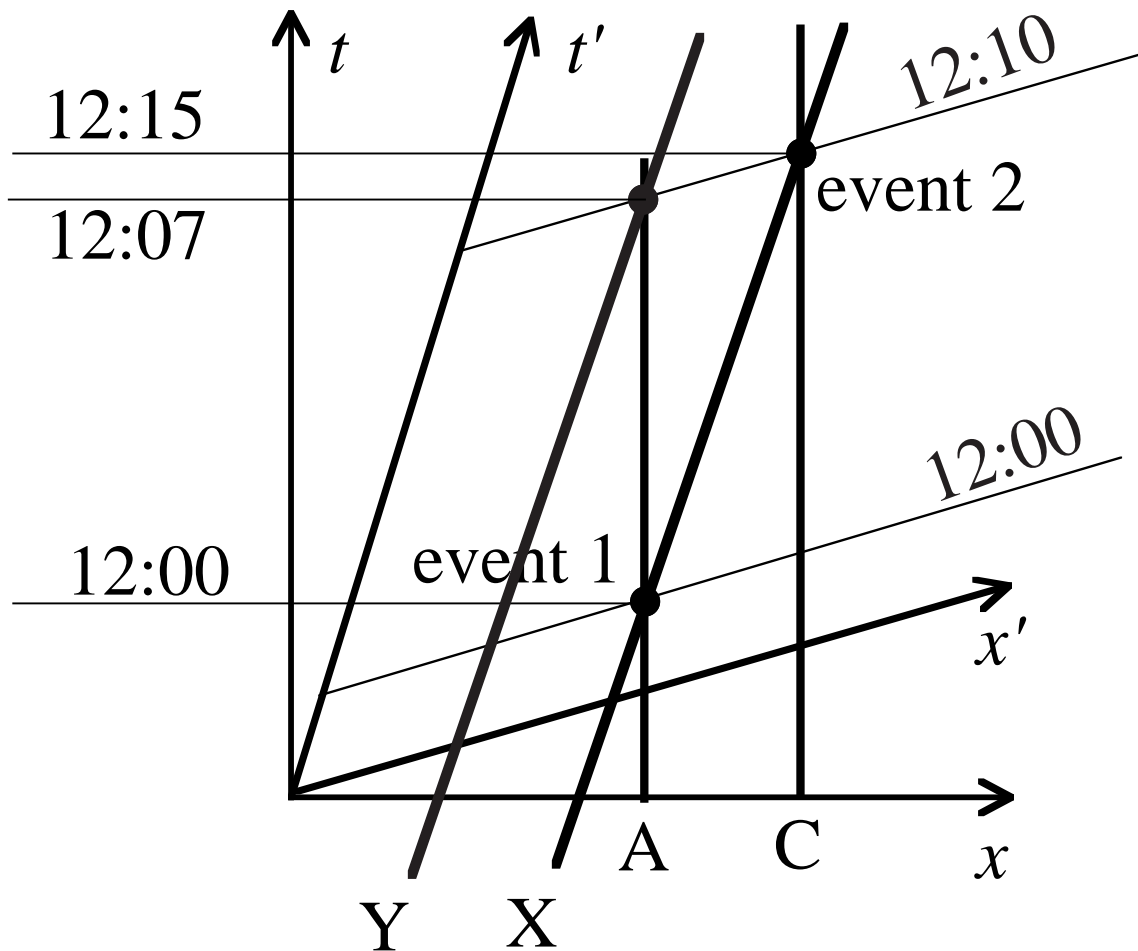


DUE: Thursday, April 15,
at the beginning of class

SPAC 205—Problem Set #4

NAME: _____

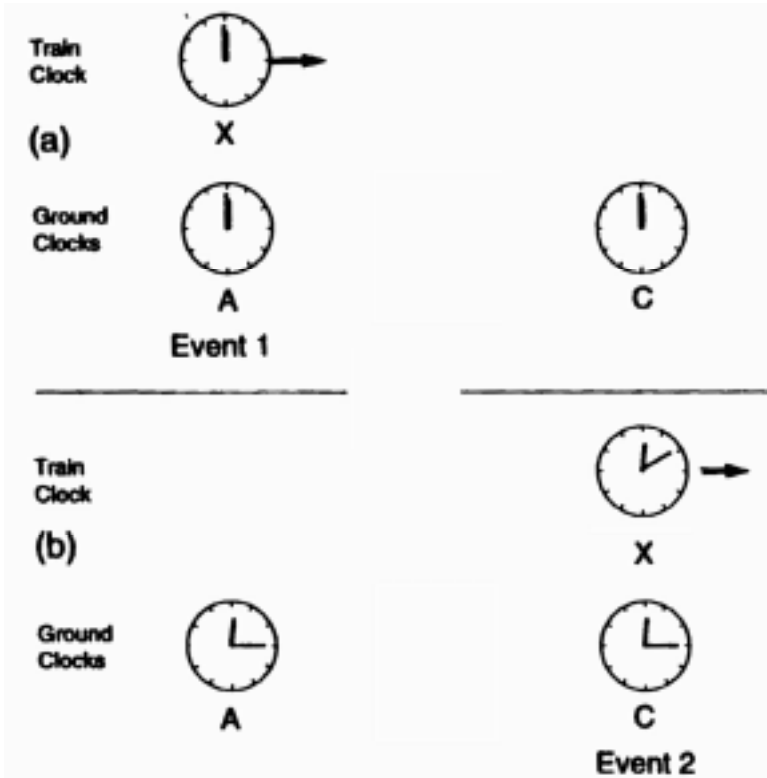
- I. (30 points) The following ST diagram (from a recent lecture overhead)



represents the situation depicted in Sartori's Figs. 3.10 and 3.11 (pp. 74–75) (reproduced on the next page with some modifications) in the ground frame:

[As we noted in class, this diagram does not do justice to the quantitative details; but qualitative relations between various points on the diagram (such as “between,” “later than,” and “simultaneous with” (in a particular frame) are the only ones that really matter for our purposes.]

**DUE: Thursday, April 15,
at the beginning of class**

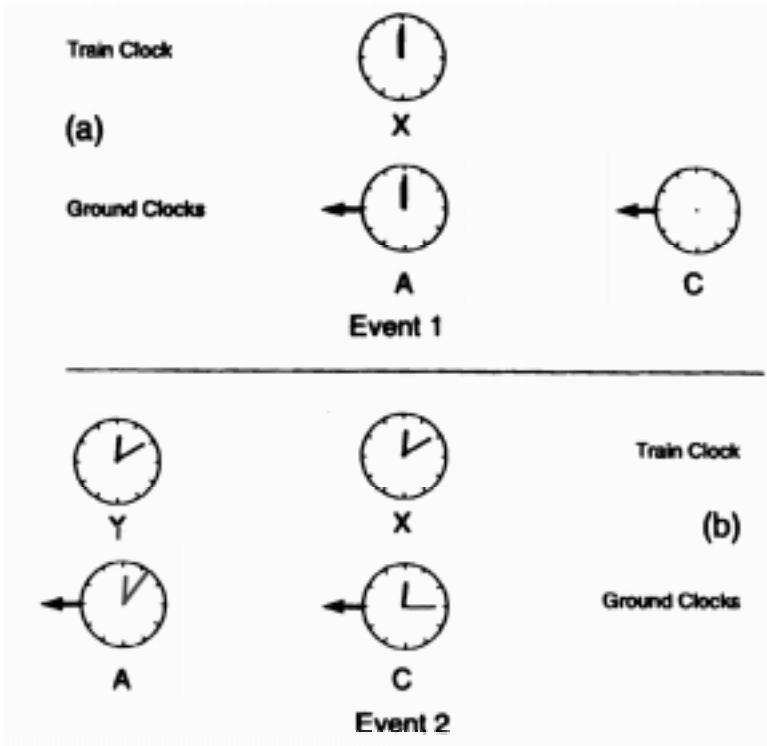


Adapted from Sartori,
Fig. 3.10.

(a) Draw the approximate location of clock Y here



(i.e., in (b) depicting event 2) and show its approximate time reading.

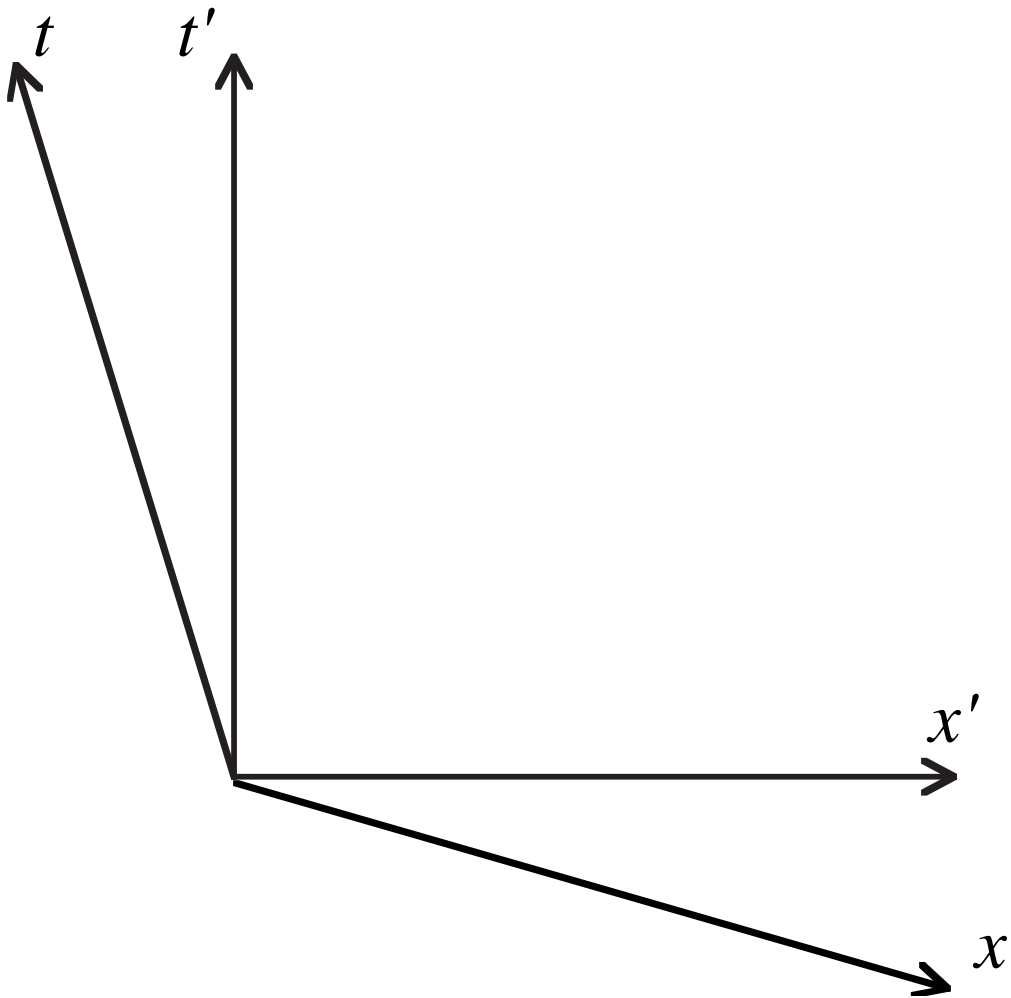


Adapted from
Sartori, Fig. 3.11.

(a) See above. (b) Draw a ST diagram of the situation in the train frame (in which the t' axis is “vertical”). See below for more details.

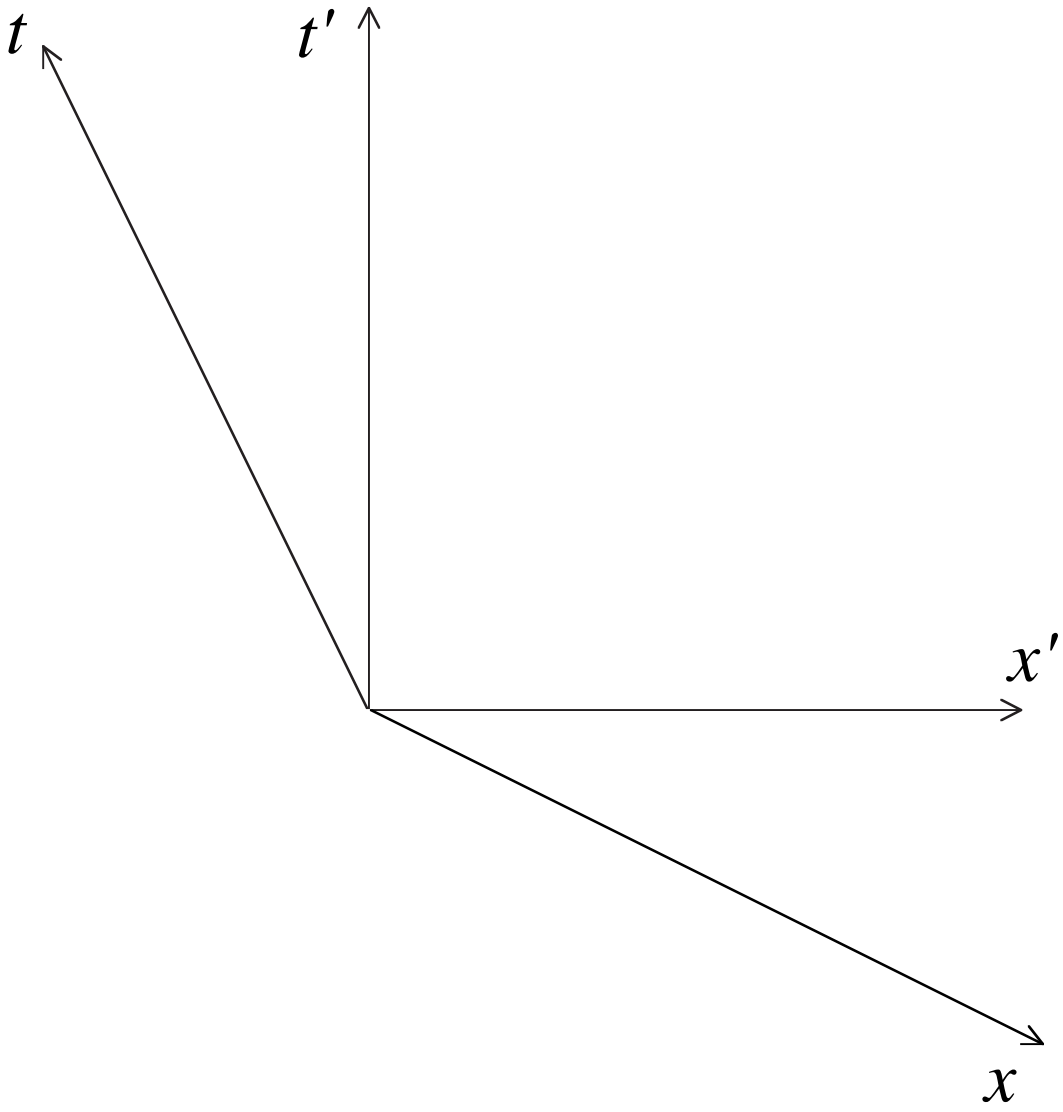
(I-b)

- Make sure to include all the relevant qualitative details in the diagram (take a cue from the (x,t) diagram above).
- Mark the location of the event representing clock Y reading whatever it does according to your answer in (a).



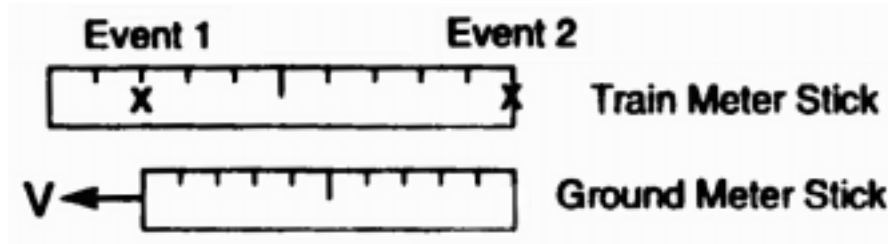
- II. (37.5 points) Variation on the Pole and Barn (Sartori, pp. 166–173). Suppose both doors are open. When the leading end of the pole reaches R, a sensitive detector located just above that door sends an electric signal to a shutter (located at F) that momentarily (i.e., immediately upon the reception of the signal) shuts front door F. Will that door collide with the pole or not? Explain your answer from two “points of view”: (a) from the “point of view” of the barn (i.e., provide a brief account of the situation in the rest frame of the barn) and (b) from the “point of view” of the pole (i.e., provide a brief account of the situation in the frame in which the pole is at rest). (c) Draw a ST diagram of the scenario for (b), i.e., draw it in the (x', t') frame, in which the pole is at rest. Don't worry about “scales” but do represent all the relevant qualitative details (in particular the order of various events in a given frame) precisely. Hint: electric signals propagate with the speed of light.

(II-c)



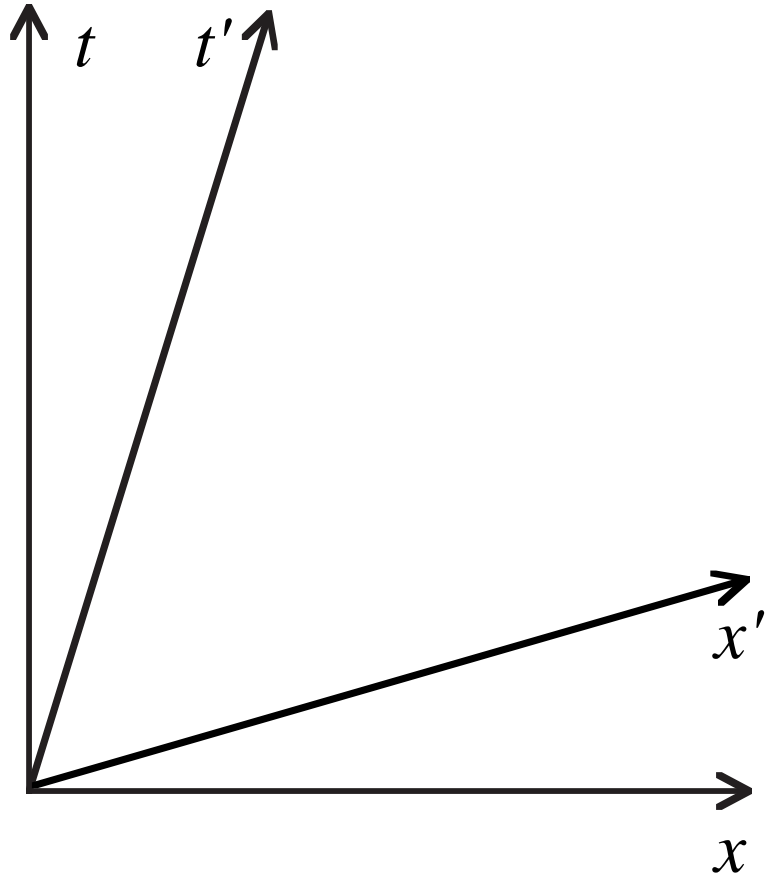
III. Variations on Sartori, Fig. 3.15, pp. 85–87: Measurements of the length of meter sticks by different observers.

1. (37.5 points) Train observers mark the position of the front end of the ground meter stick (event 1) and of the rear end (event 2) on their own meter stick. These events are simultaneous in the train frame.

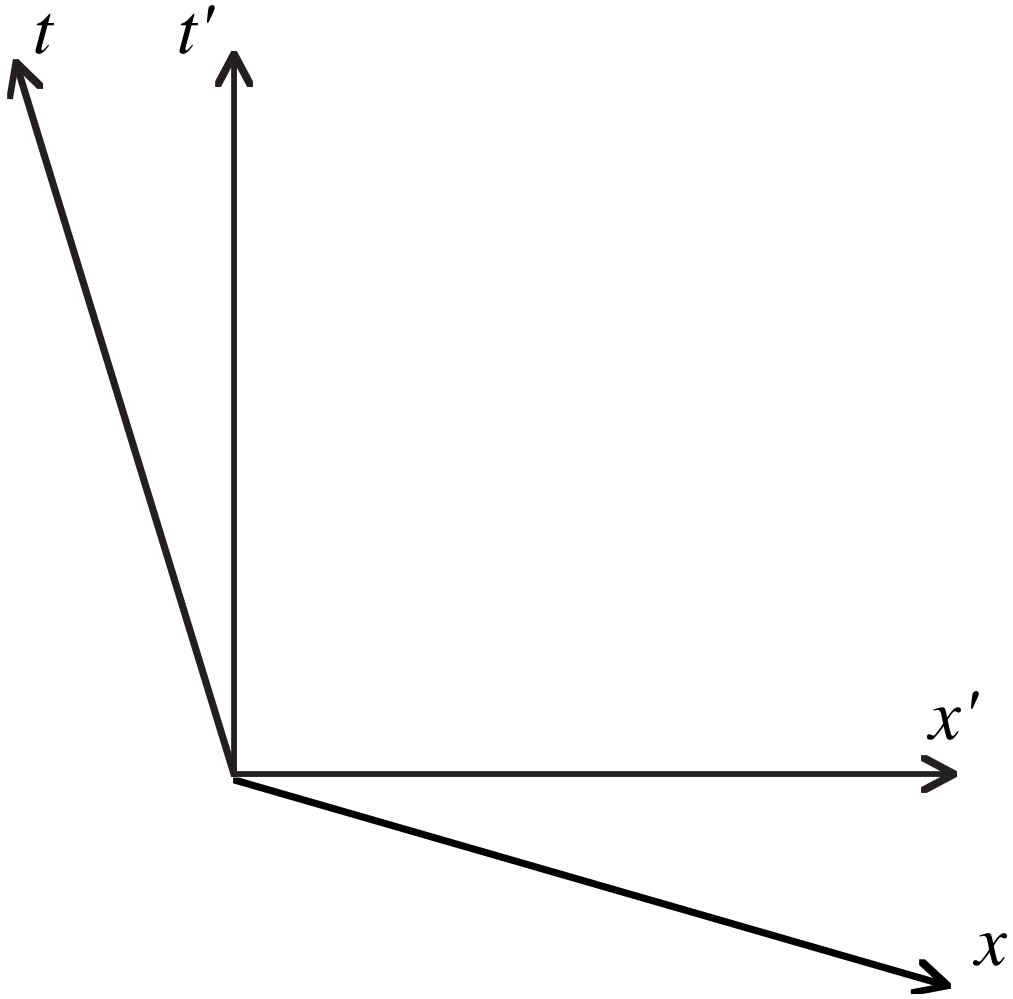


- (a) Provide a space-time diagram of the situation in the ground frame (x,t) (in which the world lines of ground observers are “vertical”). Make sure to clearly represent all the relevant details: events 1 and 2, the world surfaces of the sticks, and the world lines of the marks. Qualitative relations between various points on your diagram (such as “between,” “later than,” and “simultaneous with” (in a particular frame)) matter crucially. Quantitative details don’t matter much. So don’t worry too much about proper “scaling.”
- (b) Provide a space-time diagram of the situation in the train frame (x',t') (in which the world lines of train observers are “vertical”).
- (c) Sketch events 1 and 2 in the ground frame (i.e., provide a “snapshot” (or “snapshots”) similar to the one above, *not* a ST diagram). Make sure to clearly represent all the relevant qualitative details, such as the relative positions of the ends of the sticks and the marks at various relevant times.

(III-1-a)

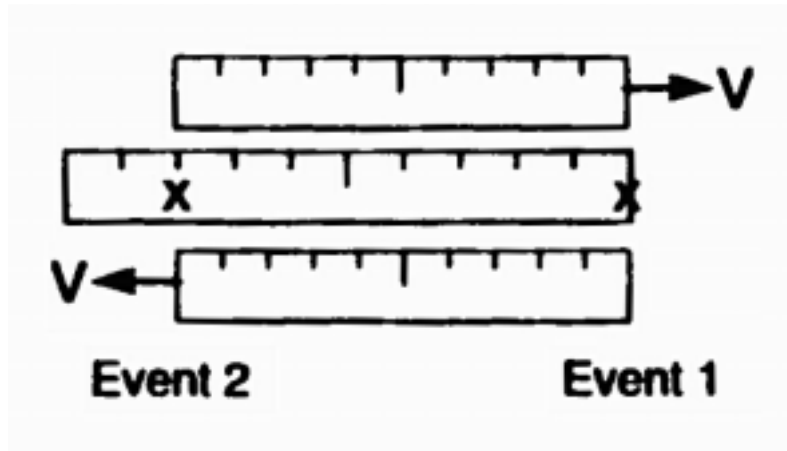


(III-1-b)



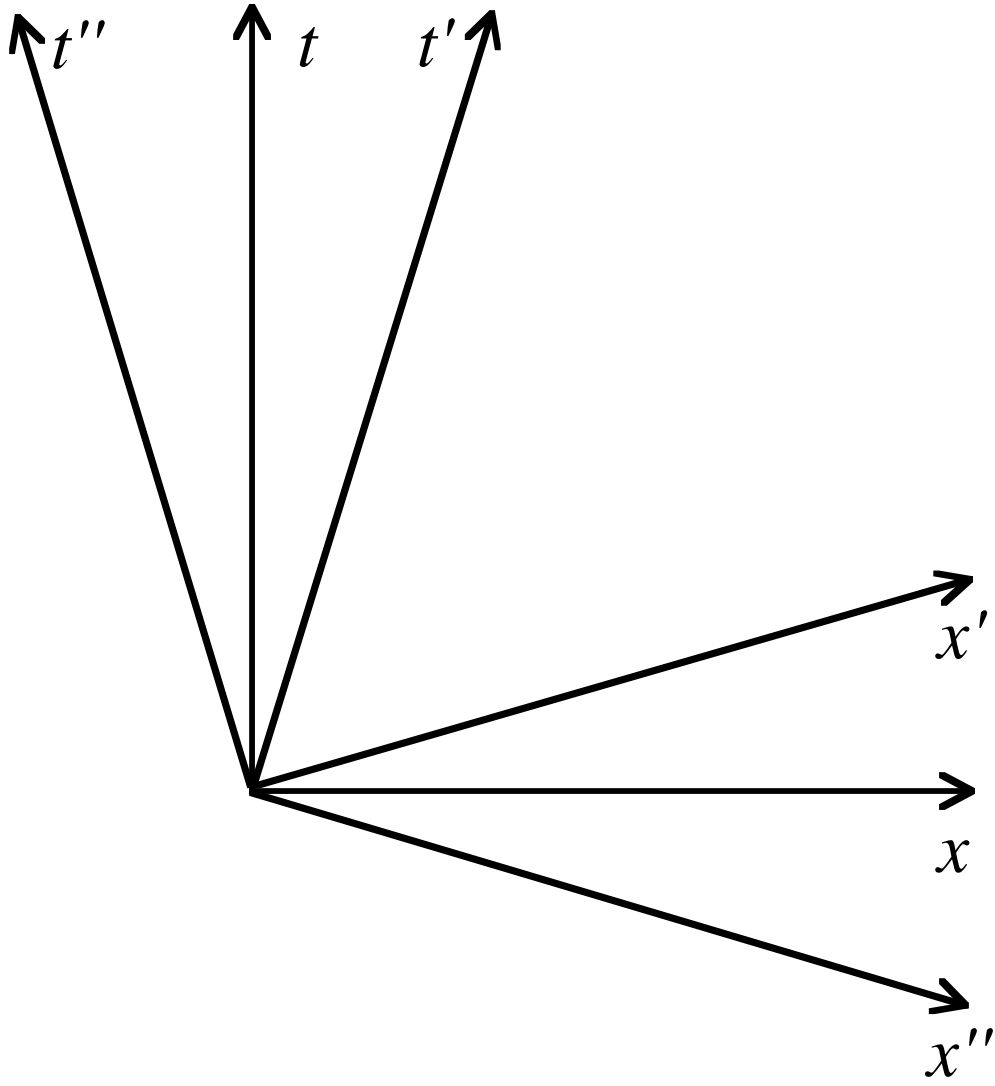
(III-1-c)

2. (45 points) Revert to Sartori's original set-up, in which marks are simultaneously made by ground observers, but add another train (and another meter stick) moving at the same speed V as the first one, but in the opposite direction.

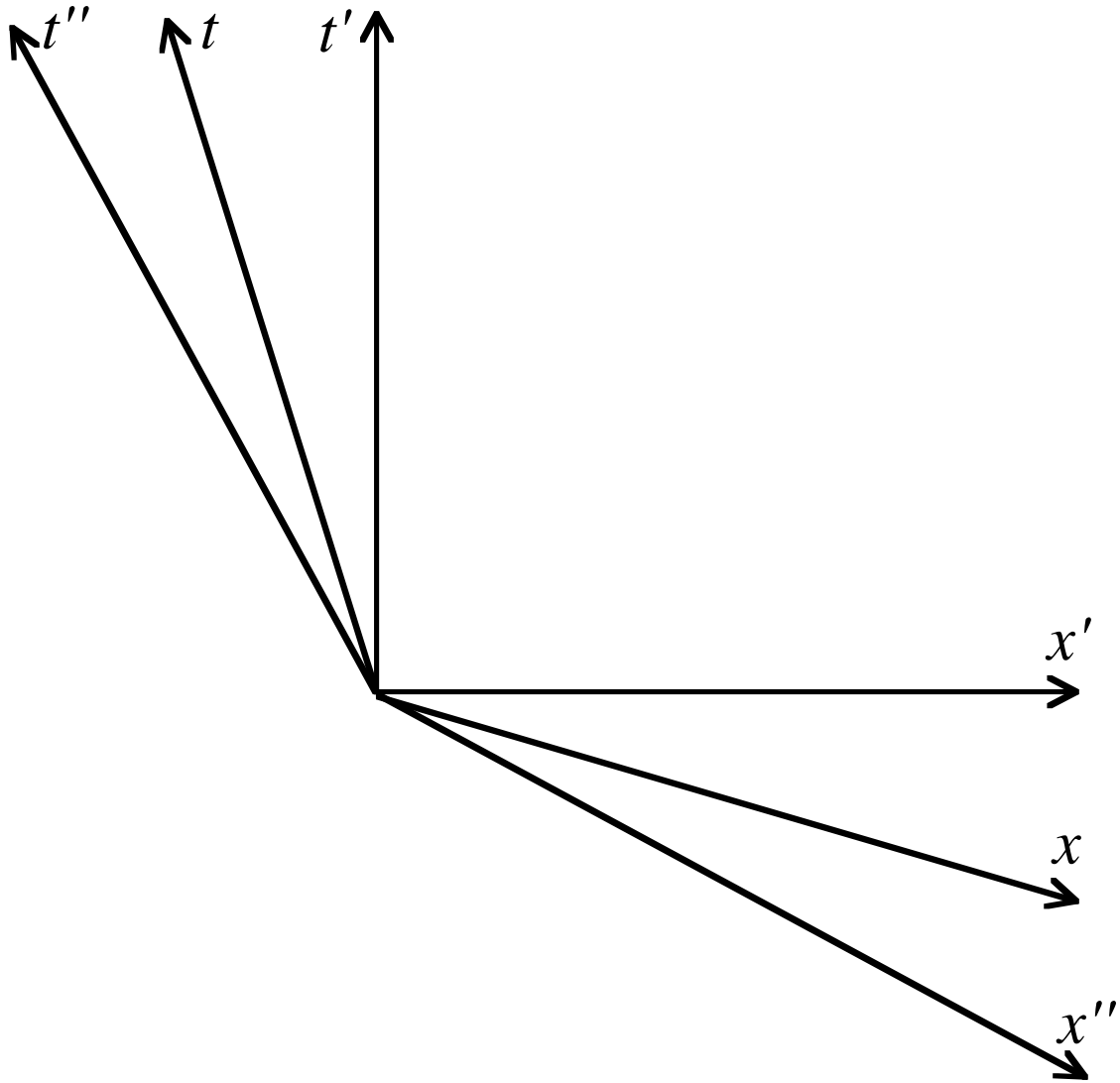


- Provide a space-time diagram of the situation in the ground frame (x,t) (in which the world lines of ground observers are “vertical”). Make sure to clearly represent all the relevant details: events 1 and 2, the world surfaces of all three sticks, and the world lines of the marks. Qualitative relations between various points on your diagram (such as “between,” “later than,” and “simultaneous with” (in a particular frame)) matter crucially. Quantitative details don't matter much. So don't worry too much about proper “scaling.”
- Provide a space-time diagram of the situation in the first (i.e., “top”) train frame (x',t') (in which the world lines of that train's observers are “vertical”).
- Sketch events 1 and 2 in the first (“top”) train frame (i.e., provide a “snapshot” (or “snapshots”) similar to the one above, *not* a ST diagram). Make sure to clearly represent all the relevant qualitative details, including the relative positions of the ends of all meter sticks and the marks at various relevant times.

(III-2-a)



(III-2-b)



(III-2-c)