Box Num. 33
Problem Set 33
April 20, 2018

1. (a) The stable isotopes of ^{76}Ge are ^{70}Ge, ^{72}Ge, ^{73}Ge, ^{74}Ge, and ^{76}Ge itself.
   The stable isotones of ^{76}Ge are ^{80}Kr, ^{79}Br, ^{78}Se, and ^{76}Ge.
   The stable isobars of ^{76}Ge are ^{76}Se and ^{76}Ge.

   (b) The mass defect of ^{3}H is 0.008557u, which corresponds to a binding energy of 7.97 MeV.
   For ^{3}He, the mass defect is 0.00718853u, corresponding to a binding energy of 6.696 MeV. The decrease in binding energy is due to the repulsion between the two protons in the ^{3}He nucleus.

   (c) The mass defect in going from ^{17}O to ^{16}O + n is 0.00305938u, which corresponds to an energy of 2.85 MeV.

   (d) The mass defect going from ^{40}Ca to ^{39}K + p is 0.00839216u, which corresponds to an energy of 7.187 MeV.

2. In Rutherford scattering, the closest approach of this incident particle is at the distance

$$d = \frac{1}{4\pi\epsilon_0}\frac{zZe^2}{K} = \frac{1}{4\pi\epsilon_0}\frac{(2)(82)e^2}{28\,\text{MeV}} = 8.43\,\text{fm}$$

   The radius of the a nucleus is approximately $R = R_0 A^{1/3}$, so in this case $R = (1.25\,\text{fm})(208)^{1/3} = 7.406\,\text{fm}$. Since the closest approach is so close to the radius of the nucleus, quantum effects come into play and the nucleus cannot be treated like a point charge, as required by the Rutherford model.

3. Using this formula, the electrostatic energy of ^{7}Be is 5.78 MeV, and the electrostatic energy of ^{7}Li is 3.25 MeV, for a difference in energy of 2.53 MeV. This rough estimate is close to the observed value of 1.7 MeV, and, as expected, is too large because of the roughness of our model.

4. The isotope with the highest binding energy per nucleon is ^{62}Ni, with an energy of 8.79 MeV per nucleon.