1. A perfectly focused monochromatic beam of π^+ at energy E_π is used to produce a conventional neutrino beam. Find the laboratory energy of ν_μ produced in π^+ decays to a function of only constants (e.g., masses, lifetimes, speed of light, etc.), E_π and θ, the angle between the beam and the outgoing neutrino in the laboratory frame. You may assume $E_\pi \gg m_\pi$ and $\theta \ll 1$.

   For a perfectly focused beam containing a range of energies from E_0 to $2E_0$, at approximately what angle would the spread in neutrino energies be smallest?

   (Harder): What is the ratio of neutrino production rates per unit solid angle at $\theta = \theta_1$ to that at $\theta = 0$?

2. For a conventional neutrino beam with typical neutrino energy $E_\nu > 1$ GeV, estimate the relative rate of quasi-elastic ν_e events to $\nu_\mu e^- \to \nu_\mu e^-$ events. (You may make a reasonable assumption about the ratio of flavors in the beam.)

   How may these two classes of events be distinguished?