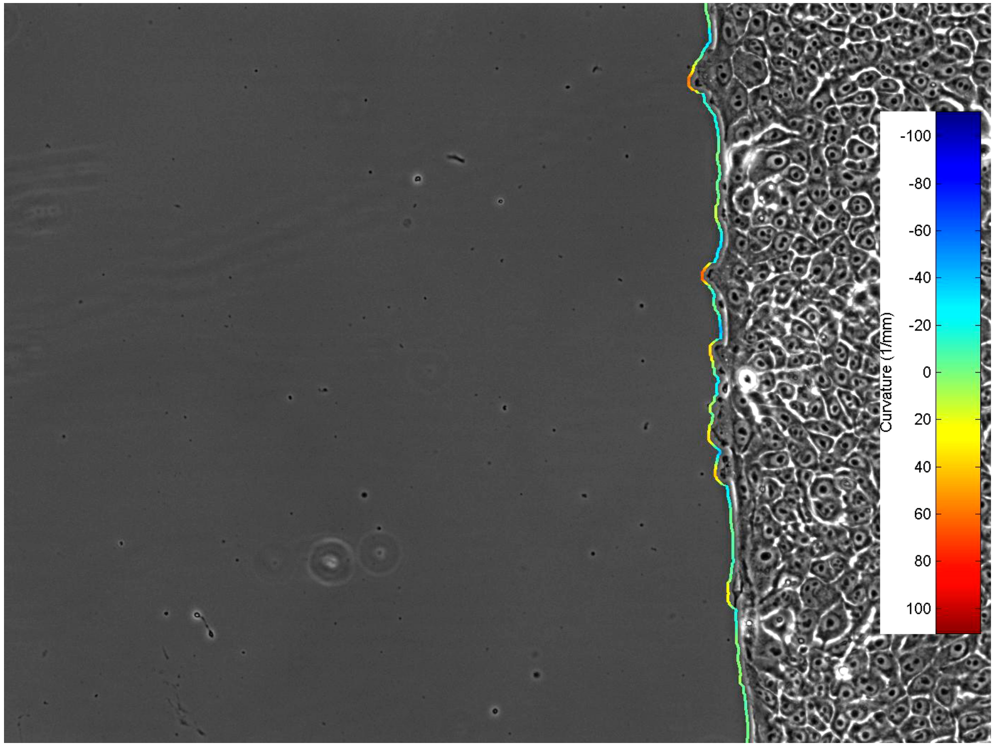
Does any of this apply to biological systems?



Wound healing, Rachel Lee (Losert Lab at the University of Maryland)

Announcements

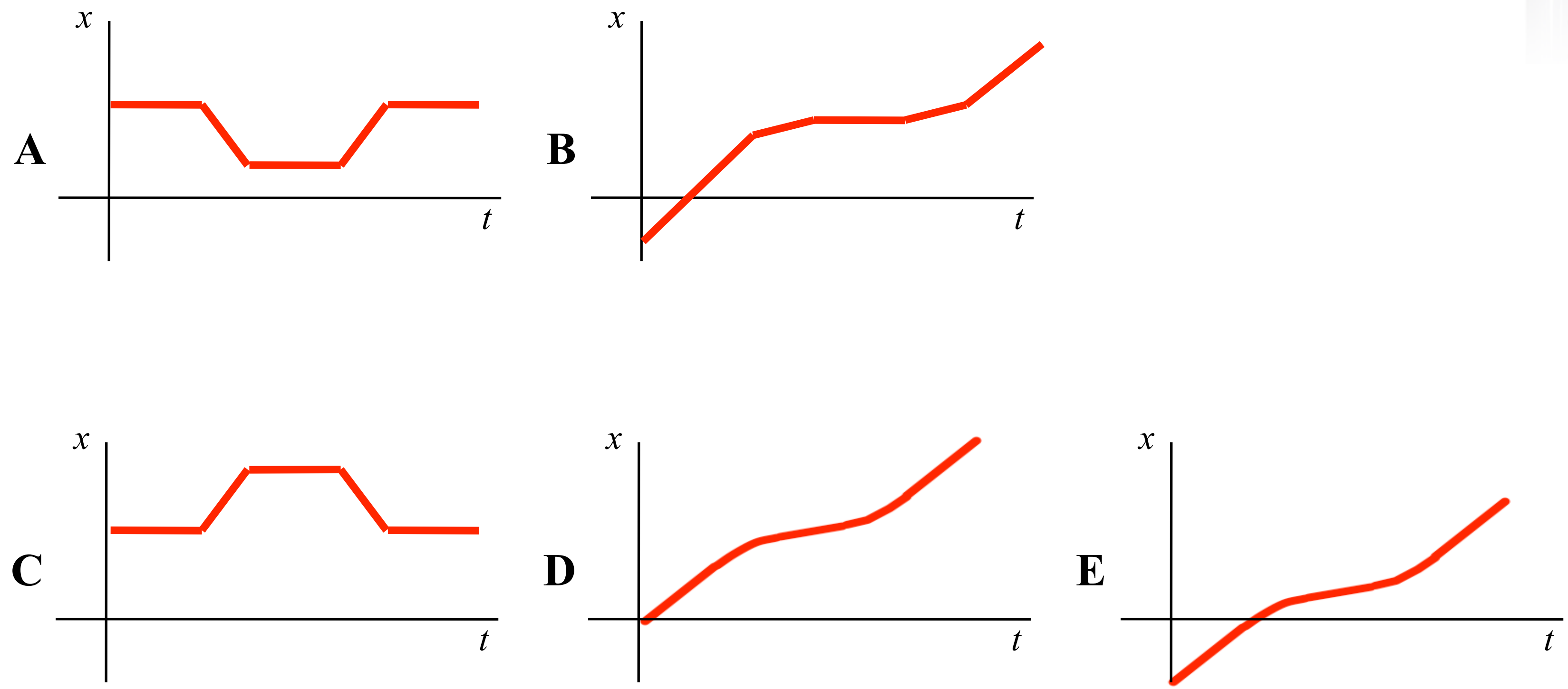
- Ch 7 reading questions due on Sunday
- Midsemester survey up on LON-CAPA in Ch7 reading questions folder
- Ch 6 & 7 Homework due next Friday

Example

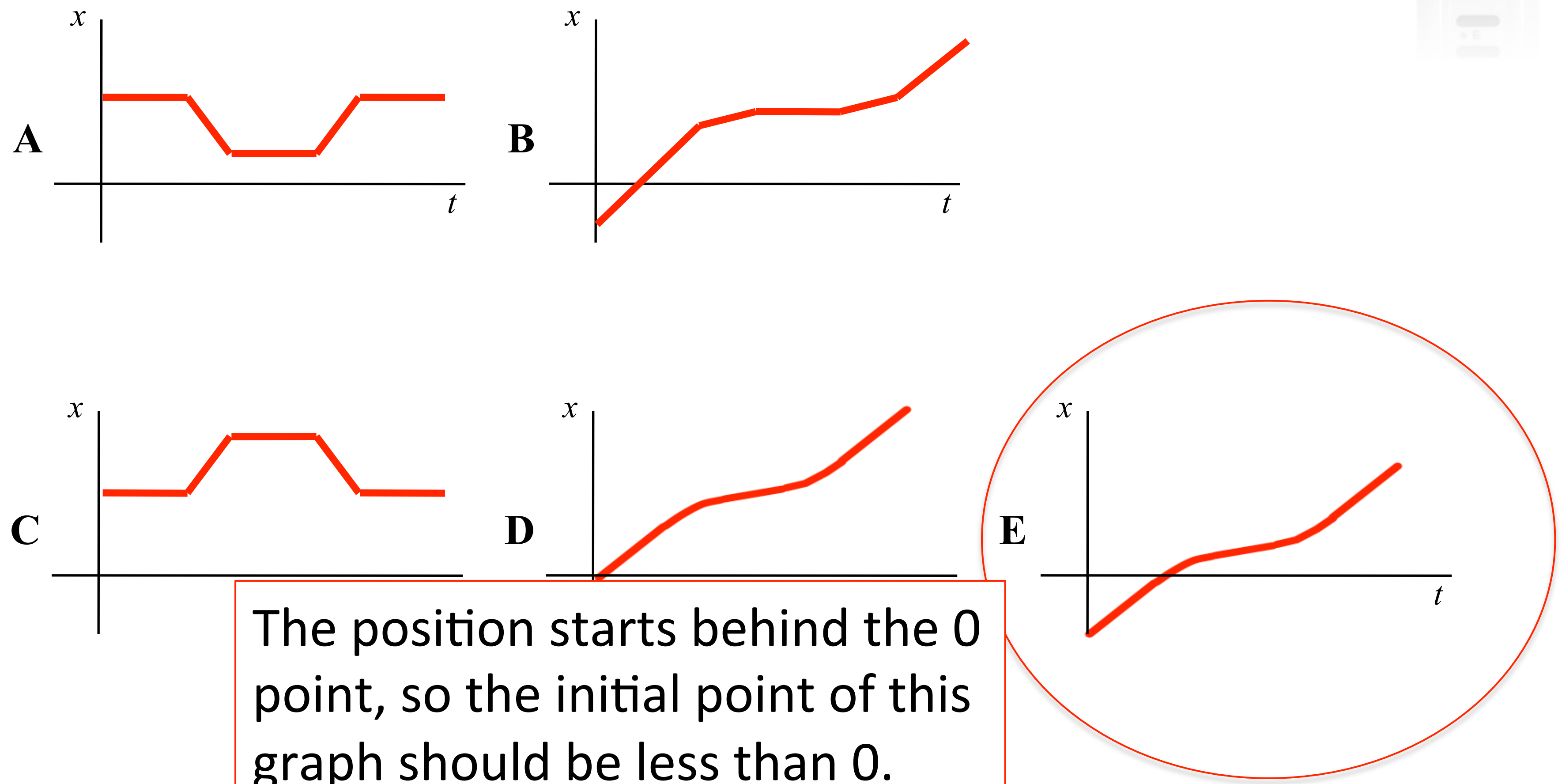
Hint! Describe in words what is happening first!

A ball rolls is rolling at a constant speed along a horizontal track as shown.
It comes to a hill and has enough speed to get over it. By thinking about its speed as it goes, sketch a graph of the position of the ball as a function of time. (ignore friction)

Which graph best describes the motion?



Which graph best describes the motion?



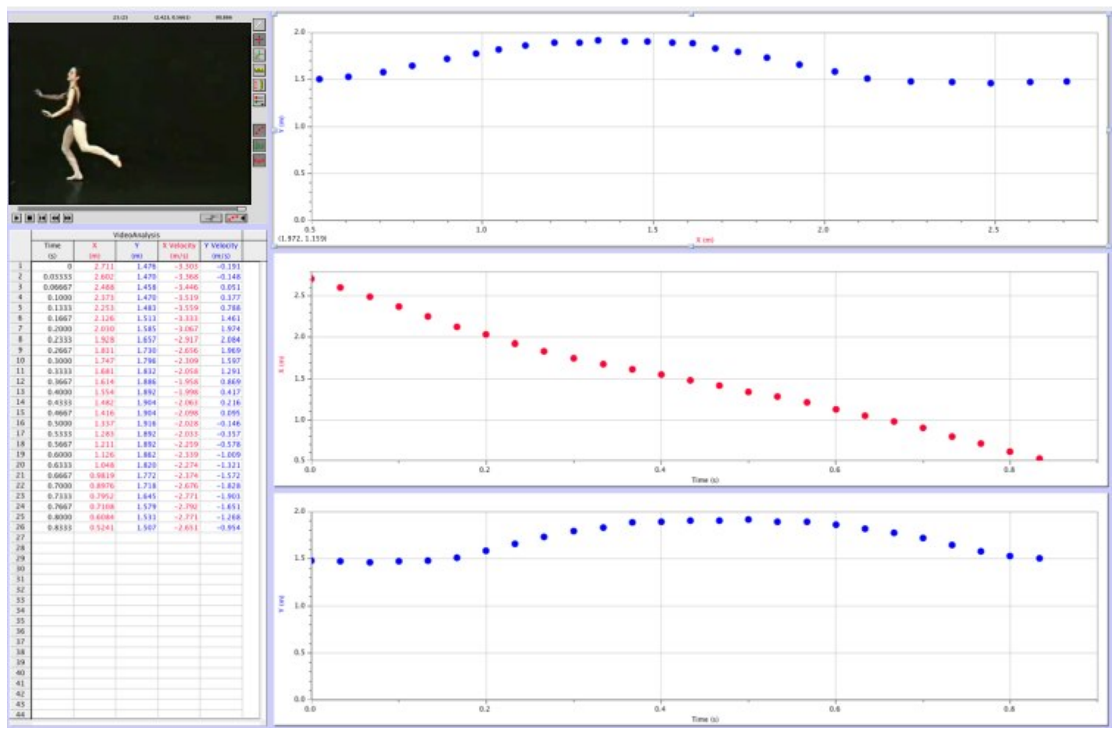
The position starts behind the 0 point, so the initial point of this graph should be less than 0.

Figuring out velocity

- We have looked at the *x-y*, *x-t*, and *y-t* plots.
- Velocity is the derivative of the position wrt time. Which plots can we get velocity from? Why?

- What will they look like?

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



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 "**<u>acceleration</u>**" 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

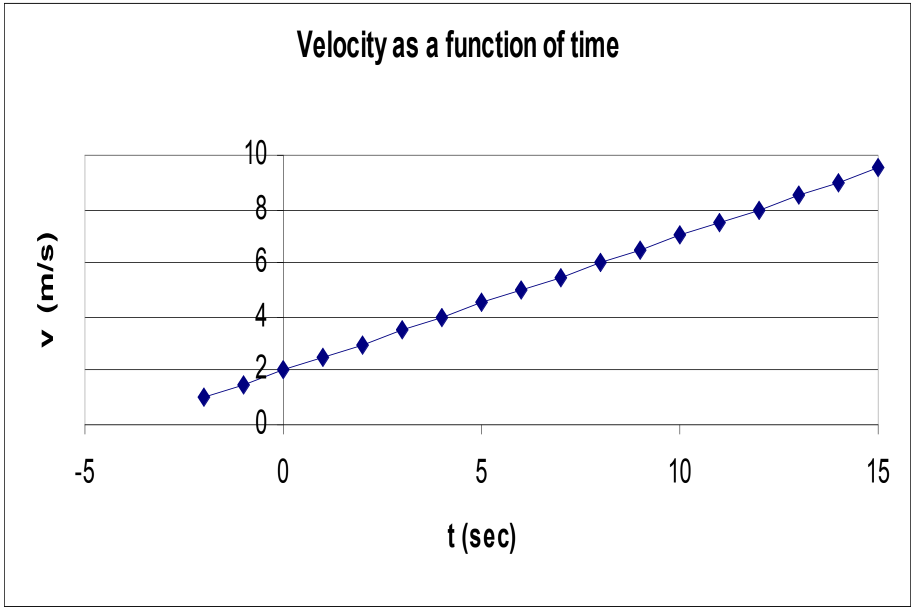
- If an object moves so that it changes its velocity by the same amount in each unit of time, we say it is in uniformly accelerated motion.
- This means the average acceleration will be the same no matter what interval of time we choose.

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

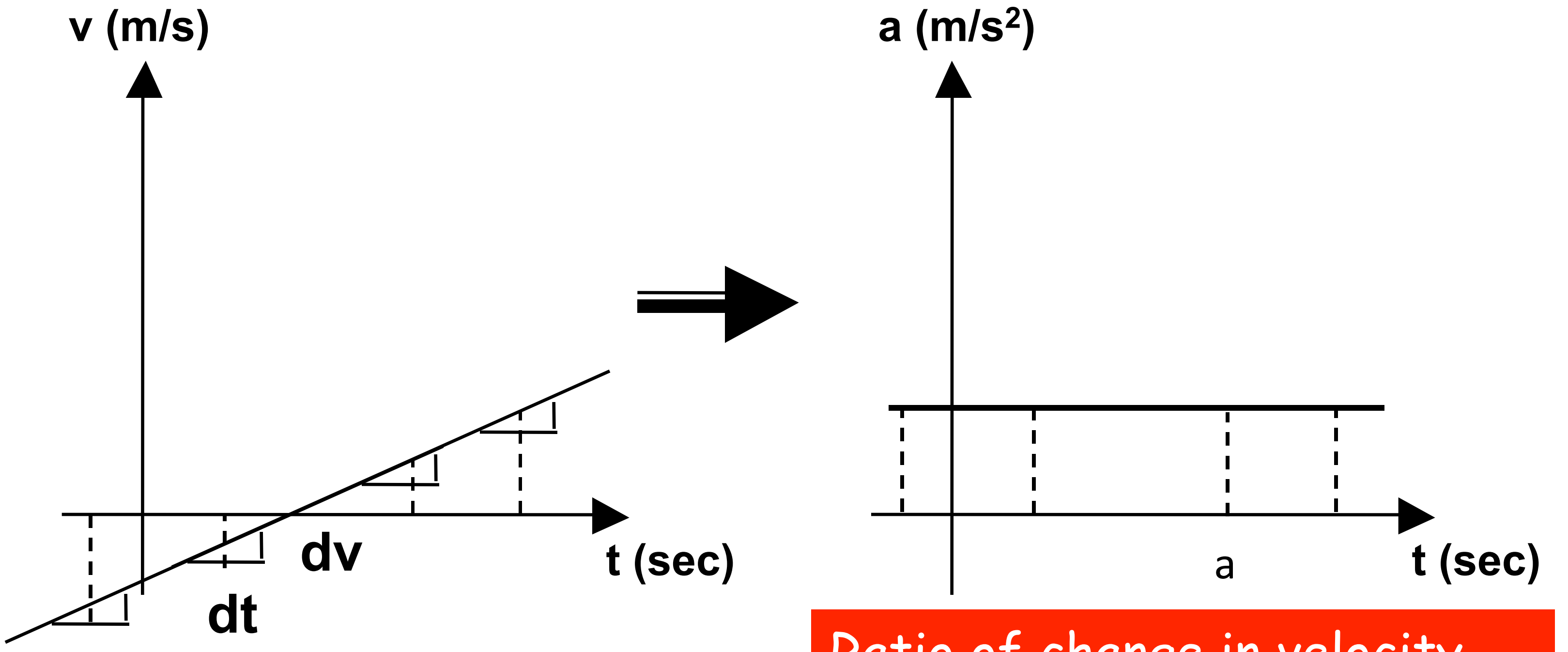
$$\Delta \vec{v} = \vec{a}_0 \, \Delta t$$

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

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



Velocity to acceleration



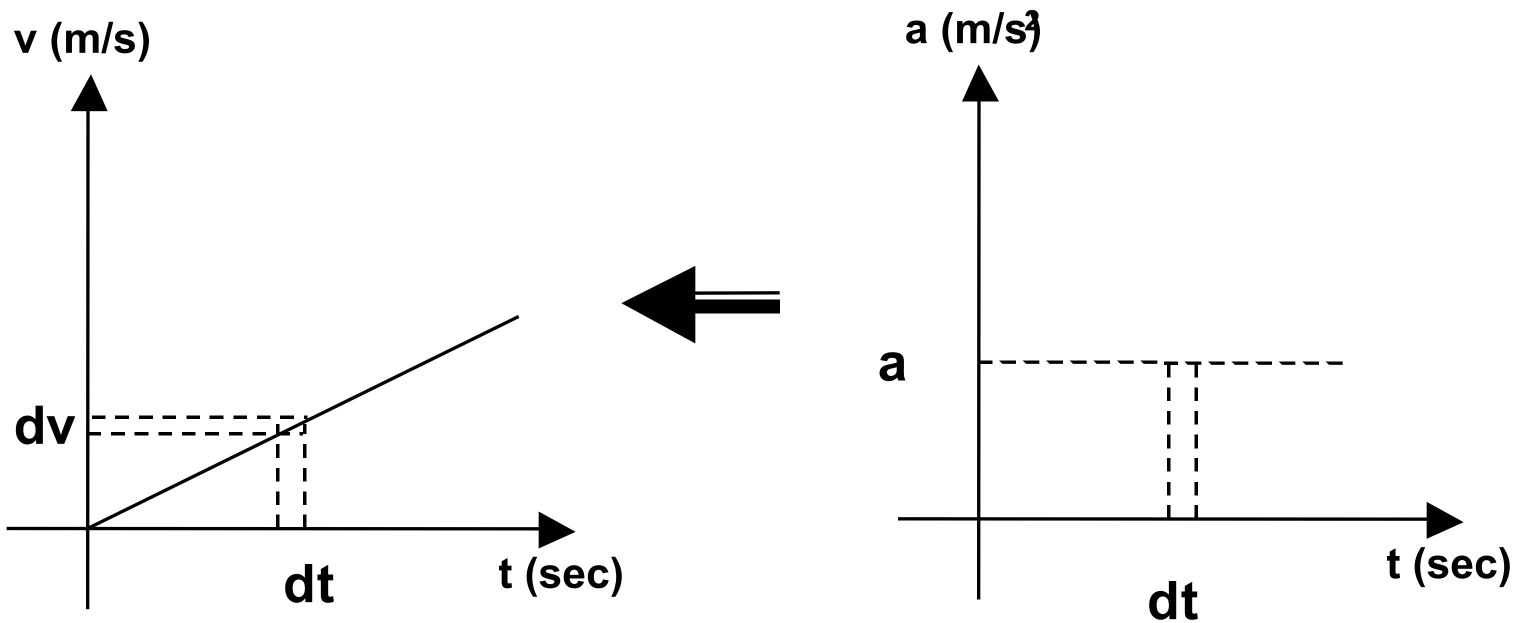
Ratio of change in velocity that takes place to the (small) time interval

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

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



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

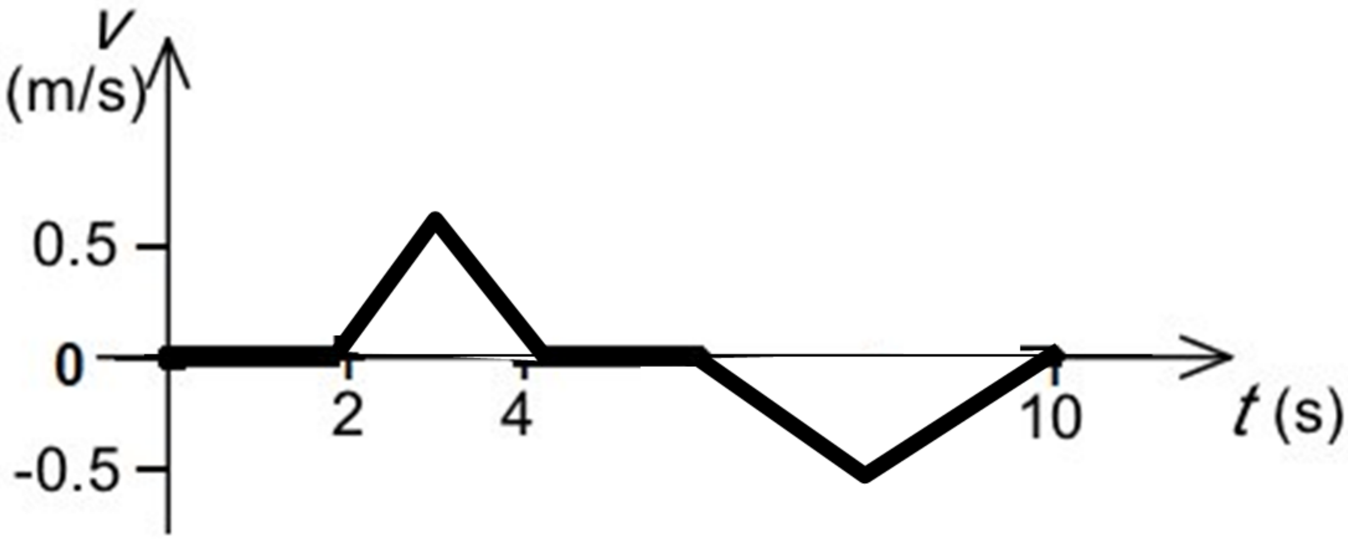
change in velocity over a small time interval

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

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

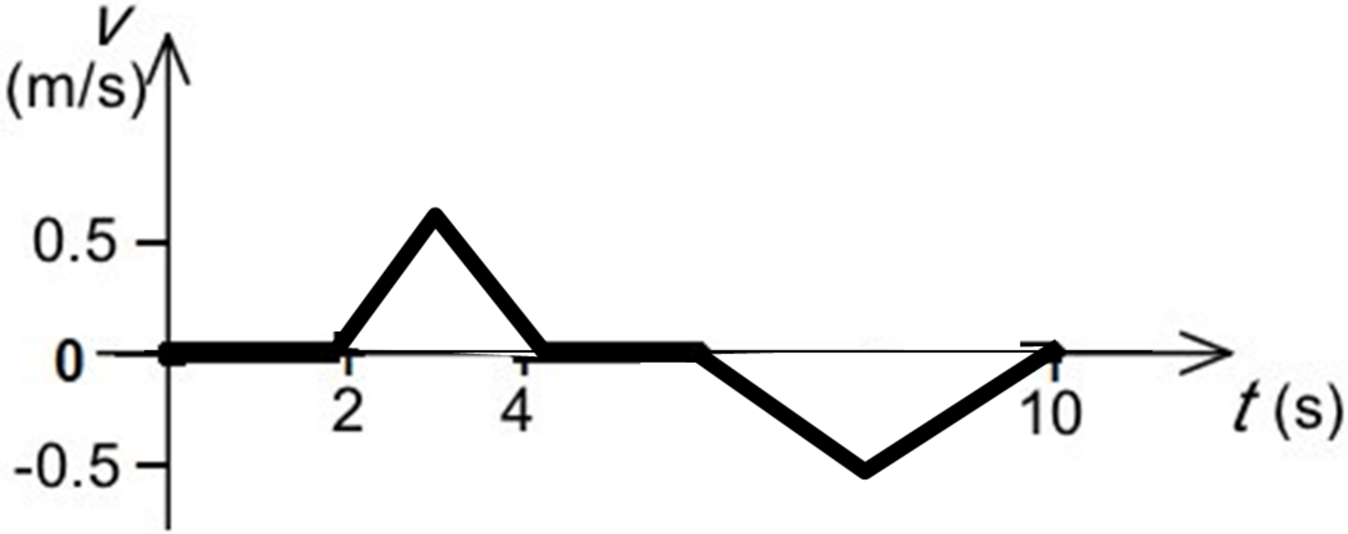
Example

- Describe in words how do you have to walk to produce the following velocity graph.



Example

- On your whiteboard, draw the acceleration graph corresponding to this velocity graph.



What have we learned? Representations & consistency

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

An object's position varies as a function of time as shown below. After 8 seconds, what is the object's acceleration?

A. 8 m/s^2
B. 16 m/s^2
C. 64 m/s^2
D. 72 m/s^2
E. None of the above

$$s(t) = 8t + 4t^2$$

An object's position varies as a function of time as shown below. After 8 seconds, what is the object's acceleration?

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B. 16 m/s^2
C. 64 m/s^2
D. 72 m/s^2
E. None of the above

$$s(t) = 8t + 4t^2$$

If we take the derivative with respect to time:
$d(s)/dt = 8 + 2*4\,t$
And then again
$d^2(s)/dt^2 = 0 + 8$
the second derivative is the acceleration

An object's position varies as a function of time as shown below. After 8 seconds, what is the object's velocity?

A. 8 m/s
B. 16 m/s
C. 64 m/s
D. 72 m/s
E. None of the above

$$s(t) = 8t + 4t^2$$

An object's position varies as a function of time as shown below. After 8 seconds, what is the object's velocity?

A. 8 m/s
B. 16 m/s
C. 64 m/s
D. 72 m/s
E. None of the above

$$s(t) = 8t + 4t^2$$

The first derivative is the velocity
d(s)/dt = 8 + 2*4 t

Then we just plug in 8s for the time.

Try describing as much as you can about the motion in these situations on your whiteboard!

1. A subway train in Washington D.C. starts from rest and accelerates at $2.0 m/s^2$ for 12s.

2. A ball is dropped from a building that is 52m high.

3. An antelope moving with constant acceleration covers the distance between two points that are 80m apart in 7s. Its speed as it passes the second point is 15m/s.

See the LBC-Physics You Tube Channel for these 3 solutions! http://www.youtube.com/user/lbcphysics