Keystone: Chapter 5

1) A particle with mass M and charge $+e$ and its antiparticle (same mass M, charge $-e$) are initially at rest, far from each other. They attract each other and move toward each other. Graph and label the various energies involved in this process, as a function of the distance r between the two particles. Be sure to include the rest energy of the particles.

2) When the particle and antiparticle collide, they annihilate and produce a different particle with mass m (much smaller than M) and charge $+e$ and its antiparticle (same rest mass m, charge $-e$). When these two particles have moved far away from each other, how fast are they going? Is this speed large or small compared to c?

3) Now take the specific case of a proton and antiproton colliding to form a positive and negative pion. Each pion has a rest mass of 2.5×10^{-28} kg. When the pions have moved far away, how fast are they going?

4) How far apart must the two pions be (in meters) for their electric potential energy to be negligible compared to their kinetic energy? Be explicit and quantitative about your criterion and your result.