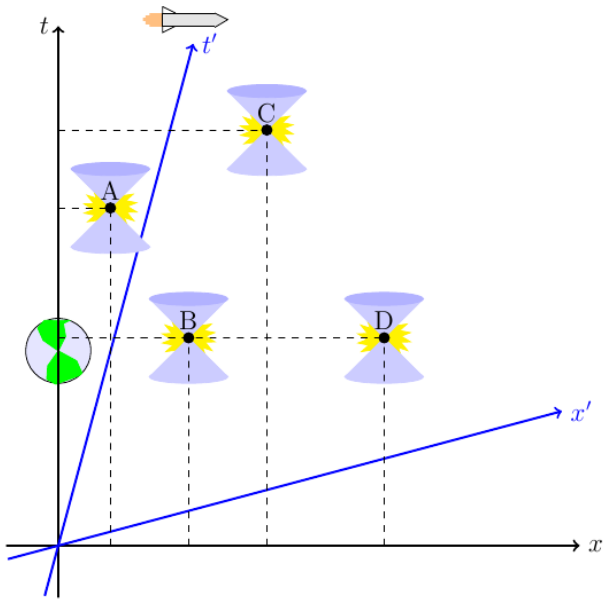
PHY 490 Homework #1 Name _____

1. Let $(x, ct) = (240, 300)$ m in System S. In a system moving at $0.8c$ with respect to S, what are the measured coordinates (x', ct')?

2. At what speed does a clock move if it runs one half the rate of a clock at rest?

3. The spacetime diagram shows four supernovae events at A, B, C, and D. These supernovae are observed on the Earth (system S) and on a fast moving spaceship (system S'). Note that the worldlines of the Earth and spaceship start at $(x, t) = (x', t') = (0, 0)$.



Answer the following questions:

a. In which chronological order do the supernovae occur in the Earth frame of reference? _____

b. In which chronological order do the supernovae occur in the spaceship frame of reference? _____

c. In which chronological order do astronomers on Earth see the supernovae? _____

d. In which chronological order do observers on the spaceship see the supernovae? _____

e. Is the chronological order in which supernovae A and B occur the same in all frames of reference? _____ Explain.

4. An observer sees two rockets on a collision path. She observes: the two rockets are 50 m in length; they are initially separated by 2.52×10^{12} m; the left rocket (A) moves at 0.800 c and the other rocket (B) moves at -0.600 c.
    a. What are the proper lengths of each rocket?

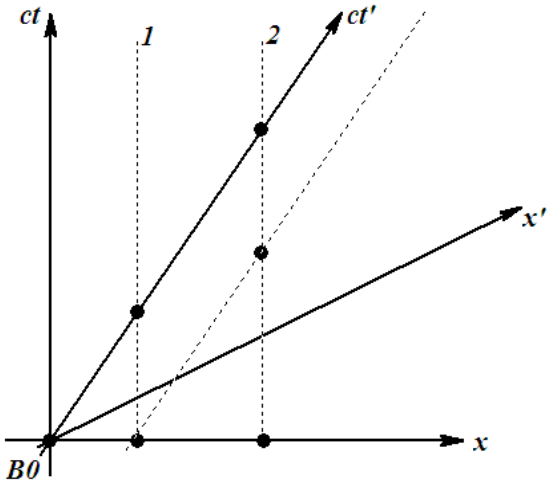
    b. What is the relative velocity of rocket B according to an observer inside rocket A?

    c. According to the "stationary" observer, how long will it be before they collide?

    d. According to an observer in rocket B, how long will it be before they collide?

5. Light at the natural wavelength of 6328 Angstroms is emitted from a source which is approaching at 0.45 c. Calculate the observed wavelength and frequency. If the light source were receding, what would the observed wavelength and frequency be?

6. A relativistic train of rest length 120 meters travels at 0.6c through a tunnel which has rest length 180 meters. In the figure below the world lines for the tunnel openings are drawn as line 1 and 2 and the world line of the front of the train is the third doted line. Let S_{tunnel} be the tunnel with coordinates (x,t) and let S_{train} be the train coordinates (x',t'). We set the origin as the event B0, the back of the train location just as the front end enters opening 1.



a. Label the following events on the spacetime diagram:
F1: The front of the train enters door 1. F2: The front of the train passes door 2.
B1: The back of the train enters the tunnel. B2: The back of the train leaves the tunnel.

b. Determine the coordinates of the following for the given frame:
Use units with $c = 1$.
   i. The coordinates (x, t) of F2 in S_{tunnel}

   ii. B1's coordinates in the *train* frame of reference

   iii. Find the coordinates of B1 in S_{tunnel}.

   iv. Use the Lorentz equations to find the coordinates of F2 in S_{train}.