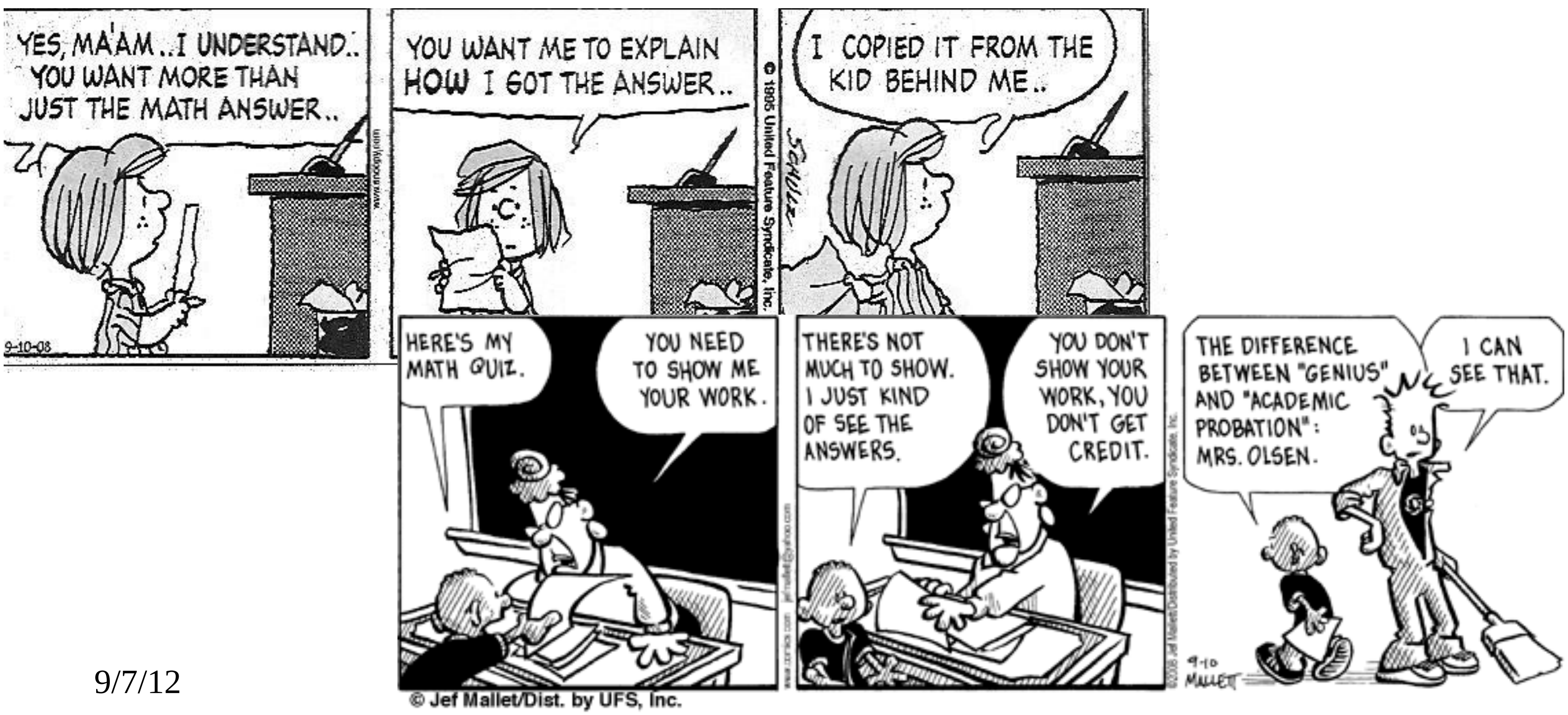
- **<u>Theme Music:</u>**

  Speed Racer Theme

- **<u>Cartoon:</u> Charles Schultz / Jef Mallett**

  Peanuts / Frazz



Reading questions

- Are the lines on the spatial graphs representing the actual motion that the object it taking in real time and space?
- Does the "graph of the eye" represent the motion of the object where as the plot against time is the object moving towards or away from the origin?
- How are we supposed to interpret x-y graphs if we are not looking at independent and dependent variables?

Most common question

- When reading the section about derivatives, I understood everything up to the point about derivative as a stepping rule. I didn't understand it much, as to how the formula was achieved. at first I thought it seemed like a slope function looking at the change of one over the change of the other, but when it got more detailed I got lost. Can I have a better explanation or a specific example?
- Can you explain the derivative as algebra section in class? It still doesn't make sense to me.

Example of a Diff Eq.

- Epidemiology: Number of people infected by a disease is proportional tothe number of people.
- A simple model for the spread of infection

$$\frac{dI(t)}{dt} = AI(t) - BI(t)$$

$A =$ rate at which population gets infected

$B =$ rate at which infected people are cured (or die)

$$\frac{dI}{dt} = (A - B)I$$

Use of Diff Eqs.

- In lots of cases – epidemiology, chemical reactions, and the motion of objects, the equations describing a system relate the values of something to its derivatives. Figuring out what happens next depends on being able to predict the future by knowing the derivative and “stepping”.

Stepping rule: Suppose we know the value of something as a function of time at a given time, *f*(*t)*, and we know its derivative, *df/dt* at that time. We can use that to predict the future!

$$\frac{df}{dt} = \frac{\Delta f}{\Delta t} = \frac{f_{end} - f_{beginning}}{\Delta t}$$

$$f_{end} - f_{beginning} = \left(\frac{df(t)}{dt}\right)\Delta t$$

$$f(t+\Delta t) - f(t) = \left(\frac{df(t)}{dt}\right)\Delta t$$

$$f(t+\Delta t) = f(t) + \left(\frac{df(t)}{dt}\right)\Delta t$$

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)

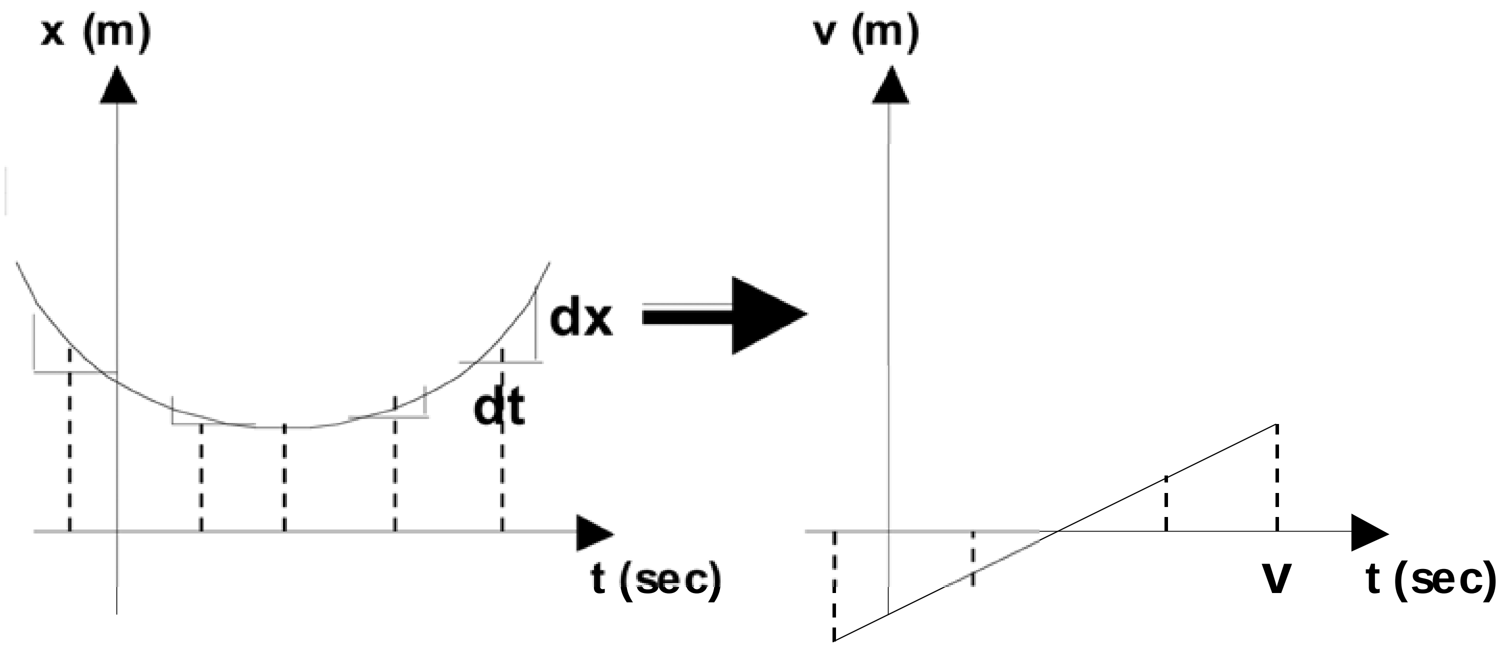
$$v = \frac{dx}{dt}$$

Can this velocity be negative as well as positive?

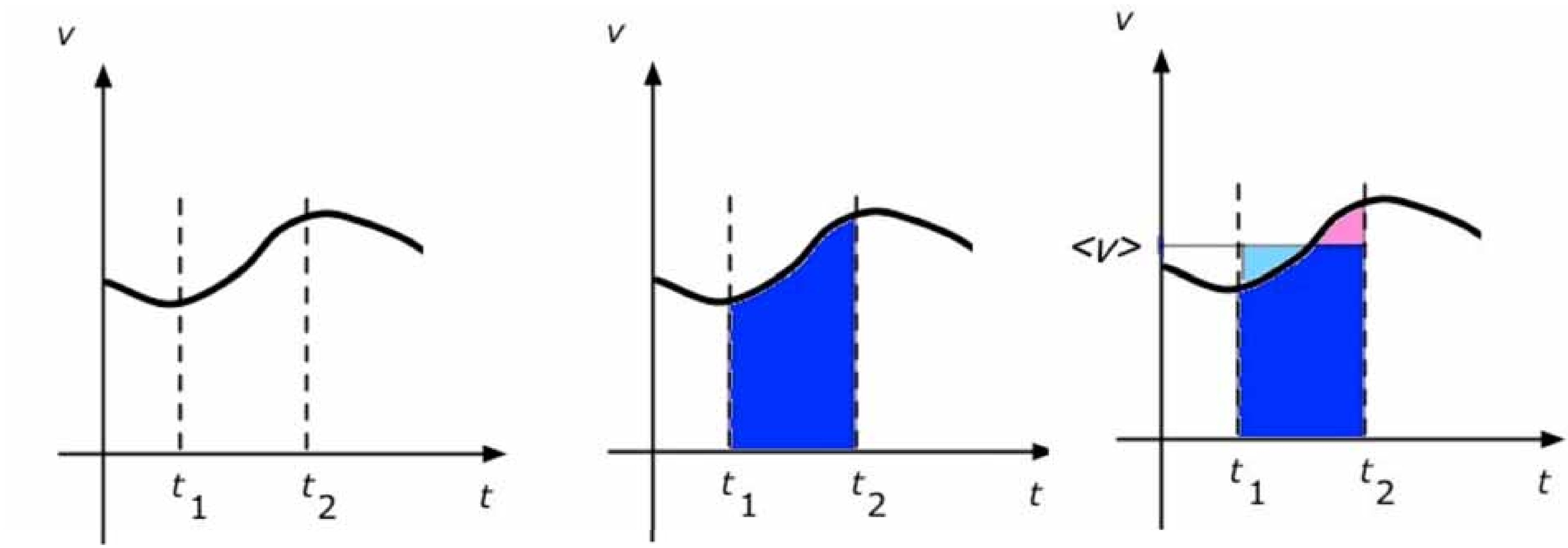
Tools: What have we learned? ☑

$$\langle \vec{v} \rangle = \frac{\text{displacement}}{\text{time it took to make the displacement}}$$

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



Reading question:
What the %*&$# does this mean?



v is a function of *t*, *v*(*t*)

What is the average velocity between times t_1 and t_2?

The total displacement between those two times it the area under the curve. (Why?)

Adjust <*v*> (a constant) so $\Delta x = \langle v \rangle \Delta t$

Foothold ideas: Vector velocity and speed

- A displacement – a change in position – has a direction. This means

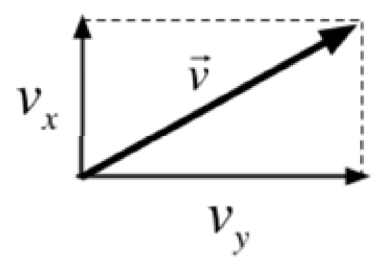
  velocity = displacement/time interval

  has one too. $\vec{v} = \frac{d\vec{r}}{dt}$

$$v_x\hat{i} + v_y\hat{j} = \frac{d}{dt}\left(x\hat{i} + y\hat{j}\right) = \left(\frac{dx}{dt}\right)\hat{i} + \left(\frac{dy}{dt}\right)\hat{j}$$

- We define speed as the magnitude of velocity. (No vector on this. Why?)

$$v = \sqrt{v_x^2 + v_y^2}$$



The sonic ranger (motion detector)

- The sonic ranger measures distance to the nearest object by echolocation.
  - A speaker clickes 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.