Definitions

Event

- Physical _____ in a certain _____ at a certain _____.

Reference Frame

- Coordinate _____ (x, y, z) and _____

Inertial Reference Frame

- Reference frame where _____ Law of _____ is _____
- No _____
- No _____

Einstein's Postulates

The Relativity Postulate

- The laws of _____ are the _____ in _____ inertial reference frame.

The Speed of Light Postulate

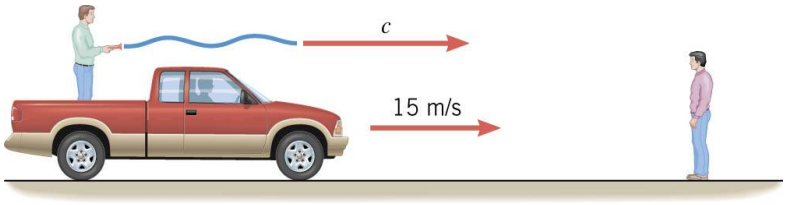
- The speed of light in a _____, measured in _____ inertial reference frame, _____ has the _____ value of c, no matter how fast the _____ of light and the _____ are moving _____ to each other.

Consequences of Relativity Postulate

- _____ inertial reference frame is as _____ as any other.
- You _____ say any reference frame is _____ at _____.
- There is no _____ velocity or rest, only velocity _____ to the _____ frame.

Explanation of Speed of Light Postulate

- The observer on the truck _____ speed of _____ to be _____ since he is _____ the light.
- Logic says the observer on the _____ measures the speed of _____ to be _____, but he doesn't.

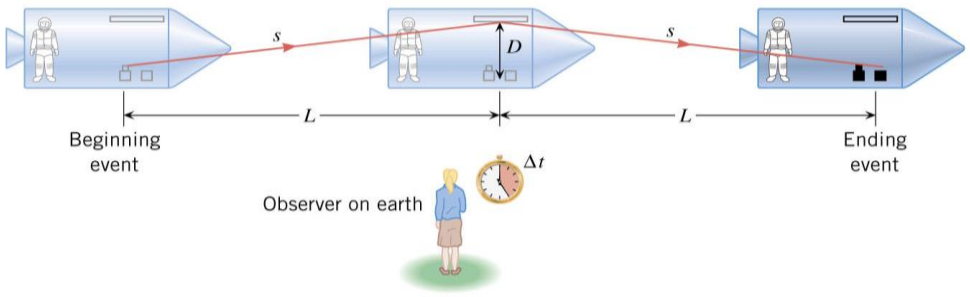


- The observer on the _____ measures speed of light to be _____ also.
- Verified by _____ many times.

Simultaneous

- Just because two events _____ simultaneous to _____ observer does not mean _____ observes see the _____ simultaneously

Time Dilation



- Astronaut measures _____ by aiming a _____ at a mirror. The light _____ from the mirror and hits a _____.
- The person on _____ says that the time of the event must be _____ because she sees the laser beam go _____.

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

- Where Δt_0 = proper time measured in a reference frame at rest relative to the event, Δt = dilated time measured in a reference frame moving relative to the event, v = relative speed between the observers, c = speed of light in a vacuum

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Let's say the USS Enterprise's 1/3 impulse speed is one-quarter the speed of light. If Spock, in the ship, says the planet will blow up in 10 minutes, how long does the away team have to beam up?

Picard is on Rigel 7 and needs to go to Earth 776.6 light-years away, but the Enterprise's warp drive is broken. If full impulse is ¾ the speed of light, how long will a Rigelian think it will take the Enterprise to get to Earth?

How long will the Enterprise's crew think it will take?

Homework

1. Which of Einstein's postulates of special relativity includes a concept that does not fit with the ideas of classical physics? Explain.
2. Is Earth an inertial frame of reference? Is the Sun? Justify your response.
3. When you are flying in a commercial jet, it may appear to you that the airplane is stationary and the Earth is moving beneath you. Is this point of view valid? Discuss briefly.
4. Does motion affect the rate of a clock as measured by an observer moving with it? Does motion affect how an observer moving relative to a clock measures its rate?
5. To whom does the elapsed time for a process seem to be longer, an observer moving relative to the process or an observer moving with the process? Which observer measures proper time?
6. (a) What is γ if v = 0.100c? (b) If v = 0.900c? (OpenStax 28.2) **1.00504, 2.29**
7. Particles called π-mesons are produced by accelerator beams. If these particles travel at 2.70×10^8 m/s and live 2.60×10^{-8} s when at rest relative to an observer, how long do they live as viewed in the laboratory? (OpenStax 28.3) $\mathbf{5.96 \times 10^{-8}\ s}$
8. Suppose a particle called a kaon is created by cosmic radiation striking the atmosphere. It moves by you at 0.980c, and it lives 1.24×10^{-8} s when at rest relative to an observer. How long does it live as you observe it? (OpenStax 28.4) $\mathbf{6.23 \times 10^{-8}\ s}$
9. A neutral π-meson is a particle that can be created by accelerator beams. If one such particle lives 1.40×10^{-16} s as measured in the laboratory, and 0.840×10^{-16} s when at rest relative to an observer, what is its velocity relative to the laboratory? (OpenStax 28.5) **0.800c**
10. If relativistic effects are to be less than 1%, then γ must be less than 1.01. At what relative velocity is γ = 1.01? (OpenStax 28.7) **0.140c**
11. (a) At what relative velocity is γ = 1.50? (b) At what relative velocity is γ = 100? (OpenStax 28.9) **0.745c, 0.99995c**