PH 429/529 **HW #3** Spring 2006

Due Friday, 21 April 2006

0. ***PRACTICE*** *(You do not need to turn this in.)*

(Example 12.8 on pp. 513–514 of Griffiths, and Problem 12.31 on p. 515 of Griffiths.)

A pion (with mass m_π) at rest decays into a muon (with mass m_μ) and a massless neutrino ($m_\nu = 0$). Find the momentum, energy, and speed of the muon.

1. **COLLISIONS II**

(Problem 12.33 on p. 515 of Griffiths.)

A pion of (rest) mass m and (relativistic) momentum $p = \frac{3}{4}mc$ decays into 2 (massless) photons. One photon travels in the same direction as the original pion, and the other travels in the opposite direction. Find the energy of each photon.

2. **COLLISIONS III**

(*Problem 12.29 on p. 511 of Griffiths, and Problem 12.32 on p. 515 of Griffiths.*)

(a) If a particle's kinetic energy ($E - mc^2$) is n times its rest energy, what is its speed?

(b) A particle of mass m whose total energy is twice its rest energy collides with an identical particle at rest. If they stick together, what is the mass of the resulting composite particle? What is its speed?

3. **ELECTRICITY vs. MAGNETISM**

(Related to Problem 12.46 on p. 534 of Griffiths, which you may wish to try first.)

Suppose you know that in a particular inertial frame neither the electric field $\vec{E}$ nor the magnetic field $\vec{B}$ has an x component, but neither $\vec{E}$ nor $\vec{B}$ is zero. Consider another inertial frame moving with respect to the first one with velocity v in the x-direction, and denote the electric and magnetic fields in this frame by $\vec{E}'$ and $\vec{B}'$, respectively.

(a) What are the conditions on $\vec{E}$ and $\vec{B}$, if any, and the value(s) of v, if any, such that $\vec{E}'$ vanishes for some value of v?

(b) What are the conditions on $\vec{E}$ and $\vec{B}$, if any, and the value(s) of v, if any, such that $\vec{B}'$ vanishes for some value of v?

(c) What are the conditions on $\vec{E}$ and $\vec{B}$, if any, and the value(s) of v, if any, such that **both** $\vec{E}'$ and $\vec{B}'$ vanish for the *same* value of v.

(d) Is it possible that $\vec{E}'$ and $\vec{B}''$ vanish for *different* values of v?

(I have written $\vec{B}''$ rather than $\vec{B}'$ to emphasize that $\vec{E}'$ and $\vec{B}''$ are with respect to different reference frames.)