

September 10, 2013

Physics 121

Prof. E. F. Redish

■ **Theme Music: Wynton Marsalis**
Where or When?

■ **Cartoon: Jim Davis**
Garfield

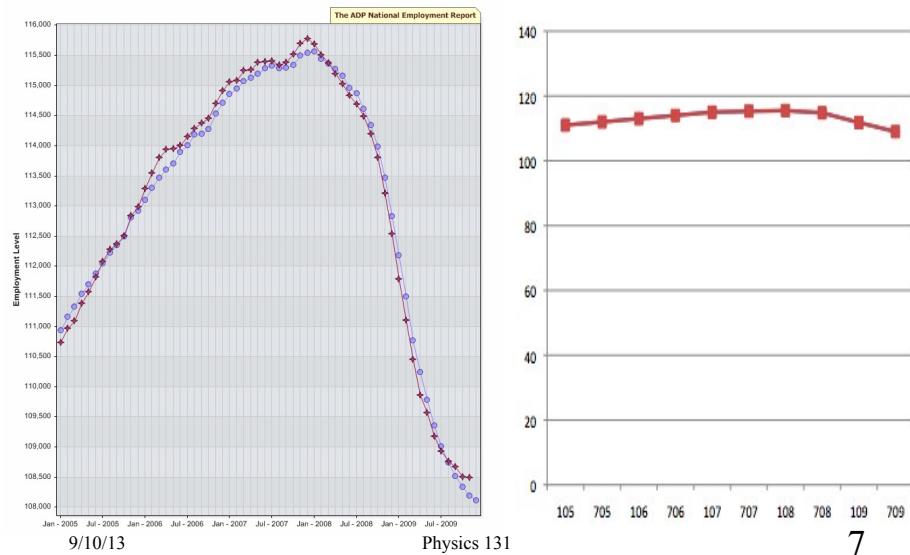


9/10/13

Physics 131

1

An example from current events



9/10/13

Physics 131

7

Foothold ideas



- We may choose to use an idea for a while – as a “foothold,” to see how it works, and perhaps reject it later in favor of a replacement or refinement.
- These ideas become the basic principles we will use to reason – the “stakes in the ground” of our safety net.

9/10/13

Physics 131

11

Cat television



- When we do science, we don't try to solve the entire universe at once.
- We restrict our considerations to a limited set of data and try to understand it. Only when we get it do we try to expand further to more situations.
- This is like looking out a window onto a small segment of the world. Since cats like to do this, I call the process “choosing a channel on cat television.”

9/10/13

Physics 131

The Main Question

(for this term, at least)



- Start by choosing a big question and then refining it:

How do things move?

Why choose this?

- concepts of measurement, rate of change, and force are basic - set frame for what are appropriate terms to use to think about motion.
- ties to everyday experience so can use and learn to build/refine intuition

Foothold ideas: Measuring “where”

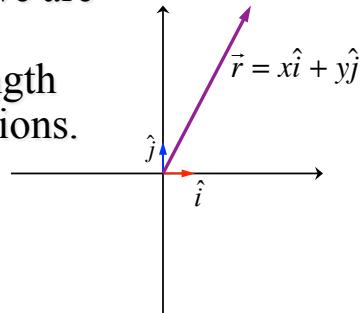


- In order to specify where something is we need a coordinate system. This includes:
 1. Picking an origin
 2. Picking perpendicular directions
 3. Choosing a measurement scale
- Each point in space is specified by three numbers: (x, y, z) , and a position vector— an arrow showing the displacement from the origin to that position.
- Vectors add like successive displacements or algebraically by $\vec{A} = A_x \hat{i} + A_y \hat{j}$ $\vec{B} = B_x \hat{i} + B_y \hat{j}$

$$\vec{A} + \vec{B} = (A_x + B_x) \hat{i} + (A_y + B_y) \hat{j}$$

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 \hat{i}



9/10/13

Physics 131

15

Foothold ideas: Measuring “when”



- Time is a coordinate just like position
 - We need an origin (when we choose $t = 0$)
 - a direction (usually times later than 0 are +)
 - a scale (seconds, years, millennia)
- Note the difference between
 - clock reading, t
 - a time interval, Δt

This is like the difference
between position and length!

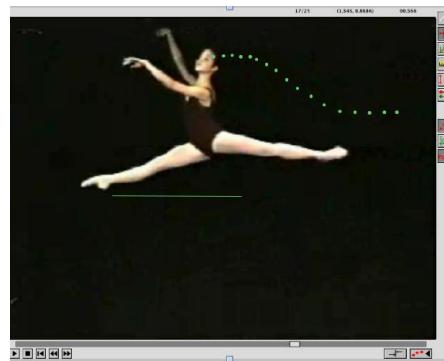
9/10/13

Physics 131

17

Graphing Position

- Graphs for the eye vs. graphs for the mind.
- 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



9/10/13

Physics 131

18

Foothold ideas: Velocity



- Average velocity is defined by
- $$\langle \vec{v} \rangle = \frac{\Delta \vec{r}}{\Delta t} = \frac{\text{vector displacement}}{\text{time it took to do it}}$$
- Note:** an average velocity goes with a time interval.
- Instantaneous velocity is what we get when we consider a very small time interval (compared to times we care about)

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

Note: an instantaneous velocity goes with a specific time.

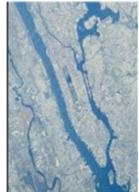
9/10/13

Physics 131

23

Multiple Representations

- We choose different ways of representing things depending on what we want to do.



- Adding multiple sensory modes adds to our sense of an object's reality.



9/10/13

Physics 131

24

Knowing-how-to-know icon: Multiple Representations

- We have many different ways that we represent information:
 - Words
 - Equations
 - Diagrams
 - Pictures
- Each gives its own way of building up something “real” in our minds.



9/10/13

Physics 131

25