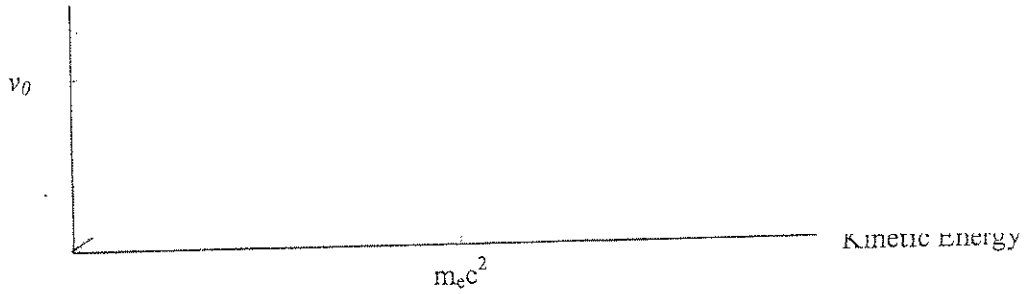
SR HW#3

8) A photon of energy, E= 10 keV, scatters from an electron at rest. The outgoing photon is at 90 degrees from the incident photon. What kinetic energy does the recoil electron have?

1, 2, 7

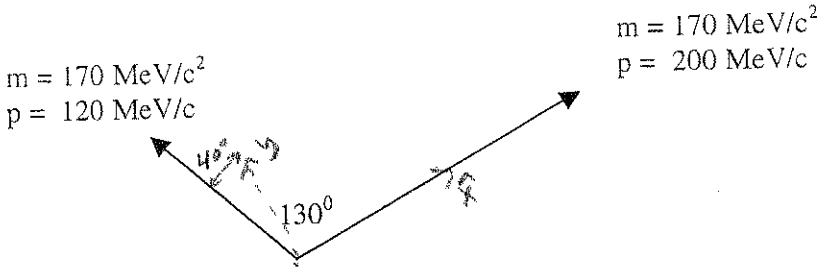
2 1) (4 pts) Solve for the speed, v_0, where the kinetic energy of an electron equals its rest mass energy. Sketch a graph of speed, v, versus kinetic energy, k, for the electron



3 2) (2 pts) As I travel towards a radio station, I observe its broadcast frequency to be increased such that $\frac{\nu'}{\nu} = \sqrt{\frac{1+\beta}{1-\beta}}$. I observe its wavelength to also be changed such that

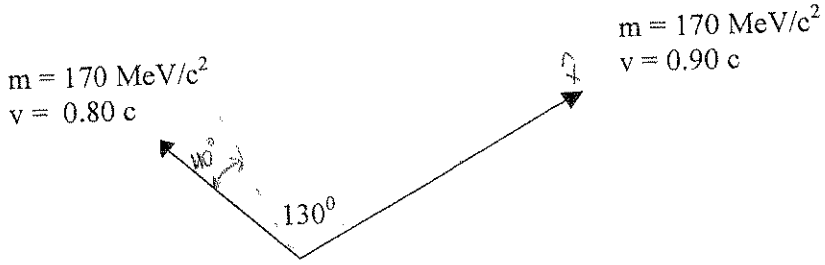
4.7) (6 pts) A Δ^+ particle decays from rest into a proton and pion. The pion has a rest mass energy of 140 MeV and momentum of 230 MeV/c. The proton has a rest mass energy of 938 MeV. What is the rest mass energy of the Δ^+ ?

8) A particle *at rest* decays into three other particles. One of them is a photon and not observed. The other two have energies and momentum shown. What is the rest mass energy of the original particle?

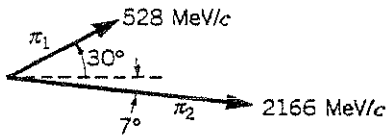


6 1) 1) A Δ^+ particle decays from rest into a proton and pion. The pion has a rest mass energy of 140 MeV and momentum of 230 MeV/c. The proton has a rest mass energy of 938 MeV. What is the rest mass energy of the Δ^+?

7. 10) A moving particle decays into two other particles as shown. What is the rest mass energy of the original particle?



8 -2) Consider a particle traveling along the x-axis to the right which decays into two pions with momentum as shown. The mass of the pions is about 140 MeV/c^2. We will determine the mass of the parent ρ meson.



a) What is the *total* energy of π_1 and π_2 combined? (Calculate them separately first.)

b) What is the total momentum in the x and y directions?

c) Using conservation of energy and momentum, what is the total momentum and energy of the parent particle?

d) What is the rest mass energy of the parent particle?

e) After many such measurements, one accumulates the figure below. Using it, estimate the lifetime of the parent ρ meson.

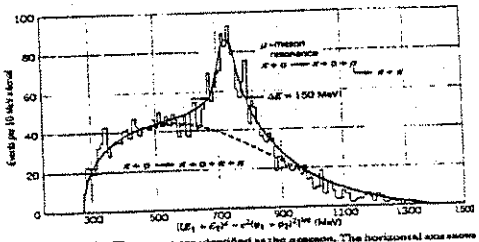
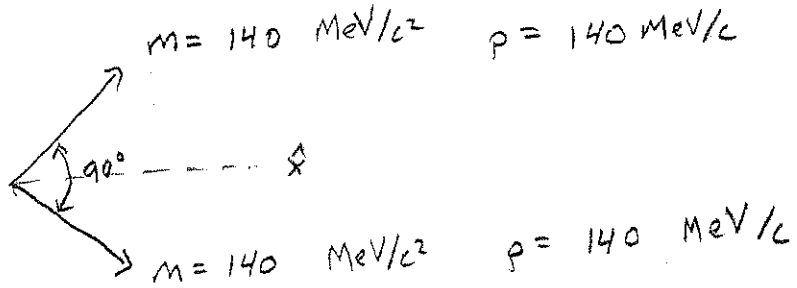


FIGURE 14.4 The resonance identified as the ρ meson. The horizontal axis shows the energy and momenta of the two decay pi mesons, combined to be equivalent to the mass of the resonance particle.

A 1) A neutral particle decays into two charged ones with characteristics as shown. How fast was the neutral particle traveling?



10 3) The neutrino beam from Fermilab to Soudan is produced by having energetic pions decay in-flight (producing neutrinos) along a 1200m tunnel. What is the maximum total energy of the pion if you want half of those entering one end of the tunnel to decay before reaching the other end of the tunnel? (The rest mass of the pion is 135 MeV/c^2, and its proper half-life is 26 nanoseconds).

4) An unknown neutral particle (invisible in the detector) decays symmetrically in flight into two singly charged particles (opening angle of 60 degrees), each with mass 450 MeV/c^2 and radius of curvature of 0.75 m in a 3 Tesla magnetic field as shown. What was the mass of the unknown particle? (hint: this requires a little playing with units – if everything goes in as MKS, then the result is in MKS; it *may* be convenient to multiply by "1" in the form of (3.0×10^8 m/s) / c) If you can not get the momentum of the particles, then use 500 MeV/c each.

12_8) A 1.0 MeV photon collides with an electron. What is the maximum *kinetic* energy which can be given to the electron? **Solve this directly using energy and momentum conservation**, and then check you results using Eqn 3-40 for Compton scattering: $\lambda_2 - \lambda_1 = \frac{h}{mc}(1 - \cos\theta)$ (note: hc=1240 eVnm)