HW #9; Due Wed. 4/19

1. On Earth, Event A happens at x=5, ct=9. Event B happens at x=1, ct=6.

a) Is there a reference frame where A and B happen at the same time? If so, find its velocity relative to Earth.

b) Is there a reference frame where A and B happen at the same place? If so, find its velocity relative to Earth.

(Hint: You may want to consider the "invariant" between any two events, $\Delta x^2 - c^2 \Delta t^2$, which is the same in all coordinate systems.)

2. . On Earth, Event A happens at x=3, ct=9. Event B happens at x=2, ct=7.

a) Is there a reference frame where A and B happen at the same time? If so, find its velocity relative to Earth.

b) Is there a reference frame where A and B happen at the same place? If so, find its velocity relative to Earth.

3. Translate the events in Figure 12.10 and Figure 12.11 into a spacetime diagram (1 diagram each). Each diagram should label event A (the original pulse of light), event B (the light bouncing off the mirror), and event C (the light returning to the source). Assume the train car at rest is 2m long, and use ns (nanosecond) time units. Suppose the train is moving at 0.6c relative to the ground. Label the trajectory of the mirror, the light pulse, and the light source on each diagram. If you don't use the Lorentz transformations to find your answers, check them to see that the events transform properly. (Hint: Pick your origin wisely!)

4**.** Ming the Merciless's rocket ship is in hot pursuit of Flash Gordon's rocket ship. Ming's ship is moving at 0.993c relative to the planet Mongo, and Flash's ship is moving at 0.990c (also relative to planet Mongo, moving in the in the same direction as Ming).

A) What does Ming see as the relative velocity between the two ships? Give your answer in terms of c.

B) Now prove your answer to A) is correct using the Lorentz transformations:

1) Make a spacetime diagram from the perspective of someone on Planet Mongo, locating each spacecraft at two different events: the moment at which Ming catches up to Flash, **and** one second before this moment. Calculate numbers for the location of each event in seconds and lightseconds. (Choose your coordinate system origin wisely!)

2) Now use the Lorentz Transformations to boost the four events into Flash's reference frame. Calculate the space-time location of events in this new frame. BE CAREFUL WITH SIGNS! <u>Make a new labeled spacetime diagram in Flash's frame.</u>

3) Using these transformed coordinates, calculate the apparent velocity between the ships (from Flash's perspective). Check against the velocity addition rule used in part A.