

Relativity: Problem Set 1

February 7th, 2012

1. Explain briefly what is meant by the term *ether*.
2. Describe the Michelson-Morley experiment.
3. Explain why the Fitzgerald-Lorentz contraction would account for the negative result of the Michelson-Morley experiment.
4. Write down Einstein's two postulates and explain why they also explain the negative result of the Michelson-Morley experiment.
5. Describe briefly the meaning of the term *inertial frame* and give an example of an inertial frame.
6. Explain why a laboratory on the Earth is not an inertial frame.
7. Let F and F' be two inertial frames such that F' moves at a speed v parallel to the x axis of F . Derive the Lorentz transformation Λ between F and F' (assume that Λ is linear).

8. Let Λ be the Lorentz transformation between F and F' described in the previous question so that

$$\Lambda = \begin{bmatrix} \cosh(\theta) & \sinh(\theta) \\ \sinh(\theta) & \cosh(\theta) \end{bmatrix}, \quad \tanh(\theta) = -\frac{v}{c}$$

Verify by multiplying the appropriate matrices that the *inverse* Lorentz transformation Λ^{-1} is obtained by changing v to $-v$.

9. Explain how it is that a moving rod appears shorter to an observer at rest.
10. A rod of length L moves at a constant speed v relative to an observer O . At what speed does the observer O measure the length of the rod to be $L/2$.