PHYSICS 5I
Homework 1
Due in class, Wednesday October 14

1. An atomic clock is at the north pole (where it is at rest). Another is at the equator, where it moves due to the rotation of the earth. How far will they be out of synchronization after 2 years? 
   Note: Just include effects of special relativity.

2. A future travel magazine advertizes a trip to the nearest star, Proxima Centauri, claiming that journey there takes just one week.

   (a) How fast must the rocket travel for this to be possible? (Express your answer as a fraction of c).
   Note: Proxima Centauri is at a distance of 4.3 light years.

   (b) The advertized time of one week is, of course from the point of view of the traveler. How much time would be taken from the point of view of an observer who stays on earth?

3. In an American movie, outlaws escape in their getaway car at a speed \( \frac{3}{4}c \). The cop is moving in a car at speed \( \frac{1}{2}c \), and fires a gun. The speed of the bullet (relative to the car) is \( \frac{1}{3}c \). Does the bullet reach its target according to (a) Galileo, and (b) Einstein?

4. When it is stationary, the half-life of a species of elementary particle is \( t_0 \). This means that if there are \( N \) of these particles at time \( t = 0 \) then there are half as many, \( N/2 \), at time \( t = t_0 \).

   We observe a beam moving with speed \( v \), and find that the number has decreased by a factor of two when it has traveled a distance \( x = 2ct_0 \). Determine \( v \), expressing your answer as a fraction of \( c \).