Homework #3

1. Two events, A and B, have coordinates $(ct_A, x_A, 0, 0)$ and $(ct_B, x_b, 0, 0)$ respectively in some inertial frame S and are separated by a spacelike interval. Obtain an expression for the boost parameter β required to transform to a new inertial frame S' in which the events A and B occur simultaneously. Show that this is not possible if the separation is timelike.

2. Construct a Minkowski diagram that shows two events from the standpoint of frame S and frame S'.

a)Let the two events take place at the same location in S' but at different times. Use the Minkowski diagram to show that they do not take place at the same place in the frame S.

b) Let the two events be at the same time in frame S, but at different locations. Use the Minkowski diagram to show that they do not take place in the same time in frame S'.

3. Consider a neutral pi meson which decays into two photons: $\pi^0 \to \gamma + \gamma$.

a) Write expressions for the momentum four-vectors of the photons in the pion rest frame.

b) In the lab frame the pion has a speed v. Suppose the two photons are emitted along the axis of motion of the pion in the lab frame. What are the two momentum four-vectors in the lab frame?

c) Check your results in both cases by showing that $(p_1 + p_2)^2 = -(m_\pi c)^2$ where m_π is the pion mass.