Homework #12: Assume a ^{238}U fissions into two equal nuclei.

1) What are the fission products?

U has 92 p & 146 n

the the product X + X contains 92 p & 146 n

X contains 46 p & 73 n

This is ^{119}Pd with 46 p & 73 n.

The fission products are two ^{119}Pd nuclei.

2) What is the difference in the total binding energy before and after fission? Assume this is the energy released by fission.

$$\varepsilon_b = \varepsilon_b^{\text{even-even}} = (15.75\,\text{MeV})238 - 17.8\,\text{MeV}\cdot 238^{2/3} - \frac{(.711\,\text{MeV})92^2}{238^{1/3}} - \frac{23.7\,\text{MeV}(238-184)^2}{238} + \frac{11.18\,\text{MeV}}{\sqrt{238}}$$

$$= 3748.5\,\text{MeV} - 683.60 - 971.08 - 290.37 + .72 = 1804.17\,\text{MeV}$$

$$^{119}Pd \quad \varepsilon_b = \varepsilon_b^{\text{even-odd}} = (15.75\,\text{MeV})119 - 17.8\,\text{MeV}(119)^{2/3} - \frac{.711(46)^2\,\text{MeV}}{(119)^{1/3}} - \frac{23.7\,\text{MeV}(119-92)^2}{119}$$

$$= (1874.75 - 430.64 - 305.87 - 145.19)\,\text{MeV} = 992.55\,\text{MeV}$$

$$\Delta = |2 \cdot 992.55\,\text{MeV} - 1804.17\,\text{MeV}| = \boxed{180.93\,\text{MeV}}$$

5) Assume the ^{238}U and its fission products are uniformly charged spheres which repel. What will be their kinetic energy when they fly apart? Compare your answer with part 2 above.

$$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}$$

$q_1 = q_2 = 46e$ $\qquad R = 1.25\,fm \cdot (119)^{1/3}$

$r = 2R = 2.5\,fm(119)^{1/3}$

$$V = \frac{1}{4\pi\varepsilon_0}\cdot\frac{46^2 e^2}{2.5\,fm(119)^{1/3}} = \frac{23^2 e^2}{\pi\varepsilon_0 2.5\,fm(119)^{1/3}} = K$$

$$K = \frac{13.69\ e^2}{\varepsilon_0 \cdot m} \times 10^{15}$$

$$= \frac{1.369\times10^{15}\cdot 1.6^2\times10^{-38}\ C^2\ m^2\cdot N}{8.85\times10^{-12}\ C^2 m}$$

$$= .396\times10^{-10}\,J \cdot \frac{1\ eV}{1.6\times10^{-19}\,J} = 2.475\times10^{8}\ eV$$

~~247.475 MeV~~

$= \boxed{247.5\ MeV}$

energy from EM larger than from part 2.