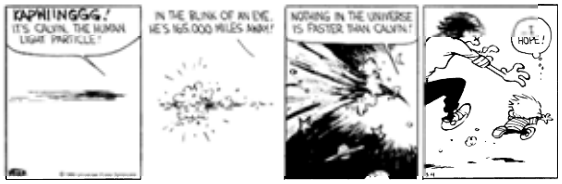
September 13, 2010 Physics 121 Prof. E. F. Redish

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






## Outline

- Quiz 1 (10 minutes)
- Recap Velocity
  - average and instaneous
  - words, equations, and graphs
  - Examples
- ILD 1
- Multiple Representations



## Graphing velocity: Figuring it out from the position

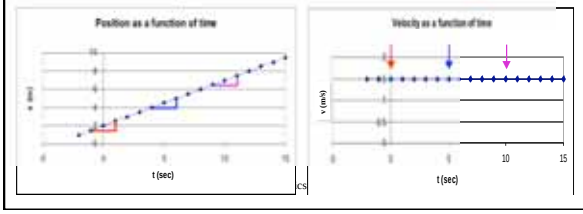
- You can figure out the velocity graph from the position graph using

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

Slope = <v>

$\Delta x$

$\Delta t$



## 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.

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## ILD 1

## The Case of Motion Graphs

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## What have we learned? Position ☑

- We specify position (along a given line) by
  - choosing a reference point (origin)
  - choosing a line
  - choosing a scale
- We specify a direction with a (dimensionless) arrow $\hat{\imath}$ and multiply it by a (positive or negative) distance to tell us where we are.

$$\hat{r} = x\hat{\imath}$$ (where $x$ is a length)

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## What have we learned? Velocity

- Average velocity is defined by

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

Note: an average velocity goes with a time interval

- 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 specific time.

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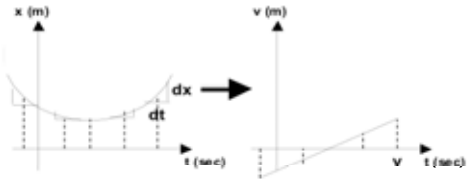
## Position to velocity




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

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

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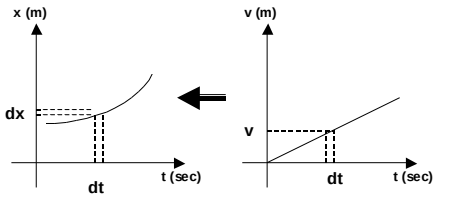
## Velocity to position




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

change in position over a small time interval

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

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

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## 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.



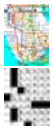
## Seventh Icon: Multiple Representations

- 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.



## 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 $v = \frac{\Delta x}{\Delta t}$
- Velocity graph → position graph: areas $\Delta x = v\,\Delta t$