Physics 111: Homework #9
Due Friday (in precept)

1. The first postulate of relativity states that the laws of physics are the same in all *inertial reference frames*. Which of the following is an inertial reference frame:

   (a) A Physics 111 student sits in a chair at rest in the lecture hall.
   (b) A Physics 111 student sits in a chair moving at constant velocity in the lecture hall.
   (c) A Physics 111 student sits in a chair which is accelerated with respect to the lecture hall.
   (d) A Metroliner travels at 125 mi/hr down a straight track to New York City.
   (e) A plane landing at Newark airport.
   (f) A child on a merry-go-round traveling at a fixed speed.

2. The Large Magellanic Cloud is a small galaxy in orbit around our own Milky Way. It is about $1.7 \times 10^5$ ly away Suppose you board a rocket and travel at speed $v = 0.99995c$ towards the Large Magellanic Cloud.

   (a) According to observers on Earth, how long will the trip take.
   (b) According to you and your compatriots on the rocket, how far do you travel?
   (c) According to you and your compatriots, how long does the trip take?

3. A 26 m rod (as measured when it is at rest) moves at a velocity near the speed of light past a 15 m window. The value of $\gamma$ is $13/5$. At time $t = 0$ according to his watch, the center of the rod passes John, he reaches out with his left and right hands, grabs both ends of the rod simultaneously, and attempts to pull it through the window. (The right hand grabs the front end of the rod and left hand the rear end.)

   (a) How long is the rod according to John?
(b) How long is the window according to an observer moving along with the rod?

(c) How far apart are John’s hand’s when he grabs the rod according to John?

(d) How far apart are John’s hand’s when he grabs the rod according to an observer moving with the rod?

(e) What is the time interval between the grabs of both ends according to John?

(f) Compute the proper distance \(\sqrt{(\Delta x)^2 - (c\Delta t)^2)}\) between the grabs at both ends according to John.

(g) What is the proper distance computed by an observer moving along with the rod.

(h) Is the interval between grabs a space-like or time-like?

(i) According to the observer moving along with the rod, John cheats. He does not grab both ends at the same time. Which hand is seen to grab first?

(j) What is the time interval between grabs according to an observer moving with the rod? (You can use the fact that the rod is 26 m to the observer moving along with the rod and you know the proper distance.)

(k) According to John, there is no problem simultaneously grabbing both ends of the rod and taking it through his window. How does the observer moving along with the rod explain what happens?