

## 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, 1.3 (p.24-28)  
Reading quiz on Tuesday  
Homework 1 due Tues midnight  
Next up: x,v, a and forces

## Office Hours & Problem Solving Sessions

Thursdays 2-5pm  
Mondays 3-5 pm

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.*

## 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?

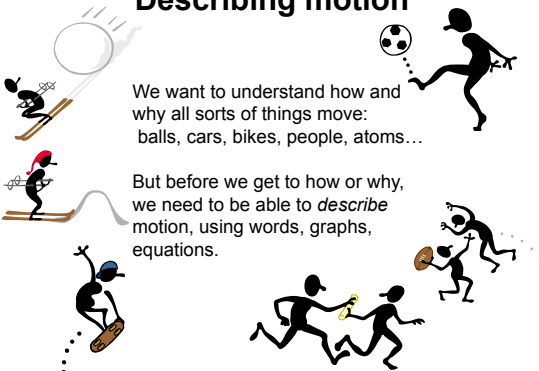
- How much do the tennis balls cost?

- a) \$110
- b) \$100
- c) \$10
- d) \$5
- e) 0

How did you get to class today?

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

## Describing motion



We want to understand how and why all sorts of things move: balls, cars, bikes, people, atoms...

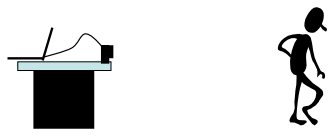
But before we get to how or why, we need to be able to *describe* motion, using words, graphs, equations.

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

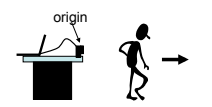
## Position

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

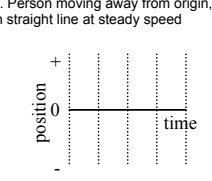


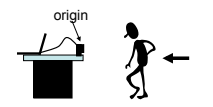
### Position versus time graphs

Sketch position versus time graphs for:

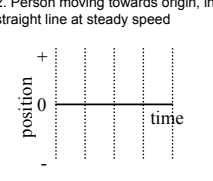


1. Person moving away from origin, in straight line at steady speed





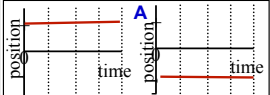
2. Person moving towards origin, in straight line at steady speed



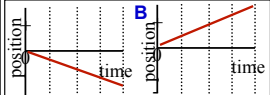
### Position versus time graphs

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

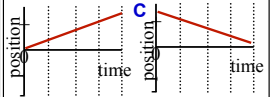
- Away from origin
- Towards origin



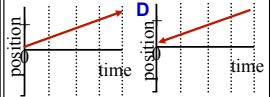
**A**



**B**



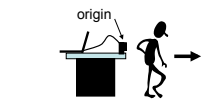
**C**



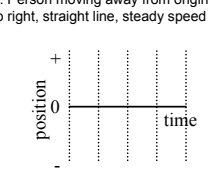
**D**

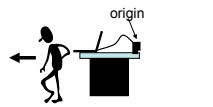
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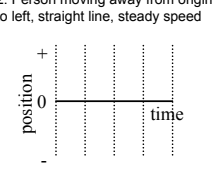


1. Person moving away from origin to right, straight line, steady speed





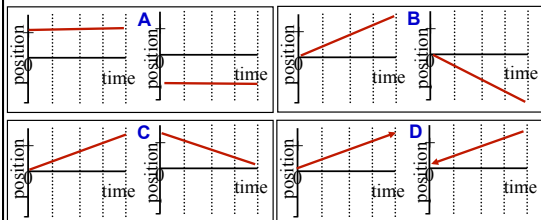
2. Person moving away from origin to left, straight line, steady speed



### Position versus time graphs

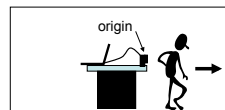
Sketch position versus time graphs for person moving in straight line at steady speed:

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

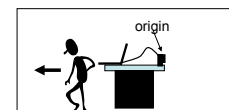
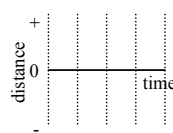


### Distance versus time graphs

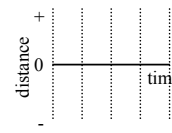
Sketch **distance** versus time graphs for:



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



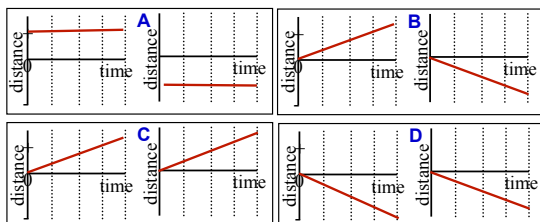
2. Person moving away from origin to left, straight line, steady speed



### 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



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' with arrows pointing to 'Speed' and 'Distance travelled'.

## 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'

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

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

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

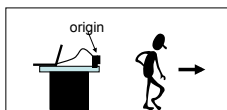
- 100 m/s
- 10 m/s
- 1 m/s
- 0.1 m/s
- 0 m/s

Hint:

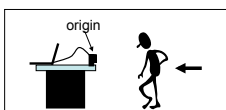
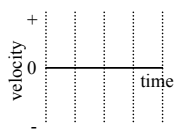
$$\text{speed} = \frac{\text{distance it traveled}}{\text{time it took}}$$

## Velocity versus time graphs

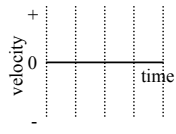
Sketch velocity versus time graphs for:



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



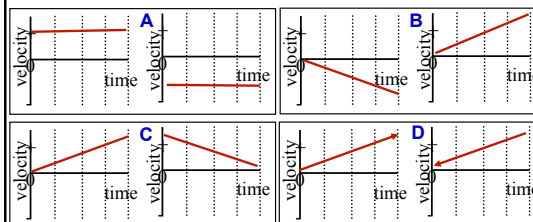
2. Person moving towards origin, in straight line at steady speed



## Velocity versus time graphs

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

- Away from origin
- Towards origin



## 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.

## Tricky speed and velocity question

I start in Boulder and drive 20 miles west to Nederland in 30 mins. When I get to Ned I go round the roundabout and head straight back to Boulder. Its downhill so I only take 20 mins for the return trip.

What is my average speed for whole trip?

- 48 mph
- 0 mph
- 40 mph
- 60 mph
- Something else

Hint: Average Speed = Total distance covered/Total time taken

### Tricky speed and velocity question

I start in Boulder and drive 20 miles west to Nederland in 30 mins.  
 When I get to Ned I go round the roundabout and head straight back to Boulder. Its downhill so I only take 20 mins for the return trip.

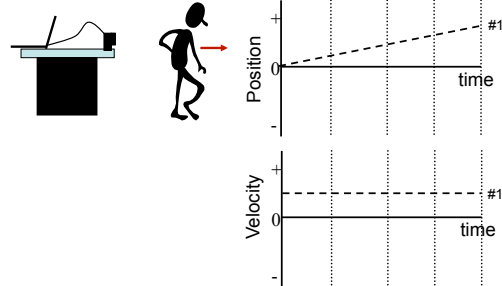
What is my average velocity for whole trip?

- a. 48 mph west
- b. 0 mph
- c. 48 mph east
- d. 60 mph west
- e. Something else

Hint: Average  $v = \Delta x / \Delta t$

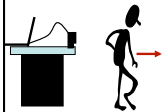
### Position and velocity graphs

Person #1 moves away from the origin as shown  
 Sketch **position vs. time** and **velocity vs. time** graphs for person #2 moving **away** from origin (motion detector) at **twice** the velocity of person #1



### Position and velocity graphs

Sketch **position vs. time** and **velocity vs. time** graphs for person #2 moving **away** from origin (motion detector) at **twice** velocity of person #1.



Pasco demo

