Problem Set #3

Due Friday, March 14 by 5pm to Dickinson 104

1. Taylor & Wheeler, 2nd Edition: Problem L-4
2. The frames S and S' are in the standard configuration, with relative velocity 0.8 in the x direction.
    a. What are the coordinates (x_1, y_1, z_1, t_1) in S of an event that occurs on the x' axis with x_1'=1500m, t_1'=5 μs?
    b. Answer the same for a second event on the x' axis with x_2'=-1500m, t_2'=10 μs.
    c. What are the time intervals (Δt and Δt') between the two events, as measured in S and S'?
    d. Take a moment and *really look* at your answers in part (c). Comment on what is remarkable/weird about your answer to that part.
3. Consider the relativistic snake example again, but let the numbers be as follows: The snake has a speed of 0.6 and proper length of 100cm (as before), but the boy holds the two hatchets 80cm apart.
    a. Show that with these lengths the experiment can be shown as a test of relativity, since the snake will be unhurt if relativity is right (and the boy times things correctly), whereas the snake will definitely be hurt if the classical ideas of space and time are correct.
    b. Use the Lorentz transformation to find the positions and times of the falling of the two hatchets as measured by the snake, and use those to verify that it is unharmed. (Assume that the boy bounces the hatchets at t=0, at which time the snake's tail is at the common origin.)
4. A rod in the reference frame of observer *O* makes an angle of 31° with the x-axis. According to Observer *O'*, who is in motion in the x direction with a velocity *v*, the rod makes a different angle with respect to the x-axis.
    a. What is the possible range of angles that observer *O'* could observe?
    b. In the case where observer O' observes that the rod makes an angle of 46° with the x-axis, find the velocity *v*.
5. A neutral K meson at rest decays into two π mesons, which travel in opposite directions along the x axis with speeds of 0.828c. If instead the K meson were moving in the positive x direction with a velocity of 0.486c at the moment it decayed, what would be the velocity of the two π mesons (in the lab frame)?
6. According to observer *O*, a blue flash occurs at x_b=10.4 m when t_b=0.124 μs, and a red flash occurs at x_r=23.6 m and t_r=0.138 μs. According to observer *O'*, who is in relative motion to *O* at velocity *v*, the two flashes appear simultaneous. Find the velocity *v*.