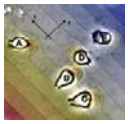
Physics 131- Fundamentals of Physics for Biologists I



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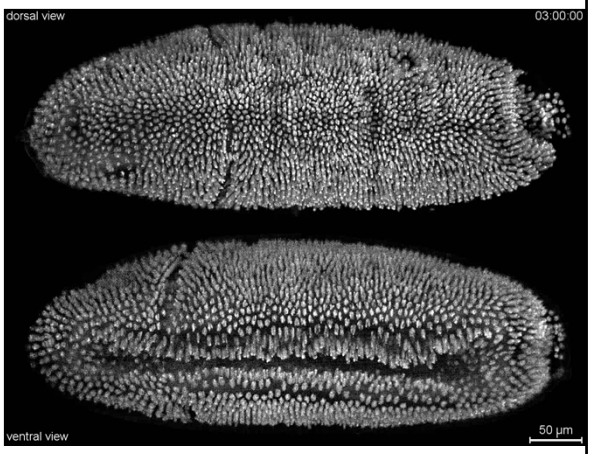
9/7/2012
Main Topic: Motion

-How can we describe motion (Kinematics)

- What is responsible for motion (Dynamics)



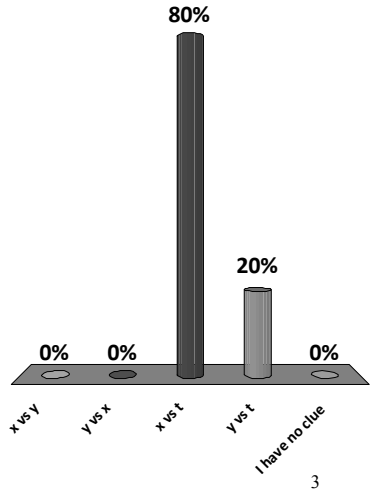
Movie of the Day
Development of a Fruit Fly Embryo – from Phil Keller, Janelia Farm

Foothold ideas: Coordinates in space

- In order to specify the position of something we need a coordinate system.
- The coordinate system includes:
  - Picking an ***origin***
  - Picking perpendicular directions for the axes of the coordinate system
  - Choosing a ***measurement scale***
- Each point in space in then specified by
  - three numbers: the *x*, *y*, and *z* coordinates.
  - a position vector– an arrow drawn showing the displacement from the origin to that position.

What does the bottom graph show?

1. x vs y
2. y vs x
3. x vs t
4. y vs t
5. I have no clue



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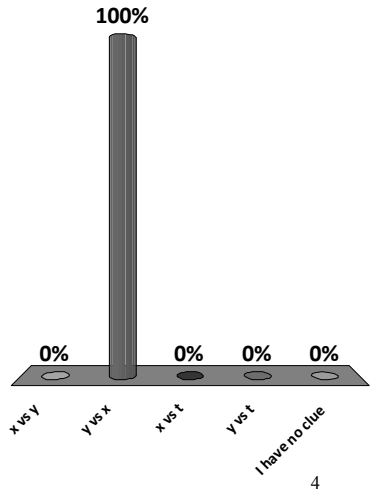
What does the top graph show?

1. x vs y
2. y vs x
3. x vs t
4. y vs t
5. I have no clue



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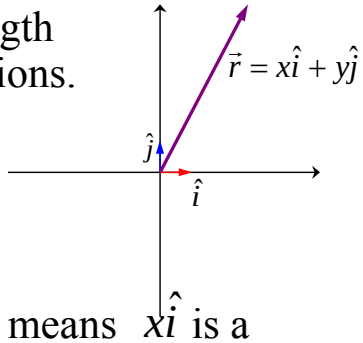
Coordinates in Space Notation

- We specify the directions we are talking about by drawing two little arrows of unit length in two perpendicular directions.
- "x" and "y" are called the coordinates and can be positive or negative.
- Note that if x is negative, it means $x\hat{i}$ is a vector pointing in the direction opposite to



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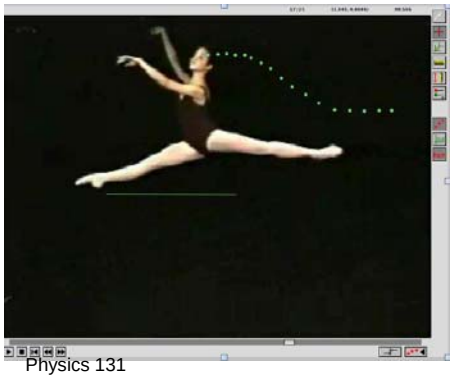
Graphing Position

- Describe where something is in terms of its coordinate at a given time.

- Choose origin
- Choose axes
- Choose scale
- Set scales on graph
- Take data from video
- Construct different graphs
- Fit the graphs with math functions



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Motion along a straight line (1-dimensional coordinates)

- We specify which direction we are talking about by drawing a little arrow of unit length in the positive direction.
- We specify that we are talking about this arrow in symbols by writing $\hat{i}$
- A position a distance *x* from the origin is written as $x\hat{i}$
- Note that if *x* is negative, it means a vector pointing in the direction opposite to $\hat{i}$

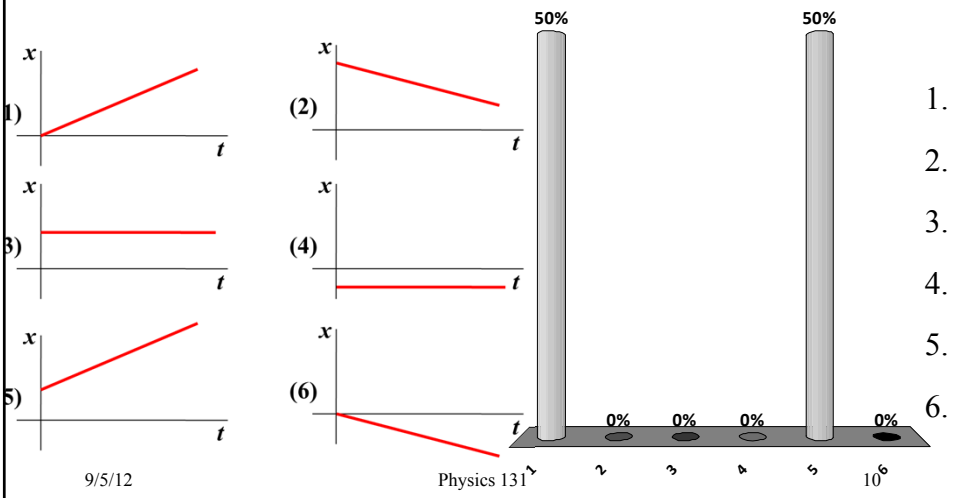
The sonic ranger (motion detector)

- The sonic ranger measures distan to the nearest object by echolocati
  - 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.

Example

- If I place the sonic ranger at the left side of the room and you walk slowly towards it
  at almost a constant velocity what will the position graph look like?
- Generate the graph on your whiteboard.

Which is the correct graph?



How does position change

- 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)

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

- Velocity

Differential equation

1. I never heard of this and I have no idea what this is – unless you mean the equation that lets me take a derivative (or maybe define what it is).
2. I have heard the term, but I'm not really sure what it means.
3. I know what it is but I wouldn't have any idea how to solve one.
4. I know what it is and I can solve some simple ones.

Epidemiology

1. I never heard of this and I have no idea what this is.
2. I have heard the term, but I'm not really sure what it means.
3. I know what it is but I wouldn't be able to explain it to someone.
4. I know what it is and I can explain it.

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 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)

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