Modern Physics Homework

Homework 4: **Due Friday, October 12**.

We will probably have an Exam on relativity on Wednesday, October 17.

1. A neutron is moving with a speed of 0.9c. What is its energy (in MeV) and Momentum (in MeV/c)?
2. A particle has an energy of 1MeV and a momentum of 0.99 MeV/c.
   a) What is its speed in units of c?
   b) What is its mass in MeV/c^2?
3. Someone tells you that a particle has an energy of 10MeV and a momentum of 11MeV/c. What do you think of this? Explain!
4. A free neutron is an unstable particle and will decay to a proton, an electron, and an antineutrino which can be approximated as having 0 mass. How much energy will this decay release?
5. Find the binding energy of ^{7}Li in MeV. (The mass of ^{7}Li = 7.016004 u)
6. A Carbon-14 nucleus decays to a ^{14}N nucleus plus an electron (and an antineutrino again). How much energy (in MeV) is released in this reaction?
7.* An unstable particle has an unknown mass and is at rest in our frame. It decays into two equal mass particles of mass = 200MeV/c^2. They each have a momentum of 141MeV/c, in opposite directions of course. What was the mass of the original particle?
8. Show that the quantity $(\Delta s)^2 = (\Delta x)^2 - (c\Delta t)^2$ is the same in all frames that move with a constant velocity relative to each other.

(An * indicates a slightly harder problem.)

The table below lists the masses of some particles in atomic mass units, amu. (You can check Wikipedia for more information about atomic mass units.) Appendix B in the back of the book has the masses of many atoms in amu, or u. 1u = 1.66×10^{-27}kg.

Oblect	Mass (u)	MeV/c^2
	1.00	931.5
Electron	0.00054858	0.5110
Proton	1.007276	938.27
Neutron	1.008665	939.57
H	1.007825	938.78