Answer on question # 51449, Physics, Solid State Physics

Question Using the semi-empirical mass formula for the binding energy of nuclei, calculate the value of the atomic number (Z) for the most stable nucleus at a given mass number. Calculate Z0 for A = 60. Take the values of g = 23.7 and d = 0.71 .

Solution The most stable nucleus at a given mass number will be the one with the biggest binding energy:

$$E_c = \alpha A - \beta A^{2/3} - d\frac{Z^2}{A^{1/3}} - g\frac{(A/2-Z)^2}{A} + \delta, \qquad \delta = \pm\chi A^{3/4} \text{ or } 0$$

A is give and equal to 60, but we can change Z. Let us take derivative with respect to Z, to find local extremum of this function of Z.

$$E_c' = -2d\frac{Z}{A^{1/3}} + 2g\frac{A/2-Z}{A} = 0$$

So we can find Z now:

$$-0.71\frac{Z}{60^{1/3}} + 23.7\frac{60/2-Z}{60} = 0$$

$$Z \approx 21$$

So this formula tells us that nuclei with Z=21 will be most stable. It can be true, however, because most stable with A=60 is ${}^{60}_{28}Ni$.