Physics 323, Spring Quarter 2016
Electrodynamics: Homework Assignment 9
(a) Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)
(b) Use 8½ x 11 paper & staple (1-point penalty each otherwise)
(c) Due June 2 either 9:00 am in class or 8:45 am in the instructor's mailbox; late homework gets 0.

1. a. Suppose you're building a "Higgs factory". This is colliding-beam accelerator to produce copious numbers of Higgs bosons at rest in the laboratory. One beam consists of electrons, the other beam positrons. What's the beam energy of the electrons? What's the beam energy of the positrons?
b. Suppose each beam has 1 ampere of current and the beams are constrained to rotate in the circular path of radius 10 km. How much power is required to maintain the beams in circulation?
c. Now suppose you wanted to produce Higgs bosons in a fixed-target accelerator. This particular accelerator consists of a H_2 target (at rest in the laboratory) struck by a proton beam. What's the beam energy of the protons?

2. In a certain low-energy electron-positron colliding-beam accelerator, the electrons and positrons particles have speed 0.6 c. Suppose the collision products consist solely of photons.
a. Show there must be two or more photons in the final state.
b. In the case where two photons are in the final state, show that the photons are back-to-back with equal energies (in the lab frame).
c. In the case where two photons are in the final state, find the energy of each photon, find the wavelength of the photons (in the lab frame).

3. A photon has energy 0.2 GeV with velocity in the x-direction. A second photon with energy 0.1 GeV has velocity in the y-direction.
a. What's the total energy of the photons?
b. What's the total momentum of the photons?
c. Suppose these two photons annihilate to create a single particle in the final state. Find the mass of this single particle.
d. Find the direction this single particle's velocity.
e. Find the single particle's velocity factor β.

4. Consider a copper wire carrying 10 amps of electron current and where the copper ions are stationary. The wire had cross-section $1mm^2$ and suppose there's one conduction electron per copper atom.
a. With the current off, estimate the number of conduction electrons per cm^3. You'll need physical constants of copper for this.
b. Now apply the 10 amps current. In a time Δt, how many electrons pass a certain position along the wire in that time? Find this time in two ways: (i) from the number of conduction electrons, and (ii) from the current.
c. What is the approximate drift speed of the conduction electrons?

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