Boğaziçi University
Department of Physics

Phys 311/407 Summer 2014

Problem Set #2

Reading: Rohlf Chapter 2, Section 5-1.

Problem 1:
At what speed would you have to move past a 1-m stick so that you would observe its length to be 10 cm?

Problem 2:
A beam of muons is injected into a storage ring, a device that uses electromagnetic fields to maintain the muons in uniform circular motion. The ring's radius is 100 m. Find the speed of the muons, as multiple of c, that is needed so that average of 10^6 revolutions are possible before the muons decay.

Problem 3:
a)At what speed would a motorist in a very fast car have to go so that he or she would see a red traffic light as green? **b)** Assume that the light is visible after he passes; what color (wavelength) does it seen after he or she passes it? Assume that the light looks red when the motorist is at rest. Take the wavelength of 650 nm for the red light and 530 nm for the green light.

Problem 4:
Using the Lorentz transformation, show that the quantity $p\,x - E\,t$ is invariant for a particle at position x at time t where E is the total energy of the particle and p is the momentum of the particle. [Hint: Say, the speed of particle in the S–frame is u, then write the speed of particle in the S'–frame where the S'–frame moves with speed v with respect to the S–frame. Write γ for this particle in the S'–frame, which gives us $E' = \gamma\, m\, c^2$, and $p' = \gamma\, m\, u'$.]

Problem 5:
Consider the following reaction:

$$e^- + e^+ \rightarrow \gamma + \gamma$$

The positron, e^+, is at rest, and the kinetic energy of the electron, e^-, is 1 MeV. Assume that one of the photon is detected at the same direction as the momentum of the electron. Find the energy of each photon, and the direction of the second photon.