Boğaziçi University
Department of Physics

Phys 311/407 Summer 2015

Problem Set #3

Reading: Rohlf Sections 5.2, 5.3, 5.4, 5.5

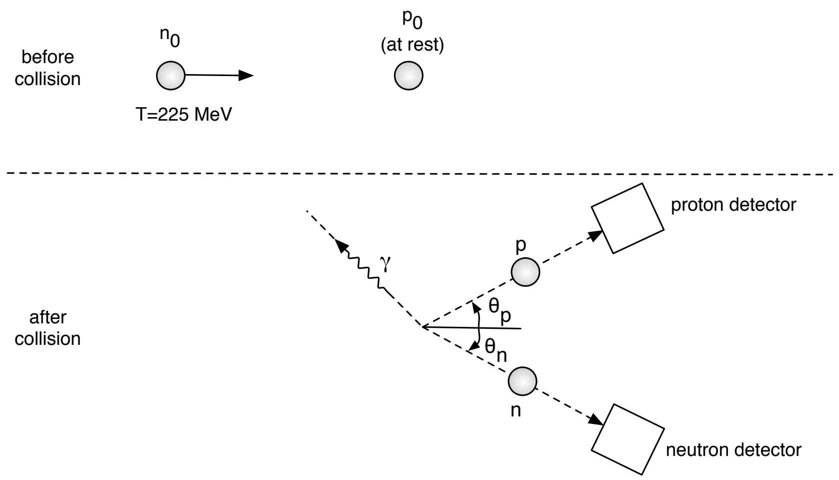
Problem 1:
What is the total energy of a particle with a rest mass of one gram moving with half the speed of light in Joules? Compare this to the energy production of the Atatürk Dam: Take the power output of the Atatürk Dam to be 2400 MW. How many hours does it take for the dam to produce the same amount of total energy of this particle?

Problem 2:
Suppose that we could use the energy released when 1 gr of antimatter annihilates 1 gr of mass to lift a mass 1 km from the Earth's surface. How much mass could we lift?

Problem 3:
A particle whose rest energy is $Mc^2 = 625$ MeV decays into π^- and π^+. If mass of pions are $m_{\pi^+} = m_{\pi^-} = 140$ MeV/c^2, what will be the momenta of the decay particles? ($M \to \pi^- + \pi^+$)

Problem 4:
The nuclear reaction $p + d \to {}^3\text{He} + \gamma$ can occur even when the initial particles have zero kinetic energy — we say the reaction is exothermic. If the gamma ray has energy of 5.5 MeV when the reaction occurs with the initial particles at rest, what is the mass of ^{3}He nucleus? Take $m_p = 938.28$ MeV/c^2 and $m_d = 1875.6$ MeV/c^2.

Problem 5: – (Challenge problem)
Consider the reaction, $n_0 + p_0 \to n + p + \gamma$. We call this np–bremsstrahlung reaction. The word *bremsstrahlung* means "breaking radiation" in German. np reaction gives out a photon; radiation. Assume that the proton (target) is at rest, and the kinetic energy of the incoming neutron is $T_{n_0} = 225$ MeV. We detect the outgoing p and n particles at $\theta_p = +20^\circ$ and $\theta_n = -20^\circ$ as seen in the following figure:



a) Find the solutions of the kinetic energy of outgoing neutron, T_n, for a given T_p. **b)** Make, preferably, a computer generated plot (or use a graphing paper and a calculator) of T_n vs T_p using the equation found in part a). [Hint: The plot will be a closed curve; there are two solution for a given T_p.] We call this curve *kinematic locus*. Take $m_n = m_p = 938.28$ MeV/c^2