Homework 1, due 9-3

1. The relativistic relation between the energy E and momentum p of a particle with rest mass m is given by

$$E = \sqrt{p^2c^2 + m^2c^4}.$$

   Show that in the non-relativistic limit, $pc \ll mc^2$, this relation reduces to the corresponding relation in classical mechanics.

2. Experiments in japan and the US recently announced the discovery of a "penta-quark" particle, officially named the $\Theta(1545)$. The Θ is produced according to $K^+ + n \to \Theta$ in collisions of positive kaons with neutrons. You are designing an experiment to observe Θ production from a kaon beam hitting a (stationary) neutron target. What is the required energy and momentum of the kaon beam? The mass of the kaon is $m_K c^2 = 495$ MeV and the mass of the enutron is $m_n c^2 = 939$ MeV.

3. You are designing a detector to observe the decay of Θ particles into kaons and neutrons. If the Θ is at rest with respect to the detector, what is the expected decay energy and momentum of the positive kaon?