

## Using Physics to Understand the World: The Physics of Everyday Life



Why are the tracks so amazing? What do they represent?

### Day 2:

- Get your clickers ready!
- Motion
  - Position
  - Velocity

### Reminders:

Reading for Tues: 1.2,  
Reading quiz on Tuesday  
Homework 1 due Tues midnight  
Next up: x, v, a and forces

### All information on course website:

[http://www.colorado.edu/physics/phys1010/phys1010\\_fa12/](http://www.colorado.edu/physics/phys1010/phys1010_fa12/)

## Office Hours & Problem Solving Sessions

Thursdays 2-5pm (today) == I'll be there 2-2:30 today

Mondays 3-5 pm

--- **NEXT WEEK ONLY:** Tues 3-5p & HW Due Tues Midnight

In Physics Helproom (G2B90)

- Enter building opposite Buffalo
- Down stairs to basement,
- G2B90 across corridor,
- Ask anyone if lost

We want to help you! Let us know if these times are totally incompatible with your schedule

*Homework too hard to do alone, but ok & learn when working together.*

*We will help interactions, coach, **NOT** give answers.*



## Clicker start up

Switch clicker code to BA

- Wait for me to get laptop connected up
- Hold down ON/OFF switch for 4 seconds
- At flashing blue light hit BA
- Answer question
- You are set for the rest of class
- Do not turn off clicker for rest of class or you will have to repeat above for each question

Remember, you can change your mind, only final answer recorded

## Special Opportunity



Interested in a guest-lecture from

**Nobel Laureate Carl Wieman?**

Founder of the PhET simulation program,  
and original (re)-designer of this course?

He might be willing to do a special guest 30  
min spot in a couple of weeks.

- a) Yes
- b) No

## Course Goals

1. To have an interesting class that covers physics.
2. To begin to see science in everyday life.
3. To understand that the universe is predictable rather than incomprehensible.
4. To see that science (particularly physics) is based on quantitative experiments.
5. To practice using logic, data, and analysis in order to solve problems.

Note: this is not an exercise in mathematics...

We will use math, but only as a tool for understanding ideas / the world --- basic mathematics...

## A math example

- You go into a store and can buy a tennis racket and balls for \$110. The clerk tells you that the racket costs \$100 more than the balls.
- How much do the tennis balls cost?

- How much do the tennis balls cost?
  - a) \$110
  - b) \$100
  - c) \$10
  - d) \$5
  - e) 0

## 2 ways to solve: both good!

*You go into a store and can buy a tennis racket and balls for \$110. The clerk tells you that the racket costs \$100 more than the balls.*

Mathy:

$$\text{balls} + \text{racket} = \$110$$

$$\text{racket} = \text{balls} + \$100$$

put second eq'n into first

$$\text{balls} + (\text{balls} + \$100) = \$110$$

$$2 \times \text{balls} = \$10$$

$$\text{balls} = \$5$$

## 2 ways to solve: both good!

Reasoning:

if I guess \$10 for balls

$$\text{racket} = \$100 + \text{balls} = \$100 + \$10 = \$110$$

$$\text{then balls} + \text{racket} = \$10 + \$110 = \$120!$$

try balls = \$0

$$\text{then balls \& racket} = \$100!$$

try balls = \$5

ahhhhh haaa!!!!

## What is Physics?

Lots of answers:

A study of matter, energy and interactions

A big part is how things move.

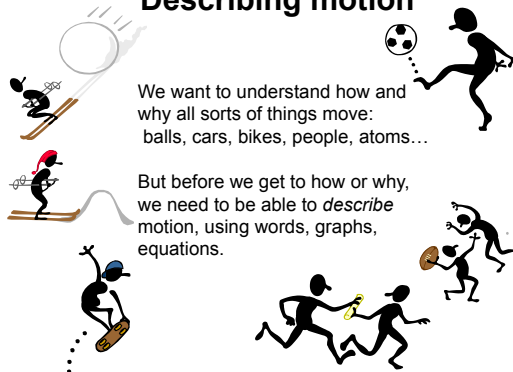
In this class:

- Objects (e.g., baseballs)
- Fluids (air, water)
- Heat
- Electricity (moving charges)
- Electromagnetic waves (radio)
- Light

How did you get to class today?


- a) Walked
- b) Rode a bike
- c) Took the bus
- d) Drove
- e) Zip line

## Describing motion



### You already know physics...

All we are doing is formalizing some of this:



Which video is of real-life:  
 a) Video #3  
 b) Video #5  
 c) they're both real, I saw them

[http://groups.physics.umn.edu/physed/People/Tom%20Koch/2\\_tracks/small\\_videos\\_website/formstandard/video1st\\_frameset.html](http://groups.physics.umn.edu/physed/People/Tom%20Koch/2_tracks/small_videos_website/formstandard/video1st_frameset.html)


What do you need to know to describe the motion of an object?

A) where it is  
 B) where it's going  
 C) both where it is and where it's going.  
 D) where its been

What do you need to know to describe the motion of an object?


A) where it is  
 B) where it's going  
 C) both where it is and where it's going.  
 D) where its been

Where it is : Position  
 Where it is going : Velocity



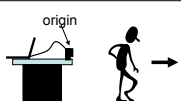
### Position

Unit: meters (abbreviation m)  
 Meter sticks; sonar  
 Symbol: Often represented by 'x'

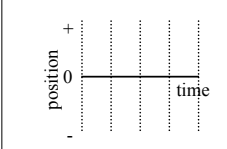


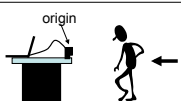
### Position versus time graphs

Sketch position versus time graphs for:

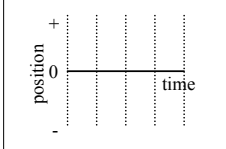


1. Person moving away from origin, in straight line at steady speed





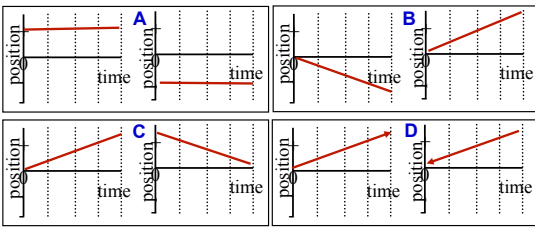
2. Person moving towards origin, in straight line at steady speed



### Position versus time graphs

Sketch position versus time graphs for person moving in straight line at steady speed:

- Away from origin
- Towards origin



**Position versus time graphs**

Sketch position versus time graphs for person moving in straight line at steady speed:

- Away from origin
- Towards origin

**Position versus time graphs**

Answer is c

- Person moving away from origin, in straight line at steady speed
- Person moving towards origin, in straight line at steady speed

**Position versus time graphs**

Sketch position versus time graphs for:

- Person moving away from origin to right, straight line, steady speed
- Person moving away from origin to left, straight line, steady speed

**Position versus time graphs**

Sketch position versus time graphs for person moving in straight line at steady speed:

- Away from origin to right
- Away from origin to left

**Position versus time graphs**

Sketch position versus time graphs for person moving in straight line at steady speed:

- Away from origin to right
- Away from origin to left

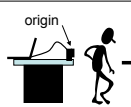
**Position versus time graphs**

Answer is b

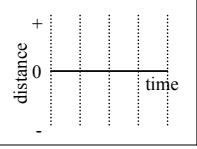
- Person moving away from origin, to right, straight line, steady speed
- Person moving away from origin, to left, straight line, steady speed

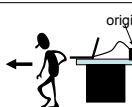
### Distance versus time graphs

Sketch **distance** versus time graphs for:

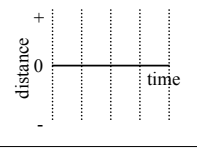


1. Person moving away from origin to right, straight line, steady speed





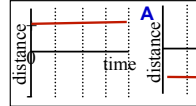
2. Person moving away from origin to left, straight line, steady speed



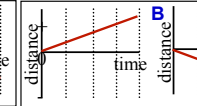
### Distance versus time graphs

Sketch **distance** versus time graphs for person moving in straight line at steady speed:

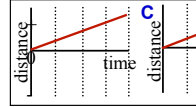
- Away from origin to right
- Away from origin to left



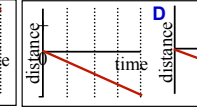
**A**



**B**



**C**

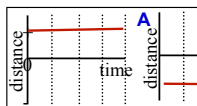


**D**

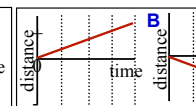
### Distance versus time graphs

Sketch **distance** versus time graphs for person moving in straight line at steady speed:

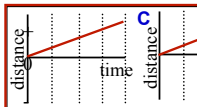
- Away from origin to right
- Away from origin to left



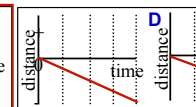
**A**



**B**



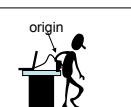
**C**



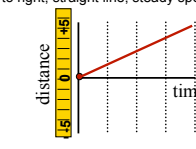
**D**

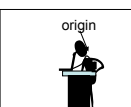
### Distance versus time graphs

Answer is c

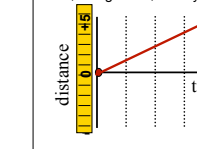


1. Person moving away from origin, to right, straight line, steady speed

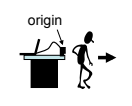
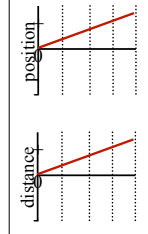


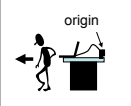
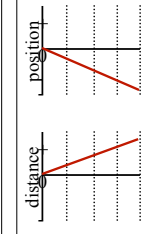


2. Person moving away from origin, to left, straight line, steady speed



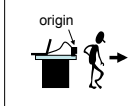
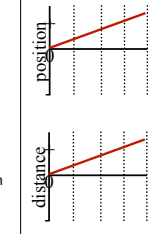
So.....what's the big difference between position and distance????

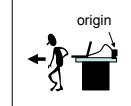
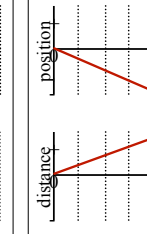



- No difference – 2 words for the same thing
- Position includes both distance AND direction
- Distance includes both position AND direction
- Position is just about a direction

So.....what's the big difference between position and distance????

- No difference – 2 words for the same thing
- Position includes both distance AND direction**
- Distance includes both position AND direction
- Position is just about a direction

## Scalars and vectors

- Distance is a **SCALAR** quantity
  - Fully described by one number e.g. 5m, 1mile etc
  - Just says how far you are from origin, but not exactly where
  - Always positive
- Position is a **VECTOR** quantity
  - Contains BOTH a number (distance) AND a direction
  - Says how far you are from origin and in what direction – precisely describes your location
  - Can be positive or negative (determined by direction)
  - Often represented by an arrow
    - Length represents magnitude of vector (distance)
    - Point of arrow give direction.
- IMPORTANT CONCEPT:** Many other **VECTOR** and **SCALAR** quantities to appear in this course!

## Speed and velocity

- Speed is a **scalar** quantity
  - Says how fast you are moving
  - Physics units m/s
  - Always positive

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

Labels: 'scalar' points to 'Distance travelled' and 'Time taken'.

## Speed and velocity

Velocity is a **vector** quantity

- Says how fast you are moving **and** in what direction
- Physics units m/s
- Can be positive or negative depending on direction
- Speed is the magnitude or size of the velocity
- Often represented by symbol 'v'

$$\text{Velocity (v)} = \frac{\text{Change in position } (\Delta x)}{\text{Time taken } (\Delta t)}$$

$$= \frac{\text{Final position } (x_f) - \text{Initial position } (x_i)}{\text{Time taken } (\Delta t)}$$

Labels: 'vector' points to 'v', 'x<sub>f</sub>', and 'x<sub>i</sub>'. 'vector' also points to the fraction bar.

Speed experiment: about how fast did the cart move? (pick the closest value)

- 100 m/s
- 10 m/s
- 1 m/s
- 0.1 m/s
- 0 m/s

Hint:

$$\text{speed} = \frac{\text{distance it traveled}}{\text{time it took}}$$

Speed experiment: about how fast did the cart move? (pick the closest value)

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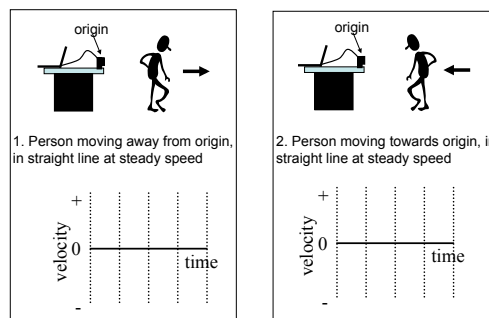
Hint:

$$\text{speed} = \frac{\text{distance it traveled}}{\text{time it took}}$$

What about **velocity**?

## Velocity versus time graphs

Sketch velocity versus time graphs for:



Velocity versus time graphs

Sketch velocity versus time graphs for person moving in straight line at steady speed:

- Away from origin
- Towards origin

Velocity versus time graphs

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Velocity versus time graphs

**Answer is a**  
 Magnitude of velocity vector is speed – constant in this case  
 Direction of velocity vector gives sign (positive or negative)

1. Person moving away from origin, in straight line at steady speed

2. Person moving towards origin, in straight line at steady speed

Speed and velocity question

- You are driving 60 miles per hour north.
- You are driving 60 miles per hour.

- both give your speed, can't tell your velocity.
2. gives speed, 1. gives velocity.
- both are giving your velocity.
- 2 gives velocity, 1. gives your speed.