Housekeeping

- Vocab quiz: Do ≠ Due
- Exam versus Vocab Quiz

Did you read chapter 7?

a) Yes
b) No
c) We have a book?

Famous quotes from Einstein

- “Everything should be made as simple as possible, but not simpler.”

Special Relativity Postulates

1. The laws of nature are the same for all observers who are in uniform motion.
2. The speed of light in empty space is the same for all observers regardless of their motion or the motion of the source of light.

Symmetry

- Nature is symmetric for a given transformation (or change) if there is no experiment one could perform that would allow one to tell whether such a transformation had been made.
- Examples:
  - position
  - time
  - uniform motion

1st postulate (Special Principle of Relativity)

- The laws of nature are the same for observers who are in uniform motion.
- Natural laws do not change with uniform motion.
- There is no experiment that can distinguish between uniform motion and rest.

Uniform motion is in the eye of the beholder
Reference Frame
- Since motion is all relative, you have to decide what you are going to use as a "reference" for your measurements.
- An object or set of objects used to provide the basis for your measurements is a reference frame
  - Your body
  - The things inside your car
  - The room you’re in

Discussion Question
- Is there an absolute reference frame (one that you know is not moving)?
- What physical principles can be used to support your answer?
- What kinds of experiments could you do to check your answer?

Circle or straight line?
- A small part of a circle looks a lot like a straight line.
- Since the Earth’s motion is nearly uniform, the laws of nature can be determined using experiments done on the Earth.

Effects From Earth’s Motion
- Foucault pendulum
- Stellar parallax
- Atmospheric flow patterns
- Ocean currents
- River flow
- Flushing toilets/draining sinks

Second postulate
- The speed of light is constant for all observers in uniform motion.
  - This is where the weird stuff starts.

Speed Limit
1. If the speed of light is the same for all observers, you can’t ever catch up with light, let alone pass it, so the speed of light is an absolute speed limit.
So..If you keep pushing on something, but can’t increase speed, what happens to Newton’s 2nd law?
Playing Catch on a Plane
- If you and a friend are across the aisle from each other on an airplane and decide to play catch:
  - What will you see?
  - What would someone on the ground see?
  - How fast is the ball moving?

Playing catch on a plane
- You see the ball go straight back and forth (I’m only worrying about horizontal motion here)
- Someone on the ground sees the ball moving forward at 500mph while it travels back and forth. The distance traveled is farther because the speed of the ball is greater. (~20mph back and forth + 500mph forward)

Playing catch with light
- If you do the same thing with a beam of light rather than a ball, the light beam’s speed doesn’t depend on how fast the plane is going.
- If the light beam’s speed stays the same, for both an observer on the ground and in the plane, distance and time must be different for the two.

Playing LIGHT catch on a plane
- So what happens to the time it takes for the light to cross the aisle?
  - A) The time is longer for the person on the ground
  - B) The time is longer for the person on the plane
  - C) Time doesn’t change

Time Dilation
- A clock moving with respect to you will always run slow.
- What ever change is making the clock tick will take a longer time to happen in a frame of reference moving with respect to your frame.

So What If?
- Suppose you send two friends, Albert and Henry off in opposite directions at the same very high speed. What will you see?
  - What will Albert see?
  - What will Henry see?
Light Clock

- A moving clock runs slow.
  - Traveling a longer distance at the same speed takes more time.

Two moving Light Clocks

- Two clocks moving in the same speed in opposite directions will tick simultaneously because they slow down by the same amount.

What does Henry see?

- Henry doesn’t agree that his clock ticks simultaneously with Albert’s.

Simultaneous Events

- Operational Definition – two events that occur at the same distance and are seen at the same time happen simultaneously.

Famous quotes from Einstein

- People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion.

Simultaneity

- Two observers in different frames of reference disagree on the simultaneity of events
- The “front” event will happen first according to a “moving” observer.
- What does this do to length?
In order to measure the length of a moving object, you need to be careful to measure the position of the front and back simultaneously. If you measure the position of the ‘front’ first and the ‘back’ second:

A. The distance you measure will be too long
B. The distance you measure will be too short
C. The distance you measure will be just right

Calvin & Hobbs

Twin Paradox

- Video
- Since everyone ended up back on Earth, everyone agrees that the measurements made from Earth were correct.
- Reality depends on your reference frame.

Where’s the proof?

- GPS
- Muons
- Hafele - Keating

Physics at the Farm:
Discovery of the Muon.