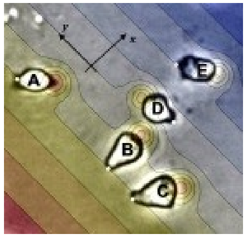
Physics 131- Fundamentals of Physics for Biologists I



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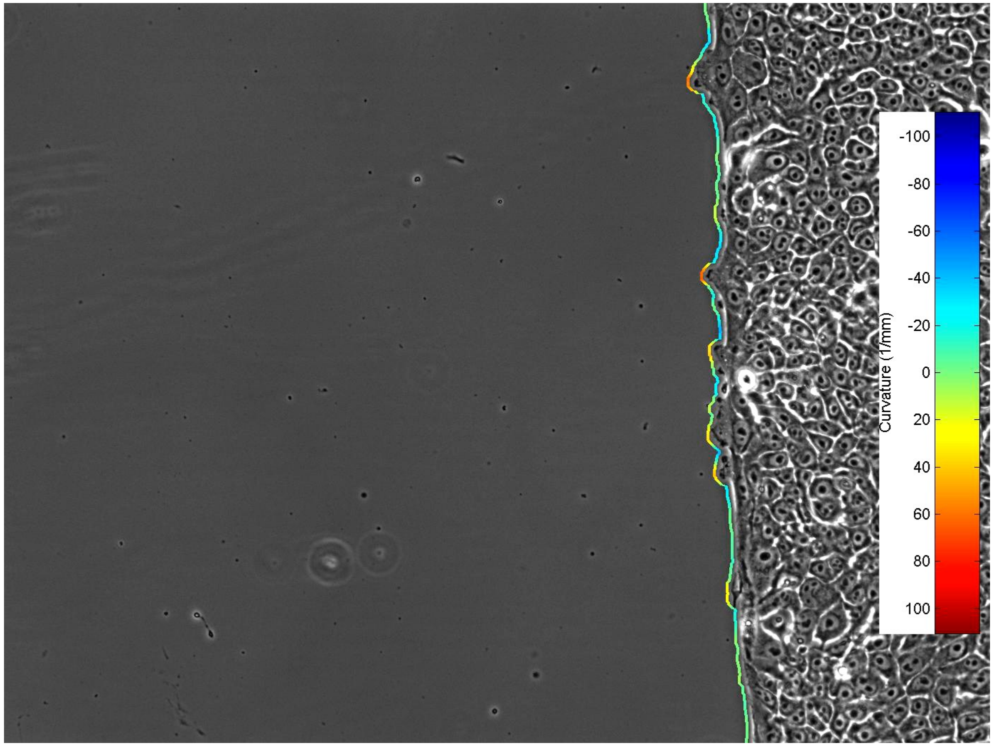
Pink Floyd



Wound healing, Rachel Lee (Losert Lab)

Outline

- Derivatives
- Velocity
- Average Velocity
- Acceleration

Are we going to get any PRACTICE with all of these equations and concepts? Its hard to learn things when there are no problems to practice with

HW2 Recitation 2, Quiz 2

Predicting the Future with Derivatives*

Suppose we know the value of something [let's call it f] as a function of time at a given time, [let's call that *f*(*t)],* and we know it's derivative at that time*.* [that's called *df/dt*]

We can use that to predict the future!

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

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

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

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

*does not apply to derivatives traders in the London and Chicago financial exchanges

Example of a Diff Eq.

- Epidemiology: Number of people infected by a disease is proportional by the number of people in the population.
- A simple model for how many people are sick at a given time [let's call that S(t)] allows us to think mathematically about the spread of infection

$$\frac{dS(t)}{dt} = AS(t) - BS(t)$$

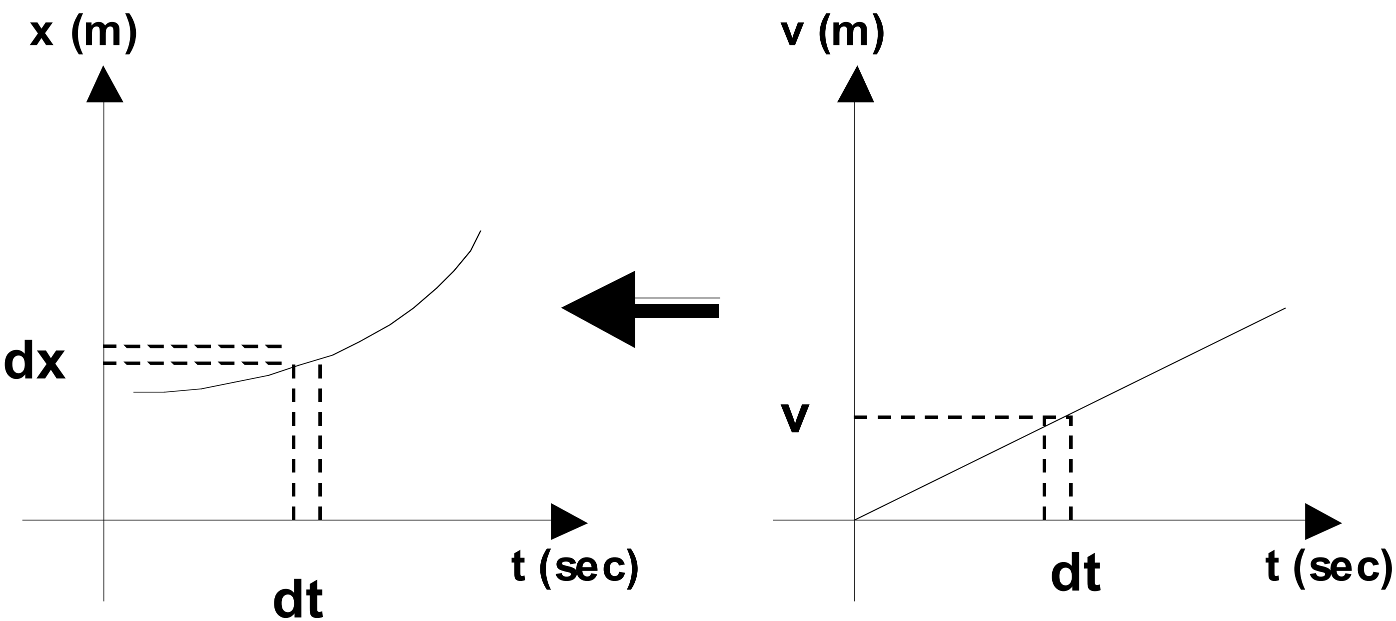
$A =$ rate at which population gets infected

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

$$\frac{dS}{dt} = (A - B)S$$

$$dx = v(t)dt$$

Predicting Position from Velocity



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

change in position that takes place in a small time interval

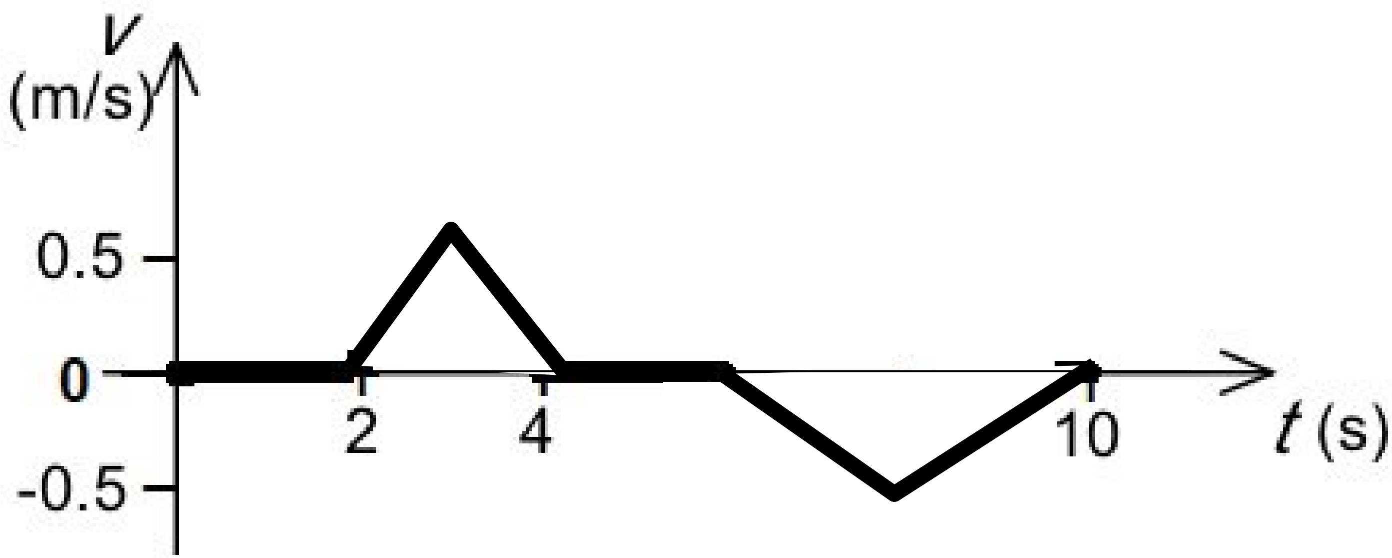
$$x = \square\; dx = \square\, v(t)\, dt$$

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

Using Velocity- work in groups and use whiteboard

(TA and LA will join discussion)

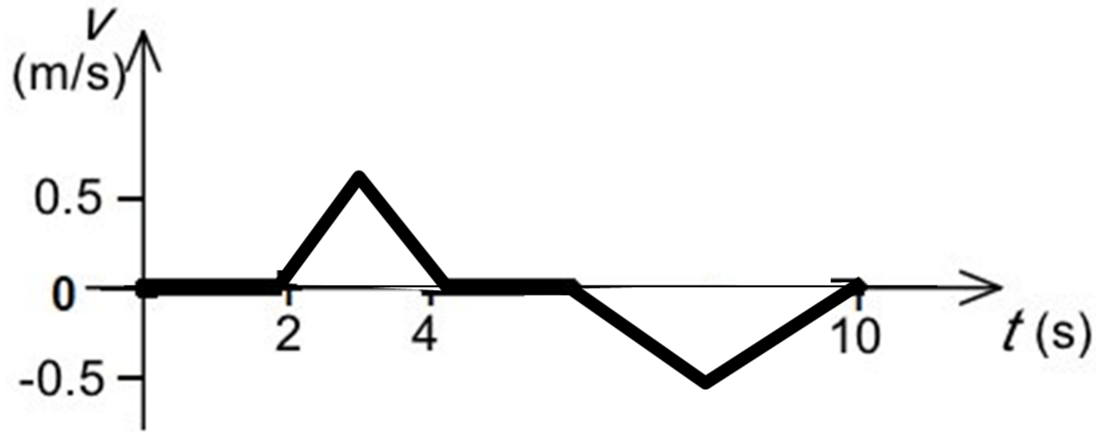
- Describe how you have to walk to make the sonic ranger produce the following velocity graph



- Draw the position graph.

Compared to her position x at t=0s, the person at t=10s is at

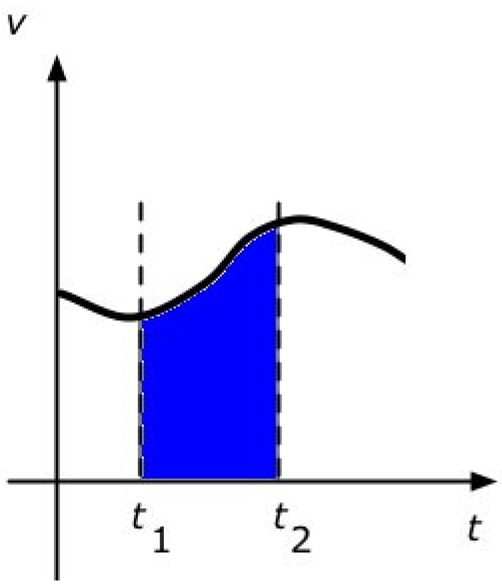
1. Same x
2. Positive x
3. Negative x
4. Larger x
5. Smaller x
6. We cannot tell from position vs time graph

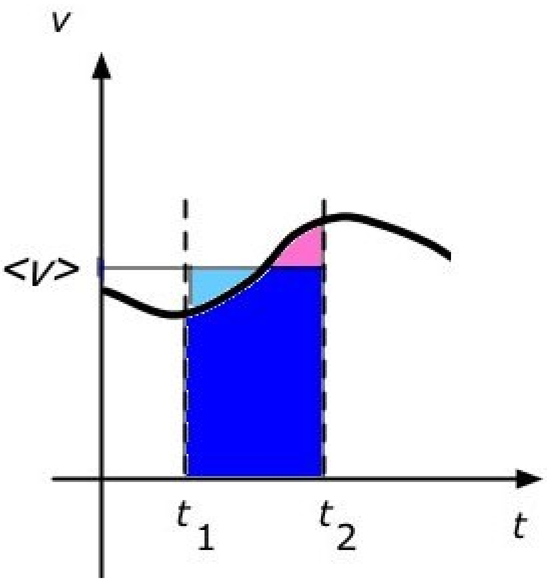


$$\langle v \rangle = \frac{\Delta x}{\Delta t}$$

$$\Delta x = \langle v \rangle \Delta t$$

Average velocity - graphical





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

$$\Delta x = \langle v \rangle \Delta t$$

The total displacement is the area under velocity vs time curve

Wouldn't it be easier to make a position graph out of a velocity graph and then calculate average velocity?

The value of the Average Velocity

1. Lies in the middle between the initial and final velocity
2. Has to be somewhere between the initial and final velocity, depends on how velocity changes with time
3. Neither
4. Don’t know

Dealing with uncertainty

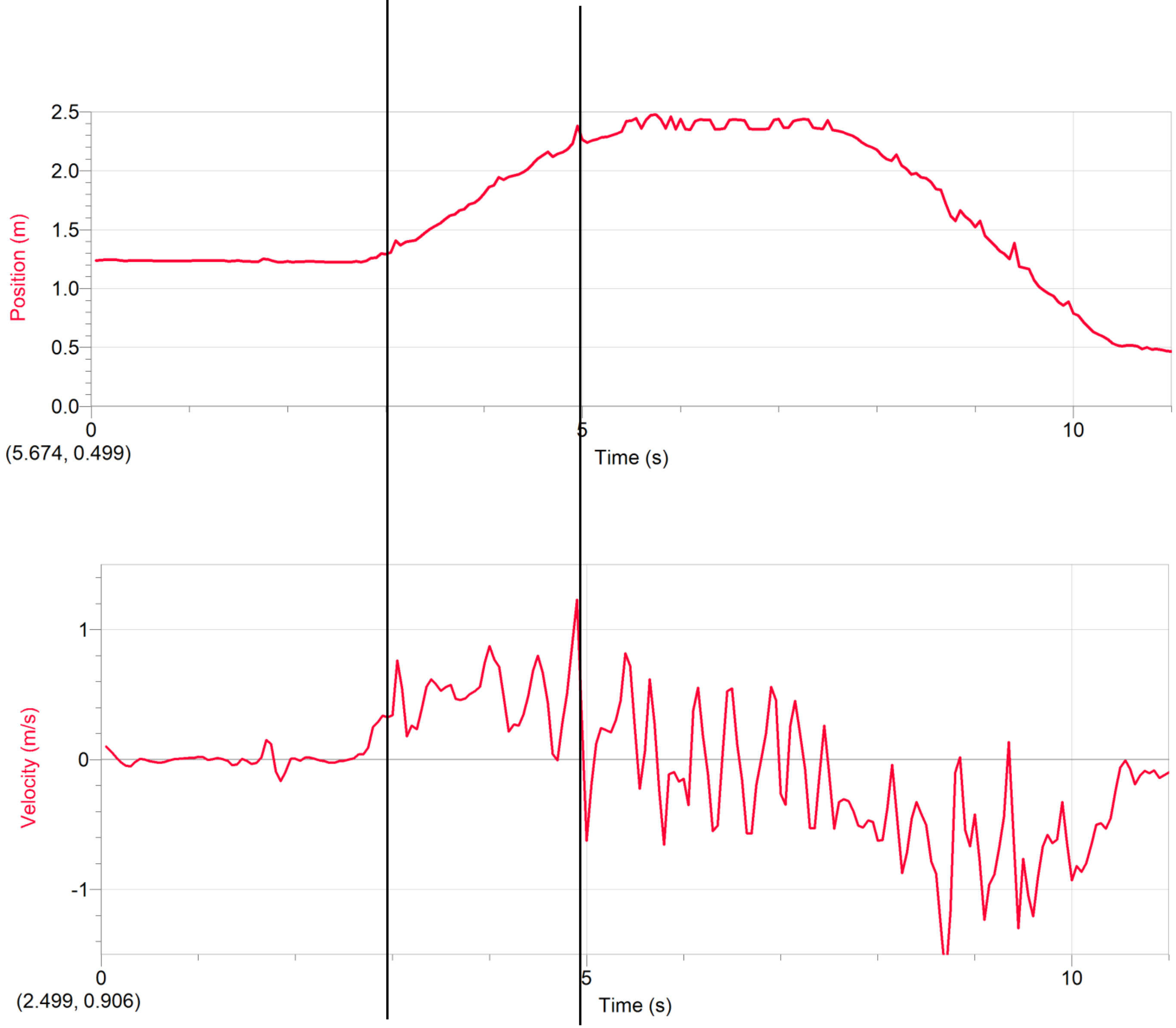
In some cases measurements have uncertainty, in other cases the moving object actually is moving with some randomness.

For the sonic ranger, the position of the person is measured with some uncertainty at each timestep.

- ***Sketch a typical (somewhat noisy) position vs time graph on the whiteboard***

Which graph will be *smoother*?

1. position vs t
2. Velocity vs t
3. Both have the same uncertainty and comparable smoothness
4. Depends on the situation



*Why would traders want to buy and sell a quantity that is a derivative (see below)

Foothold ideas: Acceleration

- Average acceleration is defined by

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

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>.