PHY 151 Practice Problem Set 2

Question 1

(a) How fast would you have to go to reach a star 240 light years away in an 85 year human lifetime?

(b) Two spaceships are racing. The slower one passes Earth at $0.70c$, and the faster one moves at $0.40c$ relative to the slower one. What is the speed of the faster ship realtive to Earth?

Question 2

A spaceship travels at $0.80c$ from Earth to a star 10 light years distant, as measured in the Earth-star reference frame. Let event A be the ship's departure from Earth and event B its arrival at the star. (a) Find the distance and time between the two events in the Earth-star reference frame. (b) Repeat for the ship's frame. (*Hint*: The distance in the ship's frame is the distance an observer has to move *with respect to that frame* to be at both events – not the same as the Lorentz-contracted distance between Earth and the star.) (c) Compute the square of the spacetime interval in both frames to show explicitly that it is invariant.

Question 3

Derive length contraction from Lorentz transformation.
(*Hint*: Suppose that frame S' moves at a speed of v with respect to frame S in the x-direction. An event takes place at (x, t) and (x', t') in S and S' respectively. The coordinates are related by

$$x' = \gamma(x - vt),$$
$$t' = \gamma(t - vx/c^2),$$

where $\gamma = 1/\sqrt{1 - v^2/c^2}$.)