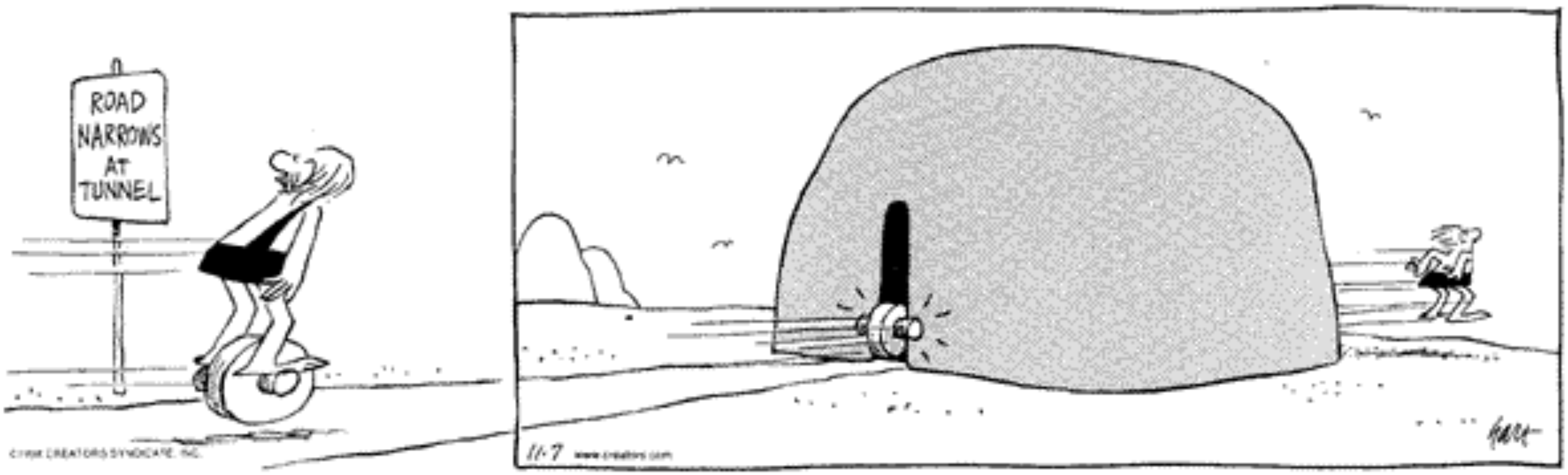
- **<u>Theme Music:</u> Run Like an Antelope**
  Phish
- **<u>Cartoon:</u> Johnny Hart**
  BC



Foothold ideas: Acceleration

- Average acceleration is defined by

$$\langle \vec{a} \rangle = \frac{\Delta \vec{v}}{\Delta t} = \frac{\text{change in velocity}}{\text{time it took to do it}}$$

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

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

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

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

Technical term alert!

- Note that in physics we use the term "**acceleration**" in a technically defined way:
  - "acceleration" = changing velocity
- The object may be speeding up or slowing down or keeping the same speed and changing direction. We still say "it is accelerating."
- In common speech
  "*acceleration*" = speeding up,
  "*deceleration*" = slowing down, and
  "*turning*"=changing direction.
- How many (physics) accelerators are there on your car?

Uniformly changing motion

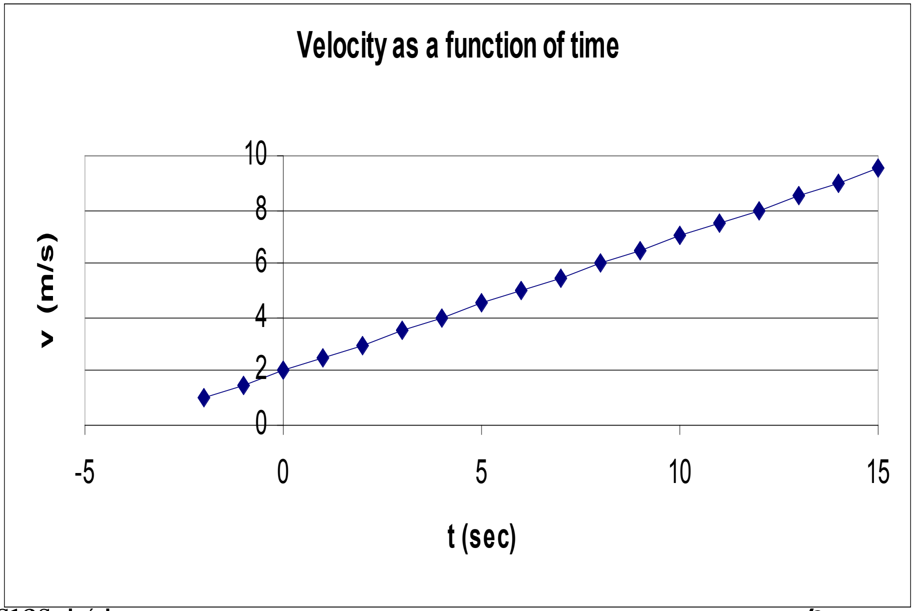
- If an object moves so that it changes its velocity by the same amount in each unit of time, we say it is in uniformly accelerated motion.
- This means the average acceleration will be the same no matter what interval of time we choose.

$$< \vec{a} > = \frac{\Delta \vec{v}}{\Delta t} = \vec{a}_0$$

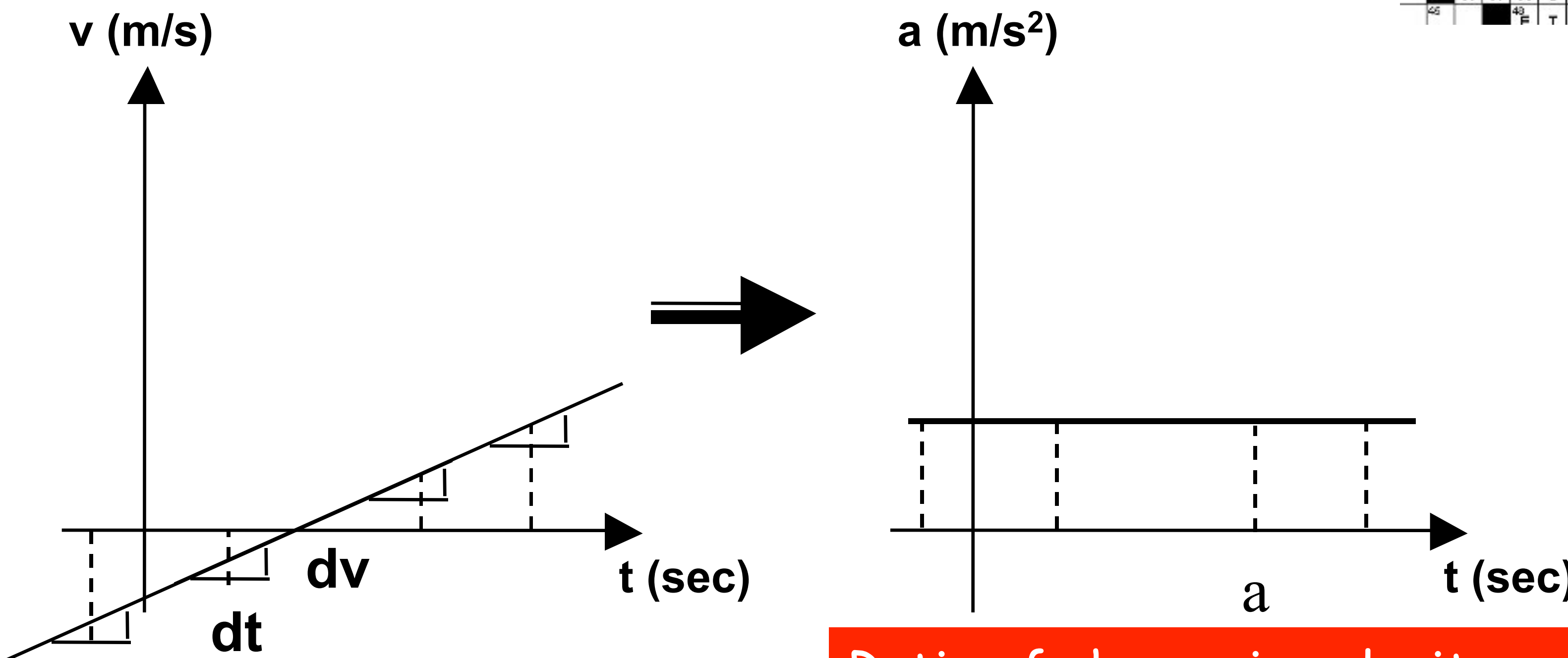
$$\Delta \vec{v} = \vec{a}_0 \, \Delta t$$

$$\vec{v}(t_2) - \vec{v}(t_1) = \vec{a}_0 \, \Delta t$$

$$\vec{v}_{final} = \vec{v}_{initial} + \vec{a}_0 \, \Delta t$$



Velocity to acceleration



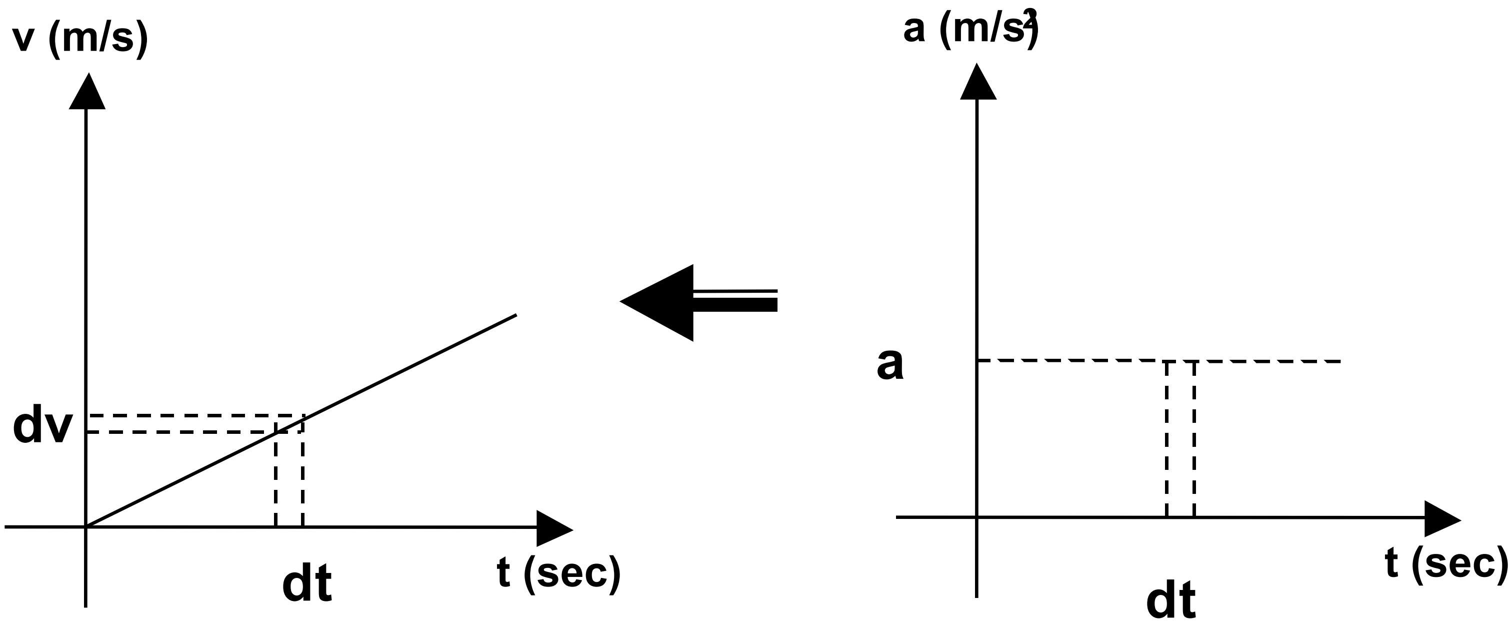
Ratio of change in velocity that takes place to the (small) time interval

$$a(t) = \frac{dv}{dt}$$

Difference of two velocities at two (close) times

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

Acceleration to velocity



change in velocity over a small time interval

$$dv = a(t)\,dt$$

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

$$v = \sum dv = \int a(t)\,dt$$

What have we learned? Representations & consistency

- Position $$\hat{r} = x\hat{i} + y\hat{j}$$ (where x and y are signed lengths)
- Velocity $$\langle \vec{v} \rangle = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{v} = \frac{d\vec{r}}{dt}$$
- Acceleration $$\langle \vec{a} \rangle = \frac{\Delta \vec{v}}{\Delta t} \qquad \vec{a} = \frac{d\vec{v}}{dt}$$
- Seeing from the motion
- Seeing consistency (graphs & equations)