Physics 3710 – Problem Set #6 *Relativistic dynamics, II*

Problems 1-5 refer to: The mass of the neutron is 1.008664 u and that of the proton is 1.007276 u, where 1 u = 931.5 MeV.

1. Suppose a neutron decays into a proton and an electron (and a neutrino, which for this problem we will ignore). The mass of the electron is 0.000549 u. How much kinetic energy does the electron carry away (assuming it carries all of the kinetic energy)?

2. What is $\tilde{\gamma}$ for the electron of Problem 1? What is the electron's dimensionless speed, u (this is a speed not a mass unit)?

3. The mass of a uranium 238 nucleus (*Z* = 92, *N* =146) is 238.050782 u. Calculate the binding energy (in MeV) per nucleon of this nucleus.

4. Suppose the uranium nucleus of Problem 3 fissions into two equal product nuclei: ${}^{238}_{92}U \rightarrow {}^{119}_{46}Pd + {}^{119}_{46}Pd$. The mass of ${}^{119}_{46}Pd$ is 118.922680 u. How much kinetic energy (in MeV) per nucleon (i.e., per 238) is released in one such fission?

5. The effective fusion process in stars like Sun is $4p \rightarrow {}^{4}_{2}He + 2e^{+} + neutrinos$. The mass of ${}^{4}_{2}He$ is 4.002603 u and the mass of the positron e^{+} is the same as the electron (Problem 1). Neutrinos have essentially no mass. How much kinetic energy (in MeV) per nucleon (i.e., per 4 nucleons) is released per fusion process?

6. By what factor is the answer to 5 greater than the answer to 4?