Practice

Understanding Concepts

1. Are airline pilots' watches running slow in comparison with clocks on the ground? Why or why not?
2. A beam of unknown elementary particles travels at a speed of 2.0×10^8 m/s. Their average lifetime in the beam is measured to be 1.6×10^{-8} s. Calculate their average lifetime when at rest.
3. A Vulcan spacecraft has a speed of $0.600c$ with respect to Earth. The Vulcans determine 32.0 h to be the time interval between two events on Earth. What value would they determine for this time interval if their ship had a speed of $0.940c$ with respect to Earth?
4. The K^+ meson, a subatomic particle, has an average rest lifetime of 1.0×10^{-8} s. If the particle travels through the laboratory at 2.6×10^8 m/s, by how much has its lifetime, relative to the laboratory, increased?

Answers

2. 1.2×10^{-8} s
3. 75.0 h
4. 2×

Answers

5. 115 m
6. 6.0 ly
7. 3.95×10^2 m
8. (a) 37.7 ly
   (b) 113 a
9. $0.89c$

LEARNING TIP

When to Round Off

When working with calculations involving relativistic quantities, don't round off until the final result is achieved; otherwise, your results could be erroneous.

Practice

Understanding Concepts

5. A spaceship passes you at the speed of $0.90c$. You measure its length to be 50.0 m. What is its length when at rest?
6. You are a space traveller, moving at $0.60c$ with respect to Earth, on your way to a star that is stationary relative to Earth. You measure the length of your trajectory to be 8.0 light years (ly). Your friend makes the same journey at $0.80c$ with respect to Earth. What does your friend measure the length of the trajectory to be?
7. A spacecraft travels along a space station platform at $0.65c$ relative to the platform. An astronaut on the spacecraft determines the platform to be 3.00×10^2 m long. What is the length of the platform as measured by an observer on the platform?
8. A star is measured to be 40.0 ly from Earth, in the inertial frame in which both star and Earth are at rest.
   (a) What would you determine this distance to be if you travelled to the star in a spaceship moving at 1.00×10^8 m/s relative to Earth?
   (b) How long would you determine the journey to take?
9. The proper length of one spaceship is twice the proper length of another. You, an observer in an inertial frame on Earth, find the two spaceships, travelling at constant speed in the same direction, to have the same length. The slower spaceship is moving with a speed of $0.40c$ relative to Earth. Determine the speed of the faster spaceship relative to Earth.