

Bilkent University, Department of Physics

PHYS 453: Nuclear & Particle Physics

First Homework

Due Date: 24 February 2012

1. Estimate the kinetic energy of a Boeing 747 (mass $M=400$ t) at cruising speed (850 km/h) and compare it with the energy released in a mosquito-antimosquito annihilation.
 2. In the LHC at CERN, two proton beams collide head on, each with energy $E_p=7$ TeV. What energy would be needed to obtain the same CM energy with a proton beam on a fixed hydrogen target?
 3. In a monochromatic π beam with momentum p_π , a fraction of the pions decay in flight into muon and a neutrino, $\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$. It is observed that in some cases the muon moves backwards (wrt pion). Find the maximum value of p_π for this to happen.
 4. A π^- beam is brought to rest in a liquid hydrogen target. Here π^0 are produced by the 'charge exchange reaction': $\pi^- + p \rightarrow \pi^0 + n$. Find: the energy of the π^0 ; the kinetic energy of the n ; the velocity π^0 ; and the distance travelled by π^0 in the lab frame, if it has a lifetime of τ_{π^0} (in its rest frame).
 5. A pion traveling at a speed v decays into a muon and a neutrino, $\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$. If the neutrino emerges at 90° to the original pion direction, at what angle does the muon come off?
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