Homework 22

We are considering atomic structure of matter. Below are problems which contain some simple, but interesting estimations. Consider the mass of the proton equal to the mass of the neutron.

1. A uranium isotope ^{238}U (238 is the mass number) is alpha-radioactive with the half-lifetime of about 4.5 billion years, ^{210}Po has the half-lifetime of ~138 days. Which one you would consider more dangerous? Explain. Which elements are the product of the alpha decay of ^{238}U and ^{210}Po? (just to remind: by alpha decay we call the transformation of one element into other with the emission of alpha-particle – cluster of 2 protons and 2 neutrons).

2. In a rough approximation, an atomic nucleus can be considered as a ball with an effective radius
$$r \cong r_0 A^{1/3} \ ,$$
where r_0 ia a constant which is approximately equal to 1.2x 10^{-15}m, A is the mass number. Using the formula above, estimate the density of the nuclear matter.

3. Does the nuclear density (obtained in the problem 1) depend on the mass number?

4. Using the periodic table of elements estimate the density of iron (Fe). Consider the atoms of iron as cubes with the side of 2.3×10^{-10}m.

5. Compare the results obtained in problems 1 and 3. Explain the difference.

6. Imagine that you "stretched" a hydrogen atom so the nucleus is now of the size of a dime. How far away from the nucleus you will, probably, find the electron? Take the size of a "normal" hydrogen atom as 10^{-10}m.