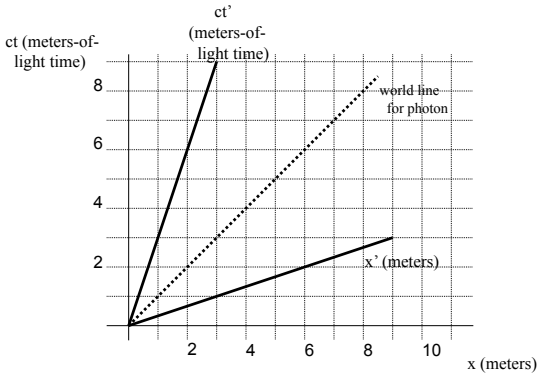
HOW DO YOU READ TIME OFF A SPACE-TIME DIAGRAM

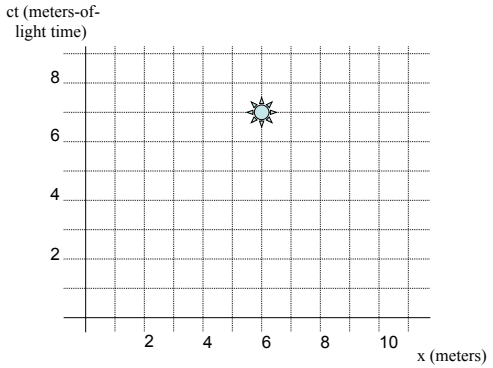
At this point, you know what a space-time diagram looks like and the look of the axes of two frames, one "stationary" and one moving with velocity *"v"* relate to the other. It will be useful to get some practice reading *time values* off such a diagram.



For the time being, let's forget about the primed axis and focus on the unprimed, so-called "stationary" axis.

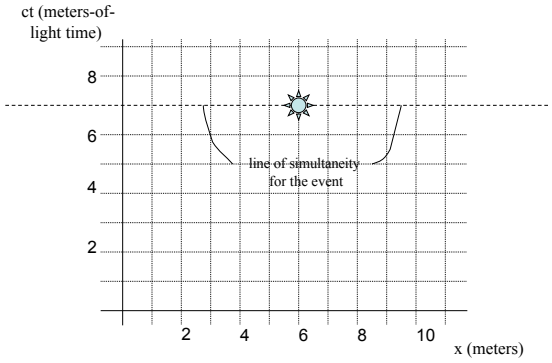
For the sake of argument, assume something happens at the spatial coordinate x = 6 meters. What are we really doing when we use the grid to determine the time at which the event happened?

Whether we cognize this or not, we unconsciously identify the *line of simultaneity* upon which the event resides, then we follow that line back to the time axis to make our reading.



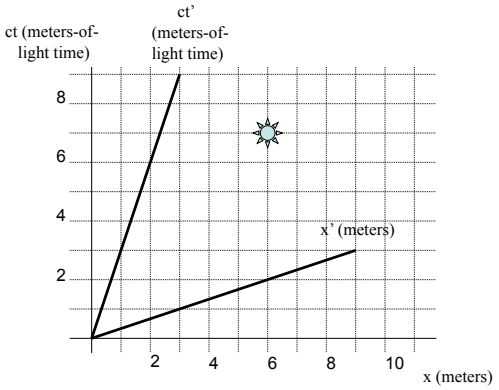
Following that procedure, we find the event happened at *7 meters of light time* in the frame from which we are making our measurement.

As a minor point of order, the *line of simultaneity* is always PARALLEL to the x-axis on the grid. That's just the way graphs work.

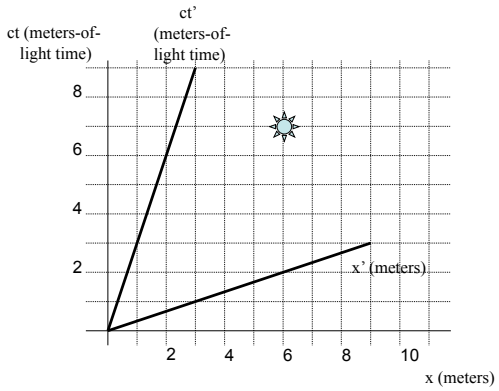


Additionally, notice that there can be any number of events arrayed along a line of simultaneity. They correspond to things happening at the same time (a firecracker goes off as someone yawns and another pops a cork of bubbly).

So now it's time to mess with a primed frame of reference. This is when it begins to get exciting. The event identified in the previous scenario is still with us, as is the same unprimed coordinate axes. What is different is that we are now assuming there is an observer who is moving with some velocity "v," relative to the unprimed frame. As we've just justified the move, we know the primed frame can be overlaid onto the unprimed frame as shown in the sketch.



Unfortunately, there is a problem. The graph as presented is misleading. Lines of simultaneity are supposed to be parallel to the position axis (the x'-axis in this case). There are parallel lines for the unprimed axis but not for the primed axis. If we wanted to take data from the moving frame (the primed axis), we have to realign the grid so the required parallel lines are in evidence. That is done on the graph on the next page.



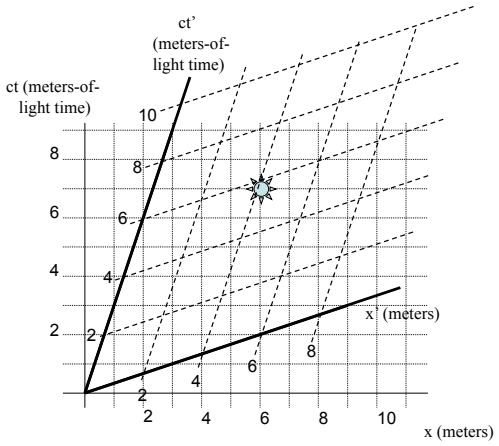
5.)

(I know, it looks as though the grid has been squished--deal with it!)

a.) We now have lines of simultaneity parallel with the x'-axis, as should be the case.

b.) To find the time of the event, we follow the line of simultaneity upon which the event resides back to the time axis and make the reading. Doing this in this case yields a time of approximately 4 meters-of-light-time.

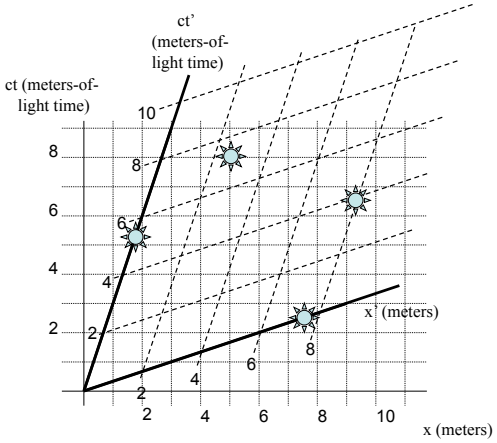
c.) As for the position, a similar maneuver yields a position of approximately 5.8 meters.



6.)

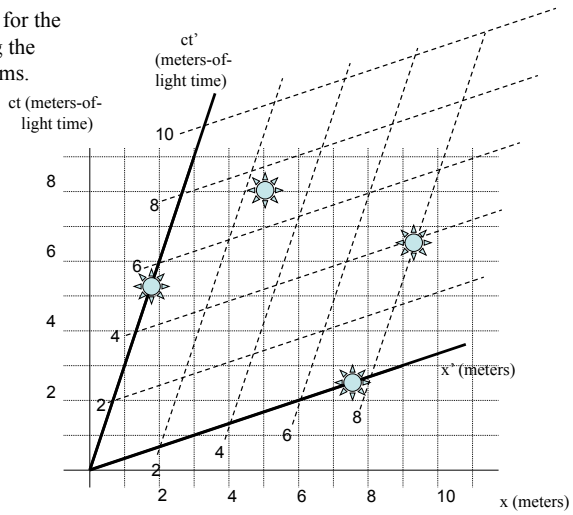
So now it's time to have some fun with this . . . (yeah, that's the ticket; we'll have some fun!)

Identify the coordinates for the four events shown using the unprimed coordinate systems.



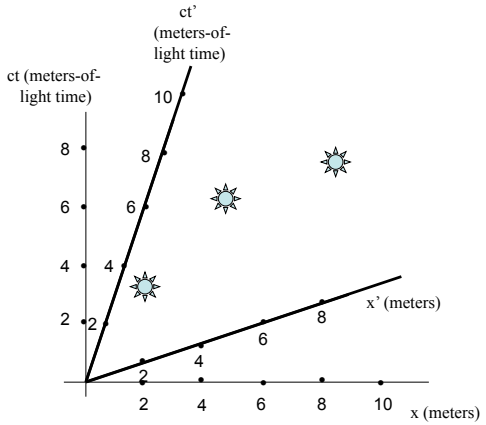
7.)

Identify the coordinates for the four events shown using the primed coordinate systems.



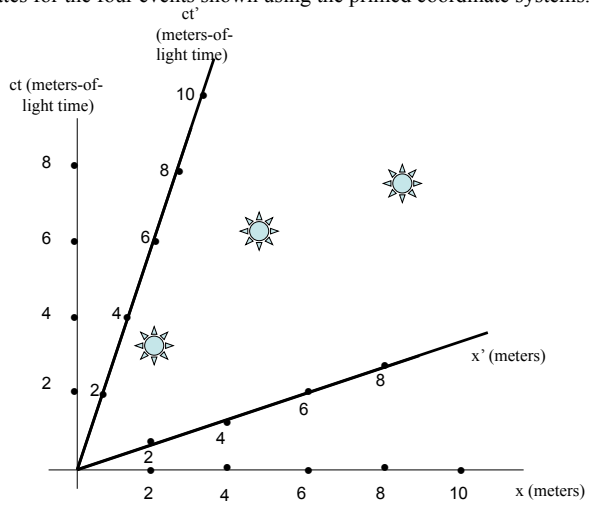
8.)

Now try to do the same points without the parallel lines. Identify the coordinates for the four events shown using the unprimed coordinate systems.



9.)

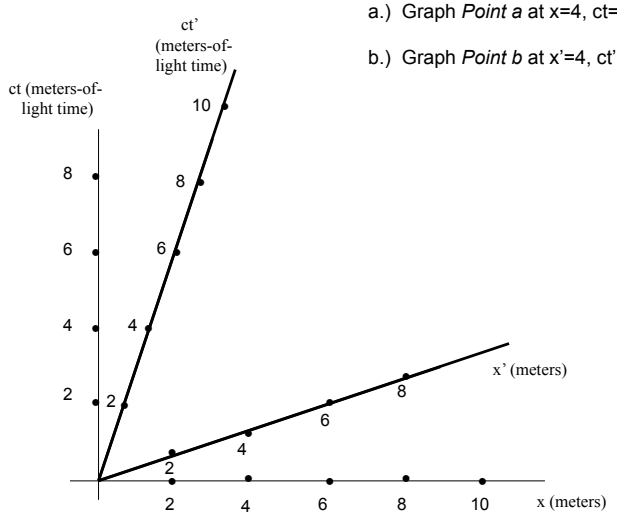
Identify the coordinates for the four events shown using the primed coordinate systems.



10.)

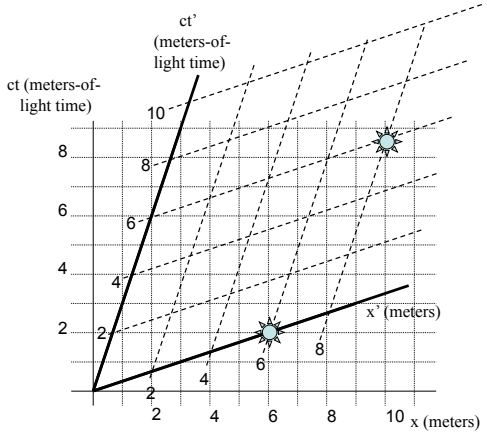
a.) Graph *Point a* at x=4, ct=7.

b.) Graph *Point b* at x'=4, ct'=7.



11.)

Now, determine the interval between the two events shown. Is it *space-like*, *light-like* or *time-like*?



12.)