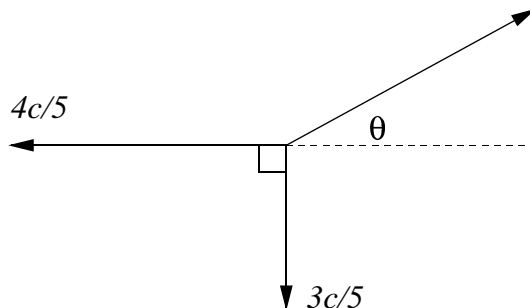


Homework Assignment #7

Physics 17 Fall 99

Due: Friday, December 10

- Quasars are the most distant objects observed in our universe. They radiate as much energy per second as a thousand or more galaxies. One possibility is that they are supermassive black holes that gobble up large clouds of gas. An observation done on one of them suggests that, when it emitted the light that has just reached earth, it was moving away from the earth at a speed of $0.8c$.
 - One of the lines identified in its spectrum has a wavelength of 1200\AA when emitted from a stationary source. At what wavelength must this line have appeared on the observed spectrum of the quasar?
 - Because of the huge rate at which they radiate their life time might be short. If the life time of the quasar was assumed to be 1,000,000 years as measured in its rest frame, over what total span of earth time would radiation from it be received on earth? (assuming that its velocity relative to earth remains constant.)
- A K^0 meson at rest decays into a π^+ meson and a π^- meson, each having a speed of $0.85c$ (π^+ and π^- mesons have the same rest mass). If a K^0 meson traveling at a speed $0.9c$ decays, what is the greatest speed that one of the π mesons can have? what is the least speed?
- A particle of rest mass M_0 is at rest in the laboratory when it decays into three identical particles, each of rest mass m_0 . Two of the particles have velocities and directions as shown.



- Calculate the direction (θ) and the speed of the third particle.
- Find the ratio M_0/m_0 .

4. A particle of rest mass m_0 and kinetic energy $2m_0c^2$ strikes and sticks to a stationary particle of rest mass $2m_0$. Find the rest mass of the composite particle.
5. An electron-positron pair can be produced by a γ ray striking a stationary electron

$$\gamma + e^- \rightarrow e^- + e^+ + e^- . \quad (1)$$

A γ ray is made out of energetic photons. A positron (e^+) is the antiparticle of the electron (e^-). These two types of particles have the same physical properties except for opposite electrical charges. In particular their rest mass is $m_0c^2 = 0.51$ MeV. What is the minimum γ ray energy that will make this process go?

6. Show that the following processes are dynamically impossible:
 - (a) A single photon strikes a stationary electron and gives up all its energy to the electron
 - (b) A single photon decays in empty space into an electron and a positron.
 - (c) A fast positron and a stationary electron annihilate to give only one photon.