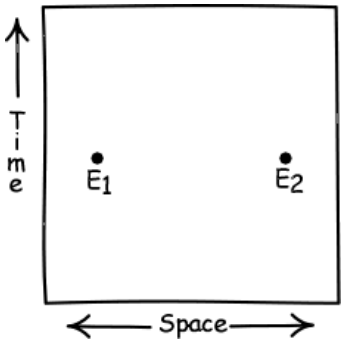
Make sure you answer every part of the question. Write out your answers (neatly!) and bring them to class on Tuesday.

A. Draw a spacetime diagram with the following elements. Be sure to label each one clearly.

An event O.
A worldline of an observer A that passes through O.
The light cone at O.
The hypersurface of all events simultaneous with O (for observer A).
An event E_{past} which is in the past of O and can causally affect O.
An event E_{future} which is in the future of O and can be causally affected by O.
An event $E_{elsewhere}$ which is outside the light cone of O and cannot be causally affected by O.
A timelike curve through O.
A spacelike curve through O.
A lightlike curve through O.

B. Using separate spacetime diagrams like the one below, answer the following questions:



(a) An observer A judges the two events E_1 and E_2 to be simultaneous. Draw the worldline of the observer A and a hypersurface of events that A will judge to be simultaneous. How does this hypersurface support A's judgment of the simultaneity of E_1 and E_2?

(b) An observer B moves relative to A and judges E_1 to be *later* that E_2. Draw the worldline of observer B and a hypersurface of events that B will judge to be simultaneous. How does this hypersurface support B's assessment of the time order of E_1 and E_2?

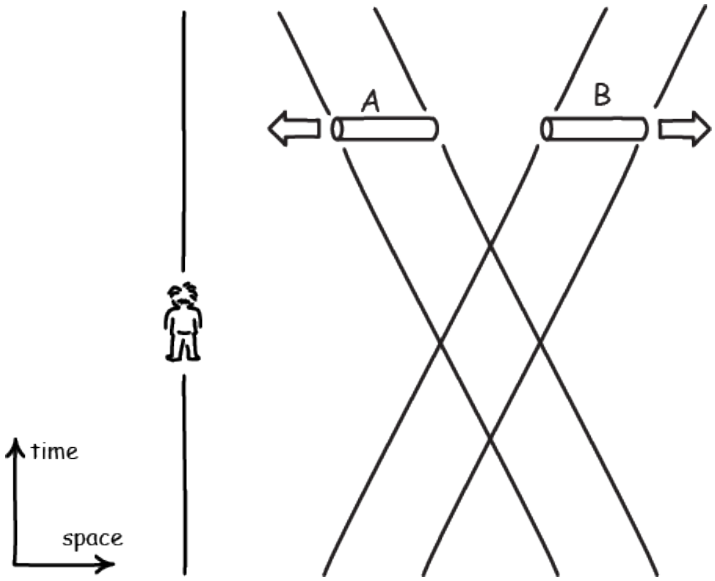
(c) An observer C moves relative to A and judges E_1 to be *earlier* that E_2. Draw the worldline of observer C and a hypersurface of events that C will judge to be simultaneous. How does this hypersurface support C's assessment of the time order of E_1 and E_2.

C. In the spacetime diagram below, two rods A and B approach one another from opposite directions.

(a) According to the judgments of simultaneity of the observer shown, the two rods have the same length: they coincide exactly when they pass by each other. Draw the observer's hypersurface of simultaneity for this moment and show that the observer will judge them to have the same length.

(b) Draw hypersurfaces of simultaneity for an observer who moves with rod A. Show that this observer will judge rod B to be shorter than rod A.

(c) Draw hypersurfaces of simultaneity for an observer who moves with rod B. Show that this observer will judge rod A to be shorter than rod B.



D.

1.

(a) What is the momentum of a body with a given mass and velocity?

(b) What happens in classical physics to a body when its momentum is increased?

(c) What happens in relativistic physics to a *slowly moving* body when its momentum in increased?

(d) What happens in relativistic physics to a *very rapidly moving* body when its momentum is increased?

2. How does your answer to 1. relate to the impossibility of accelerating bodies through the speed of light in relativity theory?

3. How does your answer to 1. relate to the famous equation Energy = mass x c^2?