

# PHYS4702 Atomic, Nuclear, & Particle Physics Fall 2015 HW #10

*Due at the start of class on Thursday 5 Nov 2015*

(1) Using MATHEMATICA or some other program, reproduce Figure 15-12 in the textbook, and add a couple of data points to show agreement as in Figure 15-10. When reproducing 15-12, include the effects of volume, surface, Coulomb, and asymmetry terms, as well as the total, as shown.

You are welcome to obtain some data values to plot from any source you like. One (professional) place to start is (<http://www.nndc.bnl.gov/ensdf/>) which references all available information for all known nuclei. See also <http://amdc.impcas.ac.cn/evaluation/data2012/ame.html>.

(2) Somewhere in your studies so far, you've likely shown that the energy required to assemble a uniformly charged sphere of charge  $Ze$  and radius  $R$  is

$$V = \frac{3}{5} \frac{1}{4\pi\epsilon_0} \frac{Z^2 e^2}{R}$$

Show that this gives the form assumed for the Coulomb term  $f_3(Z, A)$  in the semi-empirical mass formula. Evaluate the coefficient (taking a reasonable expression for  $R$ ) and compare to the value in the textbook. Use your result to calculate the mass difference between the nuclei  $^{11}\text{B}$  and  $^{11}\text{C}$  and compare to data.

(3) It is possible to purchase a commercial “*dt*” neutron generator. This device accelerates a beam of deuterons, i.e.  $^2\text{H}$ , into a target containing tritium, i.e.  $^3\text{H}$ , impregnated into a solid. Even with a very low energy deuteron beam, easily obtained with an electrostatic accelerating voltage, a relatively high energy neutron beam is obtained, because of the nuclear energy released in the reaction  $^2\text{H} + ^3\text{H} \rightarrow ^4\text{He} + n$ .

Use data in your textbook or elsewhere to calculate the energy of the neutrons emitted from the reaction in the same direction as the incident beam of deuterons, if the energy of the deuterons is 250 keV.