

Homework 11

Question 1

A muon is an elementary particle which has a lifetime of 2×10^{-6} [s] in its rest frame. Consider such a muon which was created at a distance of 100 [km] above the ground, and falls towards the ground at a velocity of 2.97×10^8 [m/s].

At what height does it decay? In the muon's frame of reference, what is the distance it has traveled during its short lifetime?

Question 2

Consider a wave with wavelength of 500 [nm] as measured in the lab's frame of reference. In another frame of reference (denoted "frame B"), the same wave is measured to have a wavelength of 450 [nm]. What is the direction of motion of frame B relative to the lab? What is the size of the relative velocity?

Question 3

A neutral pion of (rest) mass m and (relativistic) momentum $p = 3mc/4$ decays into two photons. One of the photons is emitted in the same direction as the original pion, and the other in the opposite direction.

Find the relativistic energy of each photon.

Question 4

In a pair annihilation experiment, an electron of mass m with momentum p_e hits a positron (same mass but opposite charge) at rest. They annihilate, producing two photons.

1. Why couldn't they produce just one photon?
2. If one of the photons emerged at 60 degrees relative to the incident electron direction, what is its energy?

Question 5

A particle of rest mass m and velocity V decays into two particles with rest masses m_1, m_2 .

1. Show that the decay is possible only for $m > m_1 + m_2$.
2. Find the relation between the energy and the angles of emergence of these particles.