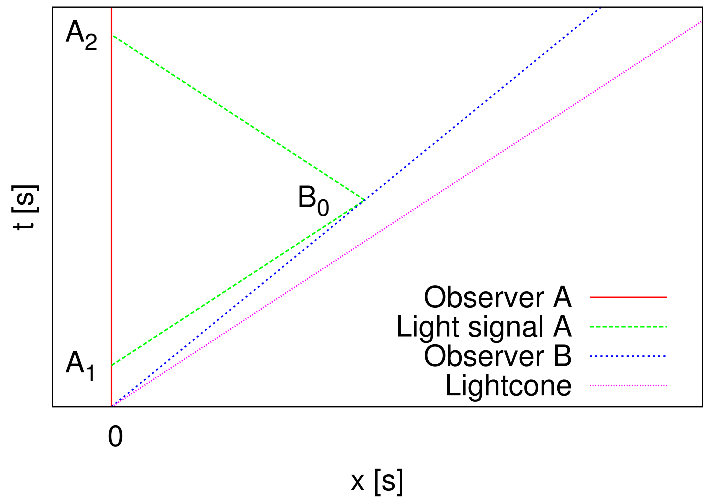

Minkowski space in which observer A is at rest and flashes a light signal at observer B, who moves with speed $4c/5$ and flashes the signal back.

Special and General Relativity (PHZ 4601/560 Fall 2017) Midterm October 20.

1. **Light signals and travel in two inertial frames: (50%).**

   In the above figure Minkowski space is parametrized by the coordinates of the rest frame S of an observer A. While observer A stays at rest, observer B moves with speed $\beta = 4/5$ along the positive x axis. At their common origin both, A and B, have set their clocks to zero. After 15 $[s]$ observer A emits at position A_1 (i.e., at $(15, 0)$ using units with $c = 1$) a light signal which reaches observer B at position B_0, who flashes it back at observer A, who receives it at position A_2 as drawn in the figure.

   (a) Find the coordinates of A_1 in the rest frame S' of B, where the translational freedom is used so that the origins of the restframes of A and B agree at time $t = t' = 0$.

   (b) Find the coordinates of B_0 in the rest frames S of A and S' of B.

   (c) Find the coordinates of A_2 in the rest frames S of A and S' of B.

   (d) Transform the above figure into the rest frame S' of B.

Turn over to backside.

2. **Spacetrip (50%).**

   (a) Assume that the earth is in an inertial frame. A spaceship leaves the earth at time 0. The spaceship is constructed so that it has an acceleration g in each of its own instantaneous rest frames. By its own clock, it accelerates on a straight-line path for 1 year, decelerates at the same rate for 1 year, turns around, accelerates for 1 year, decelerates for 1 year, and lands on earth. Calculate the time on earth at the landing.

   Instructions: Use $g = 9.81$ $[m/s^2]$, one year $= 365 \times 24 \times 3600$ $[s]$ and for the speed of light $c = 300,000$ $[km/s]$. State the result in units of years and decimal fractions of years to at least three significant digits.

   (b) How far away from Earth did the spaceship travel? Express the result in light years.