PHYS 724 - Homework #23

1. Derive the commonly used neutrino oscillation formula for 2-neutrino mixing:

$$P(\nu_a \to \nu_b) = \sin^2(2\theta)\sin^2[1.27\Delta m^2(eV^2)L(km)/E(GeV)]$$

   Be sure to obtain the value of the constant above (1.27).

2. When a neutrino is produced, say in the decay $\pi^+ \to \mu^+\nu_\mu$, we know that it must be of a definite flavor (in this case, muon flavor), i.e., the neutrino must be in a flavor eigenstate. On the other hand, since the neutrino propagates it must have a 4-momentum, whose Lorentz-invariant measure is the neutrino mass. Thus, the neutrino must be in a mass-eigenstate. In other words, we can go to the neutrino rest-frame where it must have a definite mass (or energy). How can the neutrino be in both a flavor-eigenstate as well as in a mass-eigenstate? Be very clear in your answer. Unclear answers will earn zero points.