Physics 234
Homework 7 (Due Friday, March 11)
Relativisitic Kinematics

Problem 1.
Find the total energy and kinetic energy for an electron traveling at the following speeds. Express your answer in KeV. Remember that for an electron, $m_e c^2 = 511\ KeV$.

a) $v = 0.18c$
b) $v = 0.19c$
c) $v = 0.98c$
d) $v = 0.99c$

Note that the change in v from a) to b) and from c) to d) is the same, but not the energy required to produce this change in v.

Problem 2.
A particle of rest mass m_0 has a momentum of $m_0 c$.
a) What is its speed?
b) What is its total energy?
c) What is its kinetic energy?

Problem 3.
What must be the momentum of a particle with rest mass m_0 in order that its total energy be $3m_0c^2$?

Problem 4.
The average lifetime of a muon at rest is 2.2 μs. In a particular accelerator experiment the muons produced have an average lifetime in the lab of 6.9 μs. Find for the lab frame:

a) The speed of the muons.
b) The total energy of a muon. (Express your answer in units of MeV).
c) The momentum of a muon. (Express your answer in units of MeV/c).

Note: the mass energy of the muon is $m_\mu c^2 = 105.7\ MeV$.

Problem 5.
Consider the following head-on collision in the lab reference frame. A particle of mass m_0 is traveling to the right with speed $v_0 = c/\sqrt{3}$. Another particle of mass $2m_0$ is traveling to the left with speed v. After the two collide, then form a single particle of mass M which is at rest in the lab frame. Find:

a) The speed v of the $2m_0$ particle.
b) The mass M of the particle formed after the collision.

Problem 6.
A particle of mass m_0 is traveling to the right with a speed of $.6c$. The particle decays into two particles. One of the particles has a mass of $m_0/4$ and ends up at rest after the decay. The other particle has a mass of m and travels with a speed of v after the decay. Find:

a) the mass m of the other particle.
b) the speed v of the other particle.

Problem 7.
A positron collides with an electron in the lab reference frame. Let m_e be the mass of the electron and also the positron. Initially, the electron is at rest, and the positron is moving with a momentum equal to $2m_ec$ to the right. When the positron hits the electron, they annihilate and produce two photons. One photon travels to the right, in the same direction that the positron was. The other photon travels to the left. What are the energies of the two photons produced. The photon is massless, and $E = pc$ for a photon.