HINT: TRY "CHANGING UP " YOUR LOCATION

Put WS1 on your table, then in pairs, riddle me this -

"How do you throw a baseball faster than 105 mph?"

How Aroldis Chapman Threw The Fastest Pitch Ever

08/28/2016 09:04 pm ET | **Updated** May 23, 2017

BY SD DIRK ON FLICKR (ORIGINALLY POSTED TO FLICKR AS "AROLDIS CHAPMAN") [CC BY 2.0], VIA WIKIMEDIA COMMONS

Aroldis Chapman Delivers a Fastball for the Cincinnati Reds in 2010

← 105 mph!

Goals for Today

- Introduce relativity
- Review acceleration
- Graph position, speed, and velocity
- “Text lol” activity

Relativity 101

- All motion is relative!
  - This means when we describe motion, we are moving relative to something
  - The train is leaving the station, or is the station leaving the train?

What does it even mean to be motionless?

- You might be "motionless" in your seat right now, but…
  - The Earth rotates at **1500 km/hr**
  - …and revolves around the Sun at **107,000 km/hr**
  - …which revolves around a the supermassive black hole at the center of the Milky Way Galaxy at **792,000 km/hr**
  - …which is moving outward from Big Bang location at **2.1 million km/hr!**
  - Could the universe itself be moving?

Please please please do NOT try this…

- If you're sitting on an Amtrak train going ~100 mph, and you throw a 10 mph slow-pitch softball to your classmate sitting a few rows up, how fast would the softball be going relative to the Earth?
  - It's effectively going **110 mph!**

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It’s all relative

- You would be very lost if I told you ”Disneyland is 40 km away, meet me there” unless I specify it is 40 km away *from where* and *in what direction*.

Review from yesterday

- What is the difference between distance and displacement?
- What is a scalar? What is a vector?
- Fill in the blank: “Acceleration is a change in _____ or _____”

Review: Speed vs. Velocity

- Both refer to how fast something is moving
- Both measure the **rate of change of position**
- $average\ speed = \frac{distance}{time}$ $average\ velocity = \frac{displacement}{time}$

$$v = \frac{\Delta x}{\Delta t}$$

Speed vs. velocity

- If Bob travels 50 m in 50 sec in one direction, his speed and velocity are both 1 m/s
- If Bob travels 25 m N and then goes 25 m E, his speed will still be 1 m/s, but what is his velocity?

Acceleration

- Going in a straight line at the same speed – **constant velocity**
- But if we change our speed or our direction then we have a **changing velocity**.
- Changing our **speed** or **direction** is **Acceleration**

Acceleration

- **Rate of change of velocity**
- How quickly velocity changes

- $\boldsymbol{a = \frac{\Delta v}{\Delta t}}$ $\qquad \boldsymbol{a} = (v_f - v_i)/(t_f - t_i)$

- If acceleration is a **change in velocity** and velocity is defined by a **speed and a direction**, then acceleration is a change in either **speed** or **direction**

Example #1

- The California Screamin' ride at California Adventure accelerates from 0 to 89 km/hr in 4.0 seconds at launch. What is its acceleration in m/s^2?
  - *Ans = 6.2 m/s^2*

Example #2

- You're driving down the 2 Freeway at 26 m/s when you see traffic up ahead, so you brake to 12 m/s in 7.0 seconds. What is your acceleration?
  - *Ans* = *-2.0* m/s^2
- What does the negative sign mean?

Representations

- We've done numerical & conceptual problems related to distance/displacement, speed/velocity, and acceleration
- Let's graph!

Position vs. time graphs

- Draw a position vs. time graph for a car moving at a constant 5 m/s.

Velocity vs. time graphs

- What does the velocity vs. time graph look like for a car moving at a constant 5 m/s?

Position vs. Time Graphs

time (t, s)	Position (x, m/s)
0	0
1	1
2	2
3	2
4	6
5	0

- A cheetah runs to the right 2 meters in 2 seconds, then stops for one second, then runs 4 meters to the right in one second, then abruptly runs back to where it started in one second.
- What would this look like in graph form?
- What is the slope of the graph between t = 0 and t = 2s?

Velocity vs. time graphs

- What does the **velocity vs. time graph** look like in this example?
- What is the area under the v vs. t curve?
  - Displacement!

Your turn!

time (t, s)	Position (x, m)
0	0
1	5
2	15
3	15
4	25
5	30

- In pairs
  - Draw a position vs. time graph for the table
  - Between which two time points was speed the highest?
  - Make up a story where this graph is feasible

Let’s ask a question

- How far could your car go in the time it takes to text “lol”?

Let’s do an experiment!

- In groups of 4, measure the amount of time it takes each person in the group to text ”lol” and hit “send”
  - Each person will text, and while you are texting, the other 3 group members will be timing the text with their stopwatches.
  - Average the 3 times to get the time for “name 1”, then average all four of you to get your ”group average”.
  - Then tell me your group average

Other kinds of position and velocity vs. time graphs

Breaking problems into manageable sections

- A tortoise and a hare are in a road race to defend the honor of their breed. The tortoise crawls the entire 1000. m distance at a speed of 0.200 m/s while the rabbit runs the first 200.0 m at 2.000 m/s. The rabbit then stops to take a nap for 1.300 hr and awakens to finish the last 800.0 m with an average speed of 3.000 m/s.
  - Who wins the race and by how much time?
  - Make a position vs. time graph for this situation.

Put your WS1 on your table, and

Talk to each other and figure out how you are seated!

IT'S NOT BY LAST NAME.