

Homework III
due September 22nd 2006

- 1) The muon μ is a particle of rest energy $m_\mu = 105.5 \text{ MeV}/c^2$ and life time $\tau_\mu = 2.2 \times 10^{-6} \text{ s}$.
- In the laboratory, what is the life time of a muon with a $K = 316.5 \text{ MeV}$ kinetic energy?
 - Muons produced at an altitude of 10,000m above ground level are observed to reach the ground before decaying. What must be their total energy?
- 2) In the laboratory, an electron initially at rest is accelerated by a voltage potential $U = 10^9 \text{ V}$ along the x axis. It collides with a proton moving in the opposite direction with a speed $v = 0.9c$. Express all energies and momenta in MeV and MeV/c respectively.
- In the laboratory reference frame, what is the energy, kinetic energy and momentum of the electron?
 - In the laboratory reference frame, what are the energy, kinetic energy and momentum of the proton?
 - In the reference frame of the proton, what is the energy, kinetic energy and momentum of the electron?
 - In the reference frame of the electron, what is the energy, kinetic energy and momentum of the proton?
 - In the rest frame, the momenta of the electron and proton are equal in magnitude and opposite in direction. What is the velocity of that reference frame with respect to the laboratory? What is the total energy in that reference frame? What is the kinetic energy?