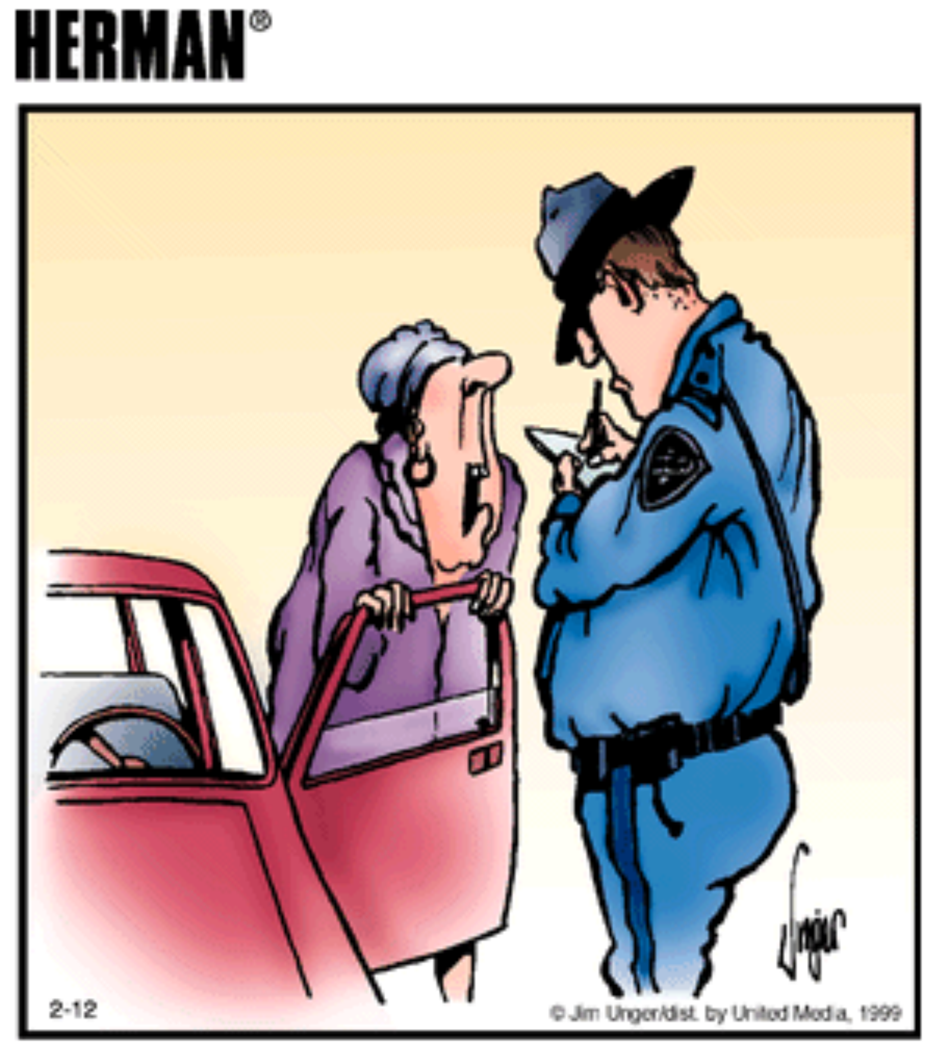
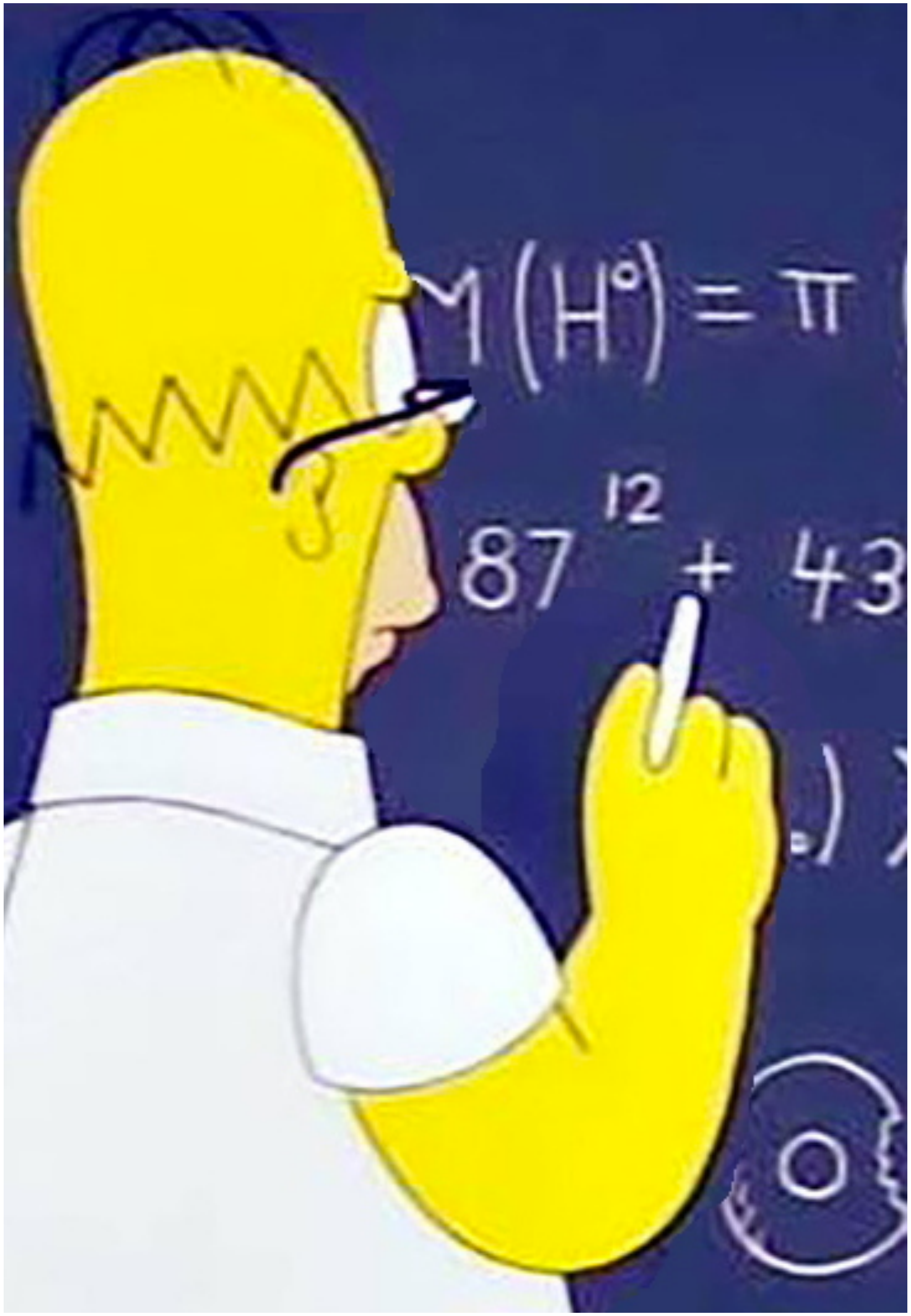
- **<u>Theme Music:</u>**
  Elton John
  Rocket Man

- **<u>Cartoon:</u>**
  Jim Unger
  Herman



"How could I have been doing 70 miles an hour when I've only been driving for ten minutes?"



The Equation of the Day

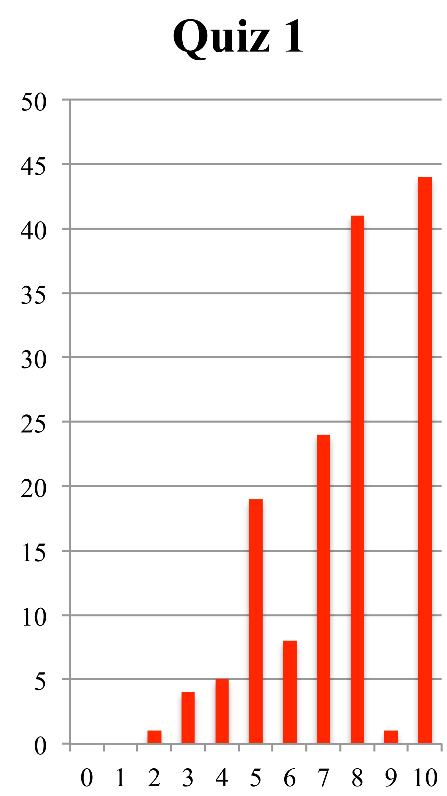
Average and instantaneous velocity

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

$$v = \frac{dx}{dt}$$

Quiz 1

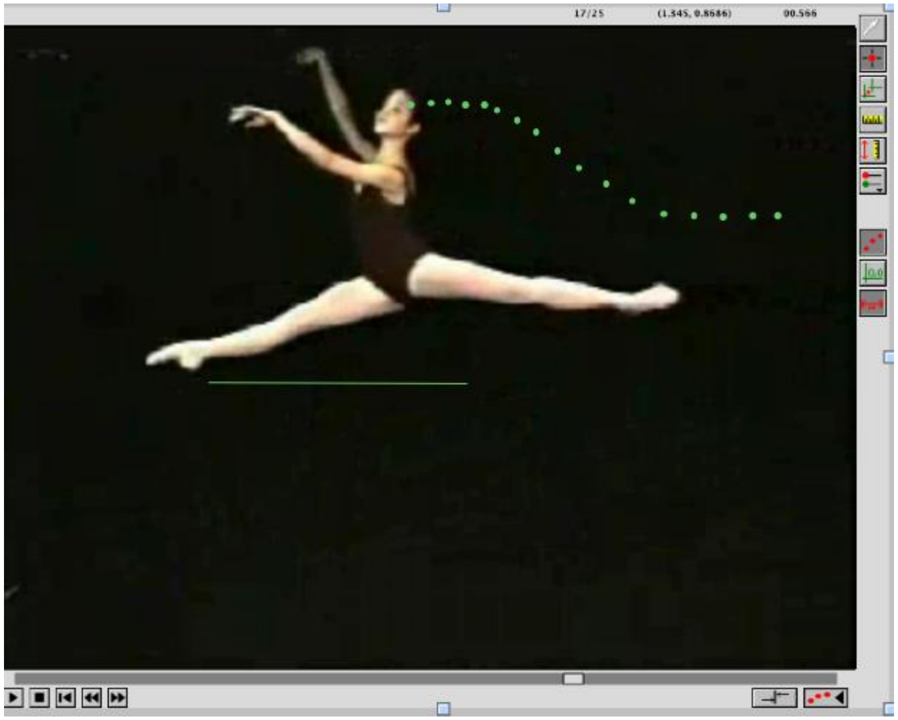
	#1		#2		#2n		#3		#4
x	**73%**	**a**	29%	**1**	**37%**	**a**	1%	a	3%
o	22%	**b**	7%	**-1**	12%	**b**	6%	**b**	**90%**
none	5%	**c**	**61%**			**c**	**47%**	c	5%
						d	**30%**	d	1%
						e	9%	e	0%
						f	1%		



Graphing Position

- Graphs for the eye vs. graphs for the mind.
- Describe where something is in terms of its coordinate at a given time.

  - Choose origin
  - Choose axes
  - Choose scale
  - Set scales on graph
  - Take data from video
  - Construct different graphs
  - Fit the graphs with math functions



The sonic ranger (motion detector)

- The sonic ranger measures distance to the nearest object by echolocation.
  – A speaker clicks 30 times a second.
  A microphone detects the sound bouncing back from the nearest object in front of it.
  – The computer calculates the time delay between and using the speed of sound (about 343 m/s at room temperature) it can calculate the distance to the object.

Foothold ideas: 1D Velocity

- Velocity is the rate of change of position
- Average velocity

  = (how far did you go?)/(how long did it take you?)

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

- Instantaneous velocity = same (but for short Δt)

$$v = \frac{dx}{dt}$$

Can this velocity be negative as well as positive?

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>.

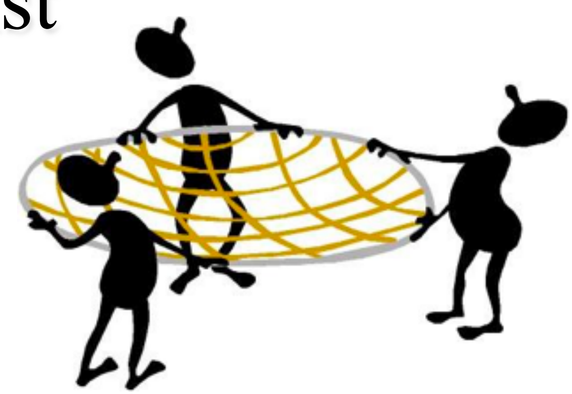
Knowing-how-to-know icon: Multiple Representations

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

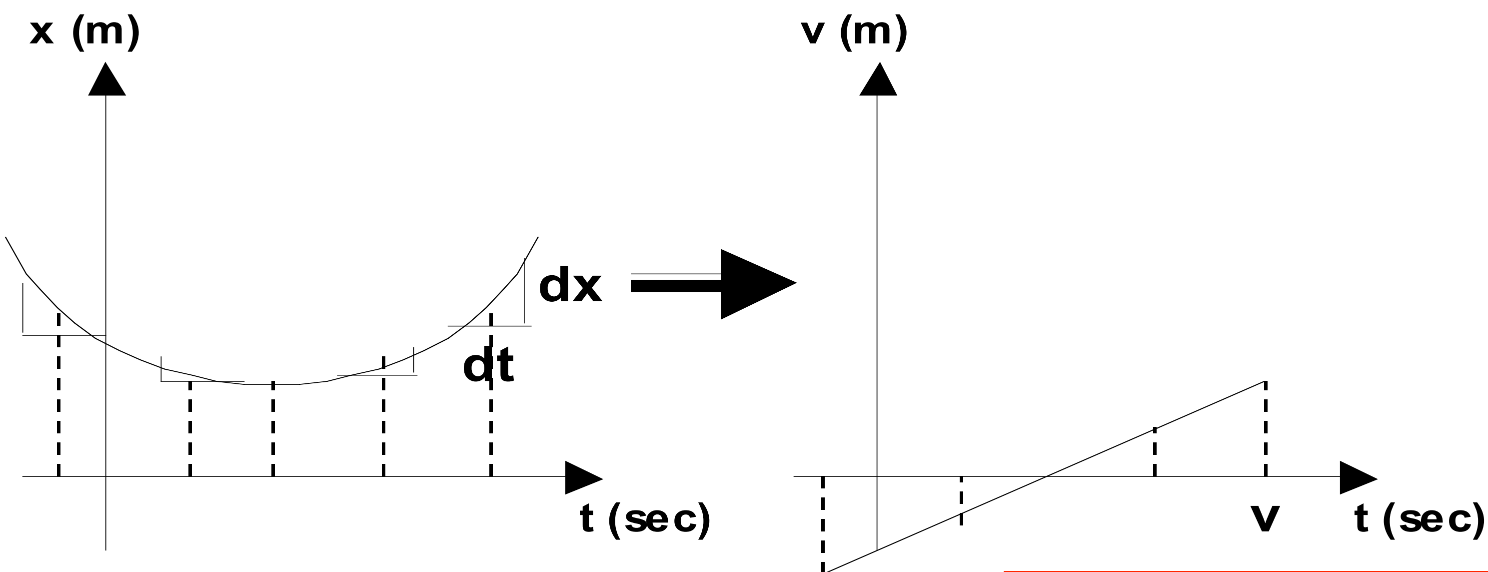
- Each gives its own way of building up something "real" in our minds.

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.



Position to velocity



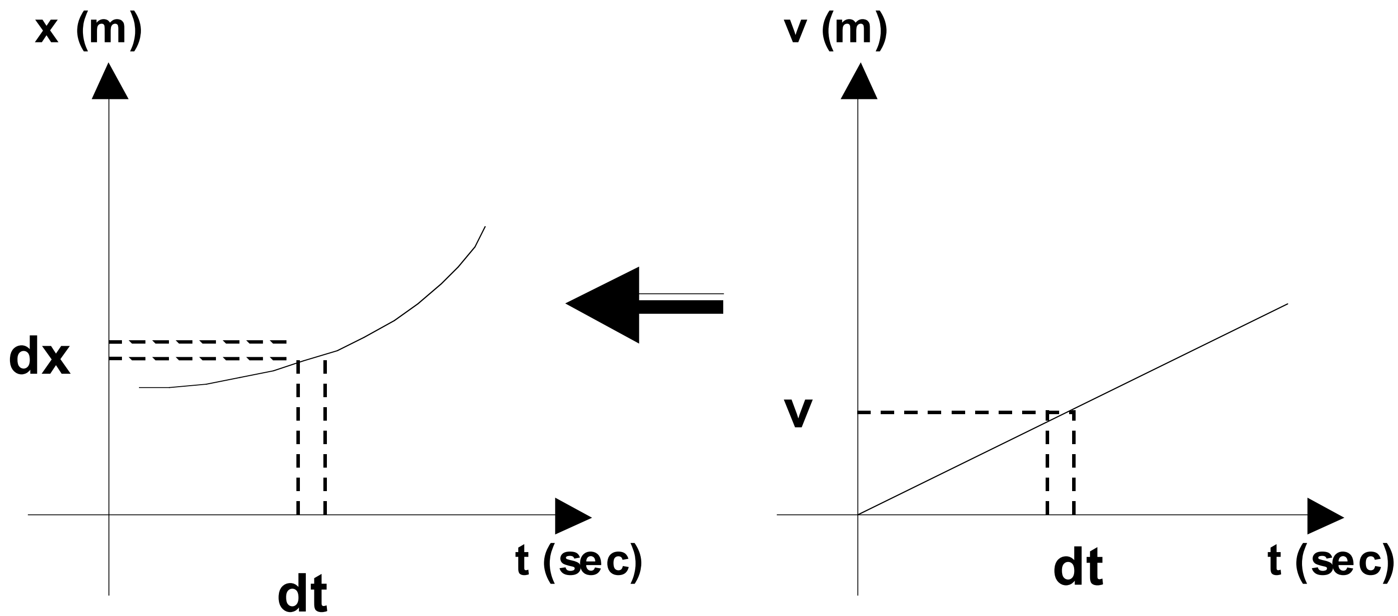
$$v(t) = \frac{dx}{dt}$$

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 $\langle v \rangle = \dfrac{\Delta x}{\Delta t}$ $v = \dfrac{dx}{dt}$

- Velocity graph → position graph

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

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.