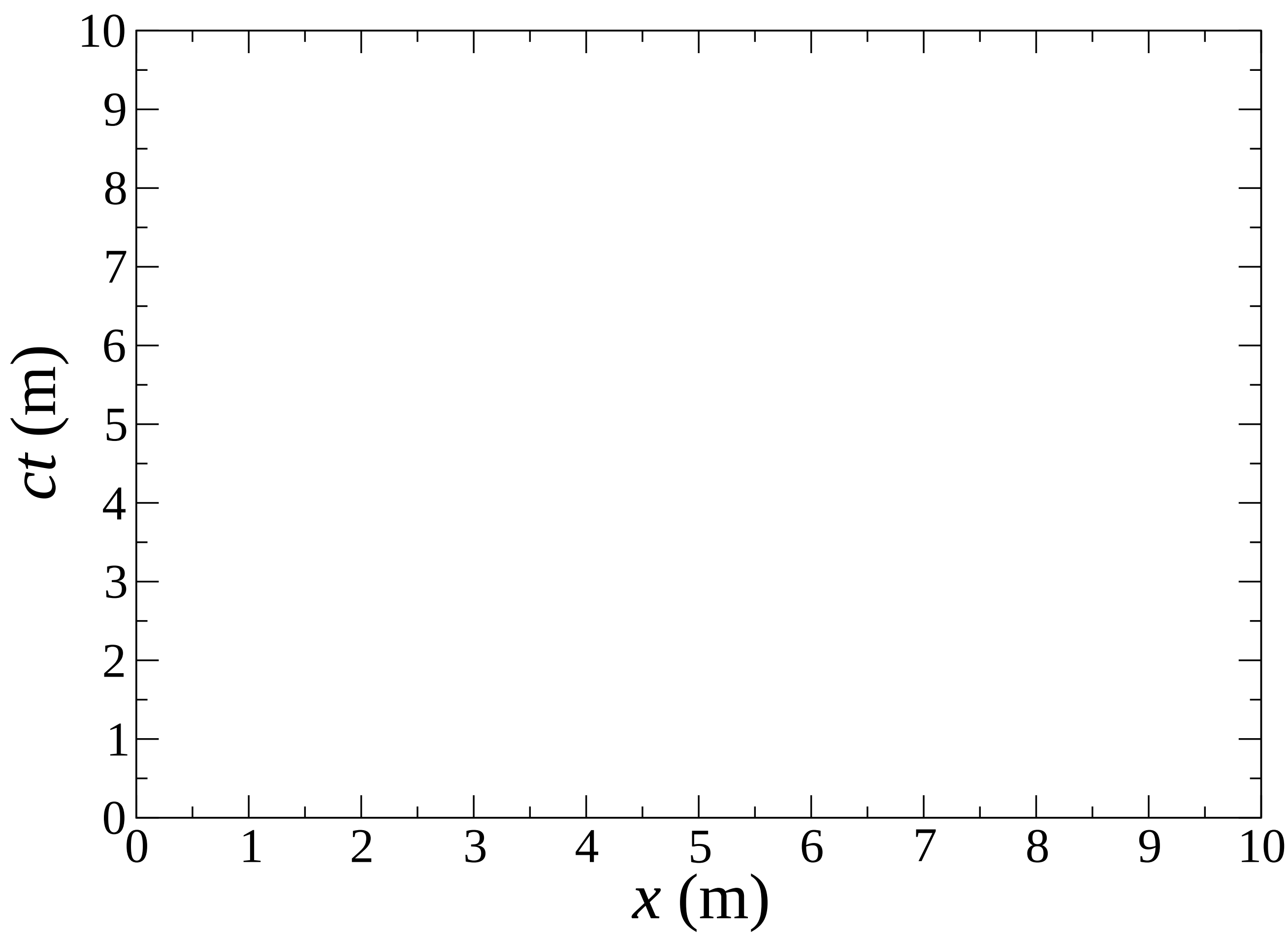
Phys 216 (SP24) **Homework Set 1**

Due: January 28, 2024, 11:59 PM CST
Please submit your work on Gradescope.

Problem 1. (7 points)

Notes:

- This problem extends the discussion we had in the last lecture about spacetime diagrams.
- Because the time coordinate in the the diagram is ct, it is measured in distance units.



Draw the following in the spacetime diagram above.

(a) (1 point) All events that occur at $ct = 3\,\mathrm{m}$.

(b) (1 point) An observer at rest at $x = 4\,\mathrm{m}$.

(c) (1 point) A light beam that passes through the origin at $t = 0$. (Assume that light travels with a constant speed c.)

(d) (1 point) The event when the light beam reaches the stationary observer specified in part (b).

(e) (1 point) An object traveling with a constant velocity less than the velocity of light and passing through the origin at $t = 0$.

(f) (2 points) A wall at $x = 5\,\mathrm{m}$, a wall at $x = 7\,\mathrm{m}$, and a ball bouncing back and forth between the walls at constant speed.

Problem 2. (3 points) This is a trivial calculation to show that the length of an object is invariant under Galilean transformations. The formulation of the problem is more important than the solution. We will return to this discussion after we introduce the Lorentz transformations.

S and S' are inertial frames in the standard configuration we looked at in the lecture. S' is moving at $10\,\mathrm{m/s}$ relative to S along the common x, x' axis.

A rod of length $4\,\mathrm{m}$ is at rest in S'. The rod is placed parallel to the x' axis with one end at the origin of the S' axis and the other end at $x' = 4\,\mathrm{m}$.

Since the rod is at rest in S', the position of each end can be measured at different times.

However, in the S frame, since the rod is moving, the ends have to be measured *simultaneously*. Let the observer in S measure the two ends at $t = 4\,\mathrm{s}$.

(a) Use the Galilean transformations to calculate the x coordinates of the two ends at $t = 4\,\mathrm{s}$.

(b) Calculate the length of the rod in the S frame.