Homework #2

1. Spaceship 1 passes spaceship 2 with a relative speed v. An observer in spaceship 1 measures a time interval Δt for spaceship 2 to pass by. Find the length of spaceship 2 as measured in its own rest frame, *i.e.,* find the proper length of spaceship 2 in terms of Δt.

2. A spaceship leaves earth destined for a neighboring star that is 4 light years away. The ship rapidly accelerates to s speed $v = 0.8c$ and then coasts.

a) How long will the trip take for an observer in the ship?

b) What will the shipboard observer measure for the distance covered during the trip?

3. Consider the addition of velocities as shown in Eqs.(2.19)-(2.21). Find the x and y components of the velocity in the frame S of a light ray that has speed c along the y' axis of frame S' where S and S' are the usual frames we have been considering with S' moving with speed v with respect to S along the common $x - x'$ axes. Show that the light ray has speed c in the frame S.

4. Consider a particle which is produced at $x = 0$ with a speed $v = 0.95c$ in the lab frame. The particle lives for a time $t = 2.2 \times 10^{-6}$ sec as measured in its rest frame before decaying.

a) How long does the particle live in the lab frame?

b) How far does the particle travel in the lab frame?

c) What is the distance between the production and decay locations in the lab as measured by someone in the particle rest frame?

d) Show that observers in either frame will determine the relative speed of the two frames to be $0.95c$.

(5.) An observer measures the velocity of two electrons and finds that one has a speed $c/4$ along the x direction and the other has a speed $c/4$ in the y direction. Find the speed of the second electron as measured in the rest frame of the first electron.