

## Relativity Problems I

1. What are the two Postulates of Special Relativity?

• See handout

2. What are *inertial reference frames*?

Non-accelerating reference frames → they differ by constant velocities

3. You drive by your friend in a car traveling at 20 m/s.

- a. If you were to throw a tennis ball with a speed of 10 m/s (according to you) in the direction that you are already traveling, what is the velocity of the tennis ball according to your friend?

$$10 + 20 = 30 \text{ m/s}$$

(This is the velocity addition we did back in unit 2.)

- b. You turn on your headlights, and the beams of light travel away from you at  $c$  (according to you.) What is the velocity of the beam of light according to your friend?

Also  $c$ ! Everyone measures light to travel @  $c$ !

4. You are watching two spaceships with velocities (relative to you) as shown. You then see ship A fire a laser (which is a beam of light) at ship B.



- a. How fast does each ship think the laser pulse is traveling?

$c$

- b. How fast does ship A think ship B is traveling? (You do not need a number answer, but you can give bounds of the correct answer.)

Bigger than  $0.8c$  but less than  $c$  (still slower than the laser)

5. If two events in two different places happen at the same time according to your friend, what must be true for you to also conclude that the two events were simultaneous?

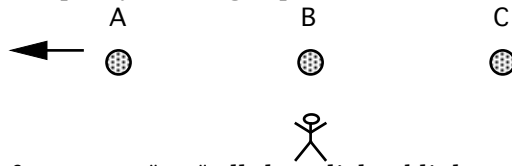
You have to be in the same reference frame as your friend. So you are not moving w/ respect to your friend

6. If two events in the same place happen at the same time according to your friend, what must be true for you to also conclude that the two events were simultaneous?

Nothing special. If the simultaneous events are @ the same location, then every reference frame will see the events as simultaneous.

## Relativity Problems I

7. You watch 3 lights travel past you at high speed, as shown in the diagram below.



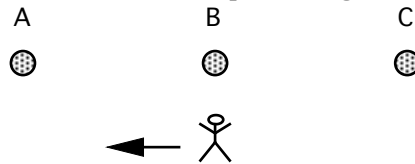
a. In your reference frame, you "see" all three lights blink at the same time. In what order do they blink in the reference frame of the lights?

A B C

b. If the lights blinked simultaneously in their reference frame, in what order would you conclude the lights blink?

C B A

8. You travel past three lights at close to the speed of light, as shown in the diagram below.



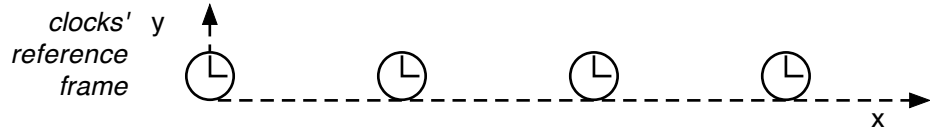
a. In your reference frame, you "see" all three lights blink at the same time. In what order do they blink in the reference frame of the lights?

C B A

b. If the lights blinked simultaneously in their reference frame, in what order would you conclude the lights blink?

A B C

9. Imagine you travel by a series of clocks as shown below. The clocks are all synchronized in their reference frame. What could the clocks look like in your reference frame?



← and the clocks get progressively earlier as the more left they are  
 ↑ This clock is ahead

Answers: 3. a) 30 m/s b) still c 4. a) c (the speed of light) b)  $0.8c < v < c$  5) you must be at rest compared to your friend 6) nothing! every reference frame will see the events as simultaneous.  
 7. a) ABC b) CBA 8. a) CBA b) ABC