2 Physics 2424 Energy & Momentum

1. The radioactive element ^{238}U decays via the emission of an alpha particle (a ^{4}He nucleus, symbol α). What is the other decay product? How much energy is released? All this energy is in the form of the kinetic energy of the decay products. How fast is the alpha particle travelling?

2. A neutron outside the nucleus β decays into a proton, an electron, and a neutrino. Note that n = 1.008665 u, p = 1.007285 u, and e = 5.48578×10^{-4} u.
   (a) Assuming the neutrino is massless, how much energy is released?
   (b) Assuming that all this energy is converted into the kinetic energy of the electron, how fast is the β electron moving?
   (c) If you ignored relativistic effects, how fast would the electron be moving.

3. Beta decay can occur inside a nucleus with the proton remaining inside the daughter product while the electron and neutrino escape. As can be seen from Appendix A of Tipler, ^{11}Be decays this way. Write out the decay formula. Assuming that the neutrino is massless, determine the recoil speeds of the decay products.

4. Consider ^{31}P which has 15 protons and 16 neutrons. Find the binding energy per nucleon. Note that n = 1.008665 u, ^{1}H = 1.007825 u, and ^{31}P = 30.973762 u.

5. Can ^{14}C decay into ^{12}C through the spontaneous emission of two neutrons?