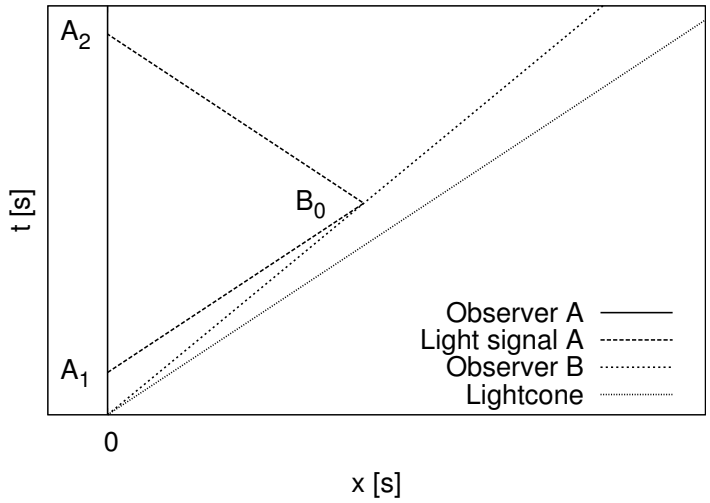

FIG. 1: Minkowski space in which observer A is at rest and flashes a light signal at observer B, who moves with speed $4c/5$ and flashes the signal back.

Electrodynamics A (PHY 5346) Fall 2016 Test on Homework December 1.

1. **Time in Minkowski space (30%).**

   In figure 1 the Minkowski space is parametrized by the coordinates of the rest frame of an observer A. While observer A stays at rest, observer B moves with speed $4c/5$ 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 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) What are the coordinates of the position B_0?

   (b) What is the time on the clock of observer B at position B_0?

   (c) What is the time on the clock of observer A when the back signal is received at position A_2?

2. **Potential in a rectangular box (30%).**

   Consider a hollow, rectangular box with $0 \leq x \leq a > 0$, $0 \leq y \leq b > 0$ and $0 \leq z \leq c > 0$. Assume that the potential is zero on five sides and on the sixth side

$(z = c)$ given by

$$\Phi(x, y; c) = \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{2\pi y}{b}\right) + \sin\left(\frac{3\pi x}{a}\right) \sin\left(\frac{\pi y}{b}\right).$$

Calculate the potential $\Phi(x, y, z)$ inside the box.

3. **Dielectric sphere (40%).**

Consider a dielectric sphere of radius R with dielectric constant ϵ_1 in a dielectric medium with dielectric constant ϵ_2. At large distances from the sphere a homogeneous, constant electric field $\vec{E} = E_0\,\hat{z}$ is found.

(a) Expand the Potential $\Phi(\vec{x})$ into spherical harmonics and state the boundary conditions at $r = R$.

(b) Calculate the Potential $\Phi(\vec{x})$ and the electric field $E(\vec{x})$ for all $\vec{x}$.

(c) Calculate the surface charge density.