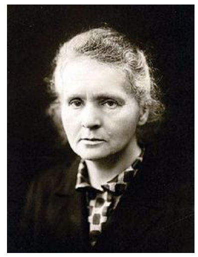
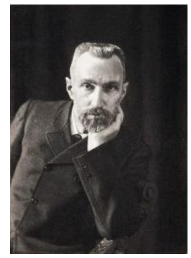
Homework 18.

Radioactivity.

We started discussing radioactivity. Radioactivity is a process of transformation of atomic nuclei accompanied by emission of high energy particles. The discovery of radioactivity is associated with three names:

Henri Becquerel (1852-1908)	Marie Skłodowska-Curie (1867-1934)	Pierre Curie (1859-1906)

We learned that there are three major kinds of particles which can be emitted as a result of radioactive decay. These are α-, β- and γ-particles.

α-particle is a heavy, positively charged particle, which consists of 2 protons and 2 neutrons. After emission of a α-particle the atomic number of an element decreases by 2 and the mass number decreases by 4.

A neutron is not a stable particle and can turn into a proton. The lifetime of a free neutron is about 12 min. This process of the neutron decay is called β^--decay and is accompanied by emission of an electron (so the total charge is conserved) and another particle which is called electron antineutrino. (β^+-decay with the emission of positron (anti-electron) is also possible, but we will not discuss it now). At β^--decay the atomic number increases by 1, but the mass number does not change.

A γ-particle is a high energy particle of electromagnetic radiation. This particle has no electric charge.

The elements whose atoms experience radioactive decay are called *radioactive*, the other elements are called *stable*.

Problems:

1. 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 2.3x10^{-10}m.

5. 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.