1. How many protons and neutrons would $^{224}$Pb have? $^{197}$W?

2. You successfully create the hydrogen isotope $^4$H (which was called quadrium in the novel *The Mouse That Roared* by Leonard Wibberly), which you measure to have an atomic weight of exactly 4.00000 u. What is its binding energy?

3. Compute the total binding energy, and binding energy per nucleon, in MeV, of (a) $^9$Be (b) $^{24}$Mg (c) $^{239}$Pu. You may confirm your answer against the data from the NNDC (see link on web page) but show your work.

4. Compute the Q-value for the neutron emission of $^4$H $\rightarrow$ $^3$H +n (using the mass of quadrium given in problem 2 above)

5. A nucleus of $^{239}$Pu captures a neutron (and so becomes $^{240}$Pu, this is important), and then $^{240}$Pu undergoes spontaneous fission. It fissions into two fragments and 4 neutrons. One of the fragments is $^{101}$Zr. What is the other fragment, and what is the Q-value?

6. Consider the mirror nuclei $^{39}$K and $^{39}$Ca. Compute the difference in binding energies, in MeV. You must do this carefully, including the fact that protons and neutrons have different masses. (You may look up the binding energies from the NNDC.) Assume that this differences in mass is due to Coulomb energy. From this deduce a value for $r_0$ in the formula $R_{rms}=r_0 A^{1/3}$.

7. (a) What is the mass excess of $^5$H if it has an atomic mass of 5.0130?
   (b) The mass excess of $^{22}$C is 15.540 MeV. Compute its atomic mass.

8. Consider two spherically symmetric distributions of matter. First is a constant density, that is, $\rho(r) = \rho_0$ out to some fixed $R_{max}$. The second is an exponential distribution, $\rho(r) = \rho_1 \exp(-r/R_{exp})$. (a) Find the rms radius for both distributions as a function of $R_{max}$ or $R_{exp}$. (b) Now, using $R_{max}$ and $R_{exp}$ such that you have the same rms radius, fix $\rho_0$ and $\rho_1$ so that both distribution have the same normalization (i.e., the integrals give the same total amount of matter). (c) Compute the form factors for both distributions. Plot $|F(q)|^2$ for both on the same plot. (Hint: plot $|F(q)|^2$ on a log scale). Point out the first two diffraction minima. You may use a computer program or plot by hand with a calculator.