Lorentz-Einstein transformation equations

1. An event occurs at x' = 60 m, t' = 8x10^{-8} s in a frame S' moving with a velocity 3c/5 along the x direction with respect to a frame S. The origins of S and S' coincide at t = 0, t' = 0. What are the space-time coordinates of the event in S?

2. The space and time coordinates of two events as measured in frame S are as follows:
   Event 1: $x_1 = x_0$, $t_1 = x_0$/c, ($y_1 = 0$, $z_1 = 0$)
   Event 2: $x_2 = 2x_0$, $t_2 = x_0$/2c, ($y_1 = 0$, $z_1 = 0$)
   a) What type of space-time interval exists between these two events?
   b) There exists a frame in which these events occur at the same time. Find the velocity of this frame with respect to S.
   c) At which time both events occur in the new frame?

3. Two events occur at the same place in a certain inertial frame and are separated by a time interval of 4 s. What is the spatial separation between these two events in an inertial frame in which the events are separated by a time interval of 6 s?

4. Two events occur at the same time in an inertial frame S and are separated by a distance of 1 km along the x axis. What is the time difference between these two events as measured in a frame S' moving with constant velocity along x and in which their spatial separation is measured as 2 km?

5. Two spaceships, each measuring 100 m in its own rest frame, pass by each other traveling in opposite directions. Instruments on spaceship A determine that the front end of the spaceship B requires 5.00 x 10^{-6} s to traverse the full length of A.
   a) What is the relative velocity of the two spaceships?
   b) A clock in the front end of B reads exactly one o'clock as it passes by the front end of A. What will the clock read as it passes by the rear of A?

Answers

1. x = 93.0 m, and t = 2.5 x 10^{-7} s.
2. These two events are separated by a space-like interval. There exist a frame in which they both occur at the same time, but one cannot find a frame in which they occur at the same position. The frame S' in which they are simultaneous is moving with a velocity -c/2 with respect to the frame S. Both events occur in S' at $t' = \sqrt{3}x_0/c$.
3. $\Delta x' = 1.34 \times 10^9$ m
4. $\Delta t' = 5.77 \times 10^{-6}$ s
5. $v = 2 \times 10^7$ m/s, one o'clock + 4.99×10^{-6} s