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 ____________ observer sees 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 \( \Delta t_0 \) = proper time measured in a reference frame at rest relative to the event, \( \Delta t \) = 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

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To be used with OpenStax College Physics
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.


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 \( 2.70 \times 10^8 \) m/s and live \( 2.60 \times 10^{-8} \) s when at rest relative to an observer, how long do they live as viewed in the laboratory? (OpenStax 28.3) **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 \( 1.24 \times 10^{-8} \) s when at rest relative to an observer. How long does it live as you observe it? (OpenStax 28.4) **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 \( 1.40 \times 10^{-16} \) s as measured in the laboratory, and \( 0.840 \times 10^{-16} \) 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**