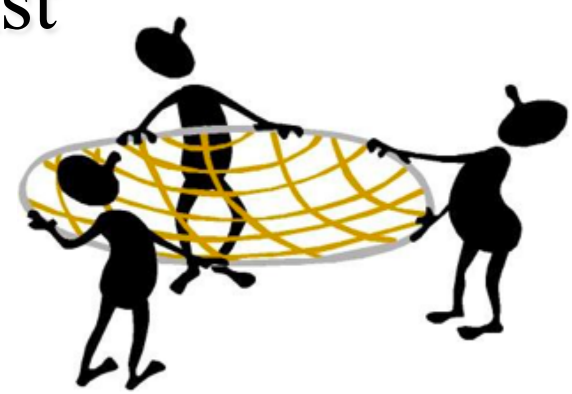
Knowing-how-to-know icon: Multiple Representations

- We have many different ways that we represent information:
  - Words
  - Equations
  - Diagrams
  - Pictures

- Each gives its own way of building up something “real” in our minds.

Knowing-how-to-know icon: Coherence – Your safety net

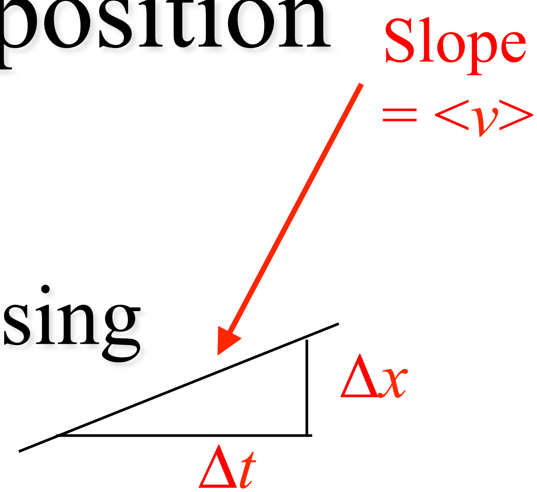
- Throughout the class we will be looking to see physical situations in a variety of different ways.
- The consistency among the different views protects us against errors of reconstructed memory.

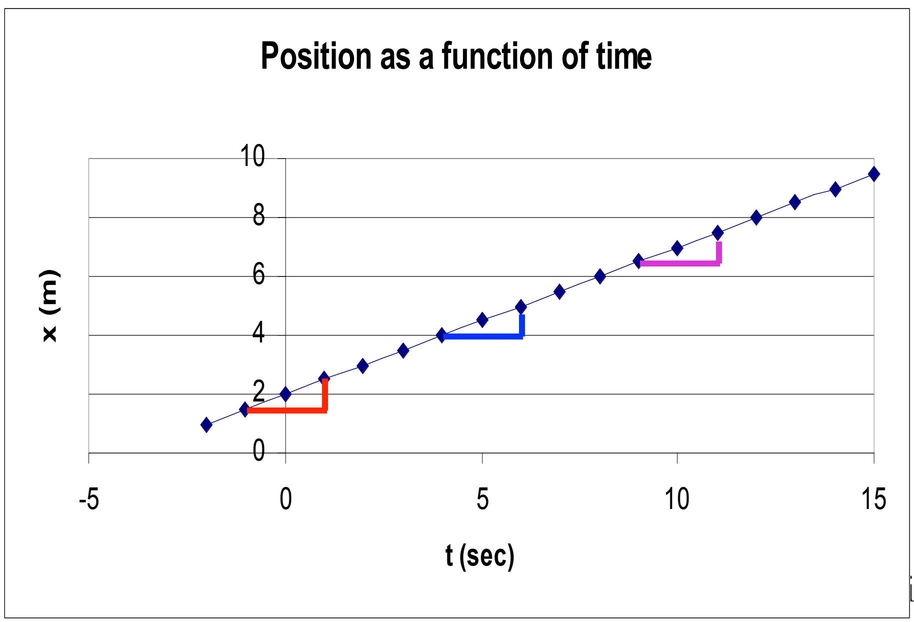


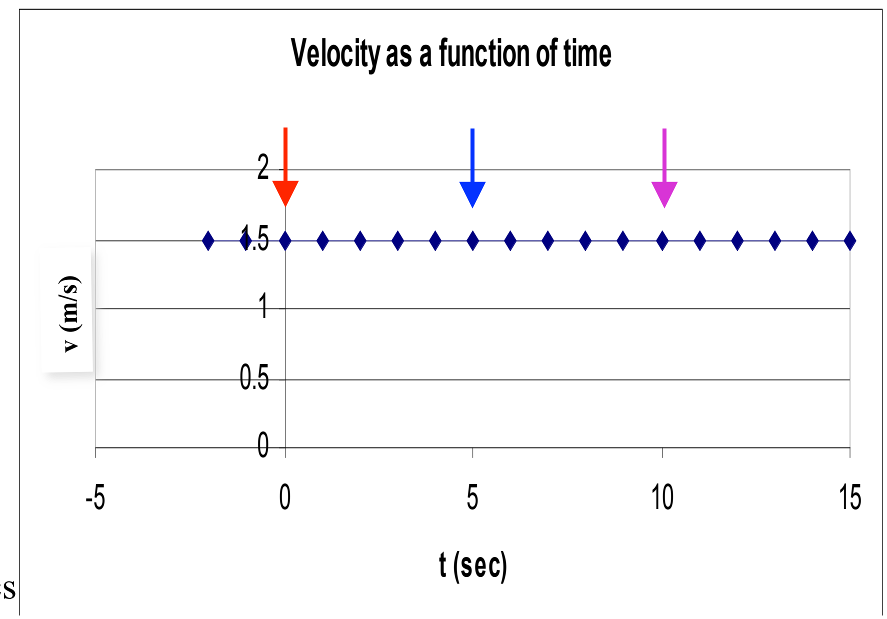
Graphing velocity:
Figuring it out from the position

- You can figure out the velocity graph from the position graph using

$$\langle v \rangle = \frac{\Delta x}{\Delta t} \qquad \Delta x = \langle v \rangle \Delta t$$



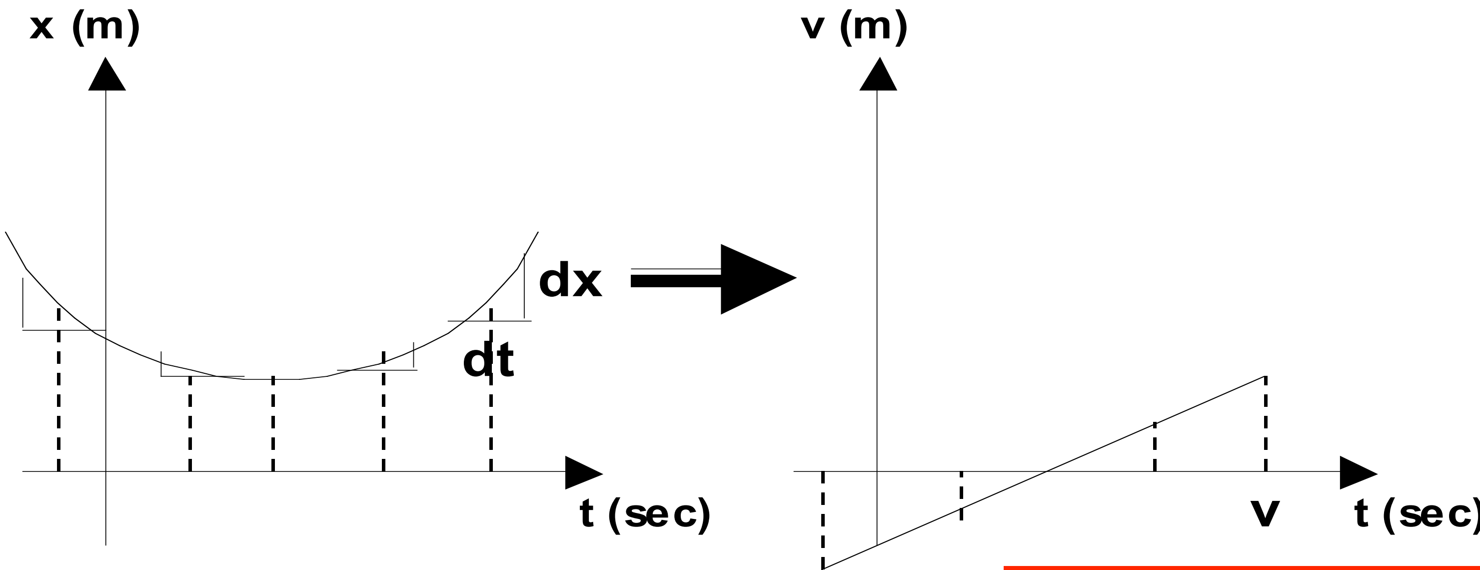




Graphing Velocity: Figuring it out from the motion

- An object in uniform motion has constant velocity.
- This means the instantaneous velocity does not change with time. Its graph is a horizontal line.
- You can make sense of this by putting your mind in "velocity mode" and running a mental movie.

Position to velocity



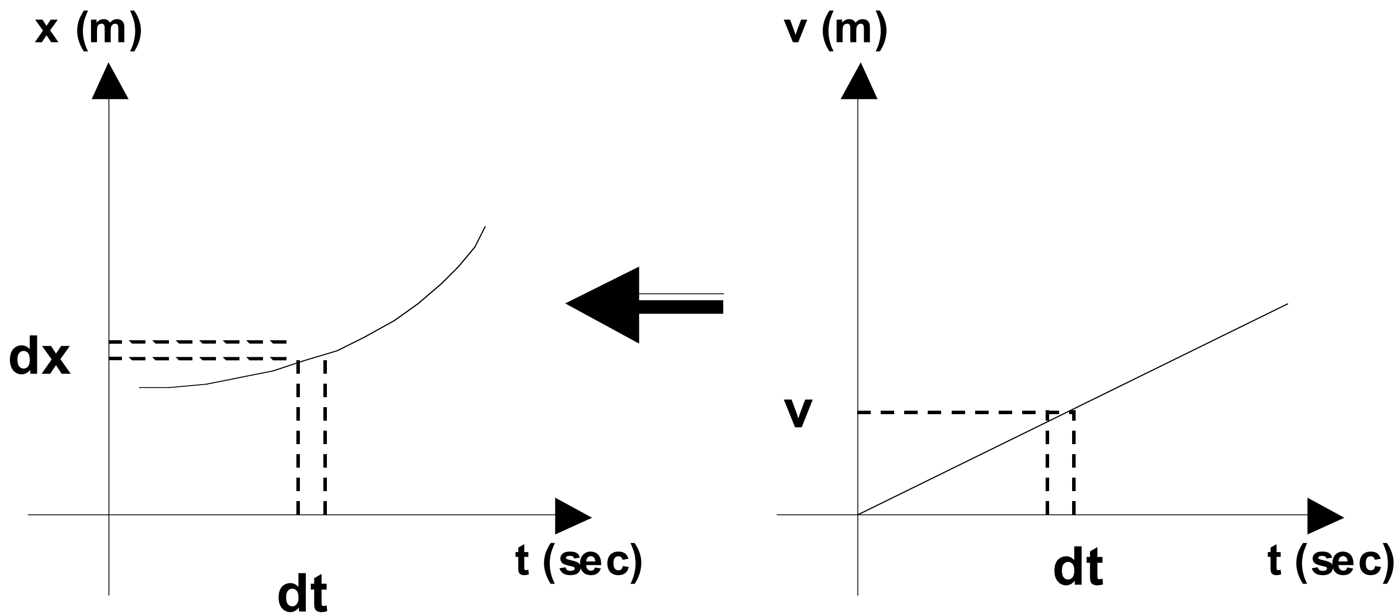
$$v(t) = \frac{dx}{dt}$$

Ratio of change in position that takes place to the (small) time interval

Difference of two positions at two (close) times

$$v(t) = \frac{x(t + \Delta t/2) - x(t - \Delta t/2)}{\Delta t}$$

Velocity to position



$$dx = v(t)\, dt$$

change in position that takes place in a small time interval

$$x = \sum dx = \int v(t)\, dt$$

sum ("Σ") in the changes in position over many small time intervals

What have we learned? Representations and consistency

- Visualizing where an object is at different times → a position graph
- Visualizing how fast an object is moving at different times → a velocity graph
- Position graph → velocity graph

  slopes $v = \dfrac{\Delta x}{\Delta t}$

- Velocity graph → position graph

  areas $\Delta x = v\,\Delta t$