Physics 14-02 Length Contraction *Name: _____*

Length Contraction

- Since the _____ moving _____ the event measures a different _____ than the observer _____ moving with the event, are the _____ different?
  - $x = vt$
  - Both _____ agree on _____
  - t is different by $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$
  - So x must be different by $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ also
- The _____ measured by a person at _____ with the event is _____ than that measured by person at _____ with respect to the _____.

$$L = L_0\sqrt{1-\frac{v^2}{c^2}} = \frac{L_0}{\gamma}$$

  - Where L_0 = proper length (Length between 2 points as measured by person at rest with the points.)
- Length only contracts along the direction of _____, the others _____ the _____

When the Starship Enterprise travels at impulse (v = 0.7c), a ground based observer measures the ship as 707 ft long. How long does the crew measure the ship?

Practice Work

1. To whom does an object seem greater in length, an observer moving with the object or an observer moving relative to the object? Which observer measures the object's proper length?
2. Relativistic effects such as time dilation and length contraction are present for cars and airplanes. Why do these effects seem strange to us?
3. Suppose an astronaut is moving relative to the Earth at a significant fraction of the speed of light. (a) Does he observe the rate of his clocks to have slowed? (b) What change in the rate of Earth-bound clocks does he see? (c) Does his ship seem to him to shorten? (d) What about the distance between stars that lie on lines parallel to his motion? (e) Do he and an Earth-bound observer agree on his velocity relative to the Earth?
4. A spaceship, 200 m long as seen on board, moves by the Earth at 0.970c. What is its length as measured by an Earth-bound observer? (OpenStax 28.12) **48.6 m**
5. How fast would a 6.0 m-long sports car have to be going past you in order for it to appear only 5.5 m long? (OpenStax 28.13) **0.400c**
6. (a) How long does it take the astronaut in to travel 4.30 ly at 0.99944c (as measured by the Earthbound observer)? (b) How long does it take according to the astronaut? (c) Verify that these two times are related through time dilation with γ=30.00 as given. (OpenStax 28.16) **4.303 y, 0.1434 y, 30.0**
7. (a) How fast would an athlete need to be running for a 100-m race to look 100 yd long? (b) Is the answer consistent with the fact that relativistic effects are difficult to observe in ordinary circumstances? Explain. (OpenStax 28.17) **0.405c, yes**
8. (a) Find the value of γ for the following situation. An astronaut measures the length of her spaceship to be 25.0 m, while an Earth-bound observer measures it to be 100 m. (b) What is unreasonable about this result? (c) Which assumptions are unreasonable or inconsistent? (OpenStax 28.18) **0.250, γ must be ≥ 1, The earthbound observer must measure a shorter length, so it is unreasonable to assume a longer length.**