

01-05

Linear Motion  
Vectors & Scalars

# What is motion?

## *Frames of reference*

- Ever been in a car that moved backwards and thought you were moving forward?
- If the universe had only one object in it, could it move?
- I can run 7 m/s and Usain Bolt can run 11 m/s.
  - what does this statement mean?
  - How long would it take Usain to catch me with a 20 m head start?

# Linear motion definitions

**Linear motion** – Motion constrained to a single dimension

- rolling a ball across a table, dropping a ball (NOT throwing a ball)

**Vector** – possessing BOTH a magnitude and direction

**Scalar** – a directionless magnitude; something that can be measured (as with a scale);

# Clicker question

- You have 45 seconds:
- Which of the following is a GOOD example of linear motion?
  - a) Kicking a field goal
  - b) Throwing a baseball from center field
  - c) Dropping a tennis ball from a tall building
  - d) Hitting a tennis serve
  - e) Trick question: None of these are good!

# Linear motion definitions

**Position (x)** – A location in space

**Distance ( $\Delta x$ )** – how far you went

**Displacement ( $\Delta x$ )** – where you are compared to where you started

Big example: running around a  $\frac{1}{4}$  mile track 4 times

# Linear motion definitions

- Rate of anything means divide by time

Speed (v) – rate of distance change

Velocity (v) – rate of displacement change

- Circular track example: average velocity versus “instantaneous velocity”

Acceleration (a) – rate of velocity change

Magnitude of acceleration (a) –rate of speed change

# Clicker question

- Red is so excited for his trip to Champaign. He leaves home and drives 100 miles, then drives back. It takes him 4 hours. What was his average velocity?
  - a) 25 mph
  - b) 50 mph
  - c) 37.5 mph
  - d) 65 mph
  - e) Trick question: None of these are correct!

# Clicker question

- Red is so excited for his trip to Champaign. He leaves home and drives 100 miles due south. It takes him 2 hours. What was his average velocity?
  - a) 25 mph
  - b) 50 mph
  - c) 0 mph
  - d) 12.5 mph
  - e) Trick question: None of these are correct!



# Linear motion definitions

**Instantaneous velocity ( $v$ )** – Speedometer reading plus direction

**Average velocity ( $v$ )** = displacement/time the passed

**Independent variable** – variable you can directly change (value for X axis)

**Dependent variable** – variable you measure, but don't directly control the result

# Linear motion variables used

- $\Delta$  – change in any quantity
- $X$  – position
- $V$  – speed or velocity
- $t$  or  $\Delta t$  – time that has passed
- $\Delta x$  – distance or displacement
- $\Delta v$  – change in speed or velocity
- $a$  – acceleration or magnitude of accel.
- $f$  - subscript for final value ( $X_f$ ,  $v_f$ , etc.)
- $i$  – subscript for initial value ( $X_i$ ,  $v_i$ , etc.)

# Clicker question

*(easy math, but lots to read....1 minute)*

- Brad tells Angelina he's taking the Rolls out for a quick caviar snack. He drives 10 miles due east, picks up the caviar and drives back. It takes him 2 hours because LA traffic is equally bad both ways. What was the average velocity of the caviar?

- a) 0 mph
- b) 20 mph east
- c) 10 mph east
- d) 10 mph west
- e) Trick question: None of these are correct!

More non-clicker phun: Who had the highest average speed (or same): Brad, Angelina, the caviar?