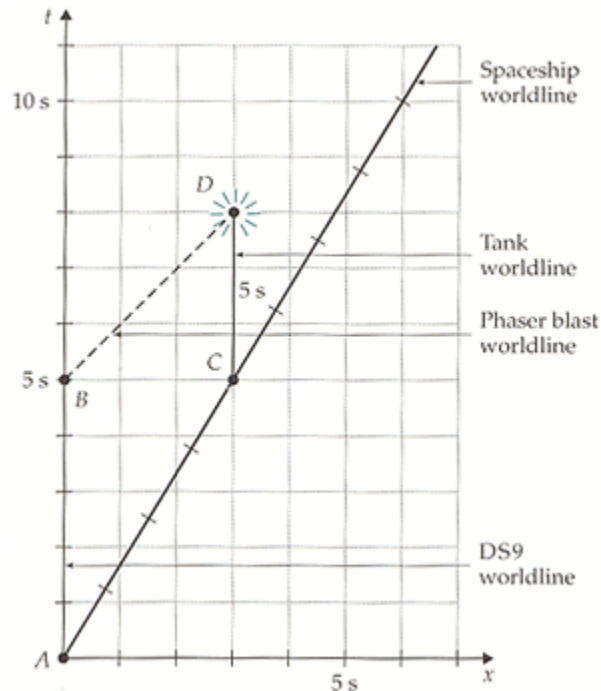


Homework due Tuesday November 21 2006

Problem:

1.- The spacetime diagram shown in the figure shows the worldline of an alien spaceship fleeing at a speed of $\beta = 3/5$ in the $+x$ direction from space station DS9 after stealing some potentially destructive trilitium crystals. The departure of the ship from DS9 is event A. At event B, DS9 fires a phaser blast (which travels at the speed of light), hoping to disable the vessel. At event C, the fleeing spaceship drops a fuel tank behind; setting the tank at rest relative to DS9 while the spaceship continues on ahead of it (the tank now shields the ship from the point of view of DS9). At event D, the phaser blast hits and destroys the tank, leaving the ship unharmed.



i.- Which event, B or C, occurs first in DS9's frame (or are these events simultaneous)?

- A) event B
- B) event C
- C) these events are simultaneous.

ii.- Which occurs first in the spaceship frame?

- A) event B
- B) event C
- C) these events are simultaneous

iii.- Calculate the time interval between events A and B in the spaceship frame.

iv.- Calculate the time of event D in the spaceship's frame, using the appropriate Lorentz transformation equation.

For honors students:

Fred sits 65 ns west of the east end (and thus 35 ns east of the west end) of a 100 ns long train station at rest on earth. Sally operates a reference frame in a train racing east across the countryside at a speed $\beta = 0.5$. At a certain time (call it $t' = 0$) Sally passes Fred. At that same instant, Fred flashes a strobe lamp (call this event F), which sends bursts of light both east and west. Alan, who is standing at the west end of the station, receives the west-going part of the flash (call this event A), and a bit later (according to clocks in the station) Ellen, who is standing at the east end of the station, receives the east-going flash (call this event E).

- a) When do events A and E occur in the station frame? Who sees the flash first (according to clocks in the station), Alan or Ellen?
- b) Draw a two-observer spacetime diagram of the situation, showing and labeling the worldlines of Sally, Fred, Alan, Ellen, and the two light flashes. Locate and label events F , A , and E as points on the diagram. Carefully draw and calibrate the t' and x' axes for Sally's train frame.
- c) When and where do events A and E occur in Sally's frame? Sally claims that Ellen sees the flash first in her frame. Is this true? Verify your assertions with calculations based on the Lorentz transformation equations.

NB distances are measured in light-time in this problem.