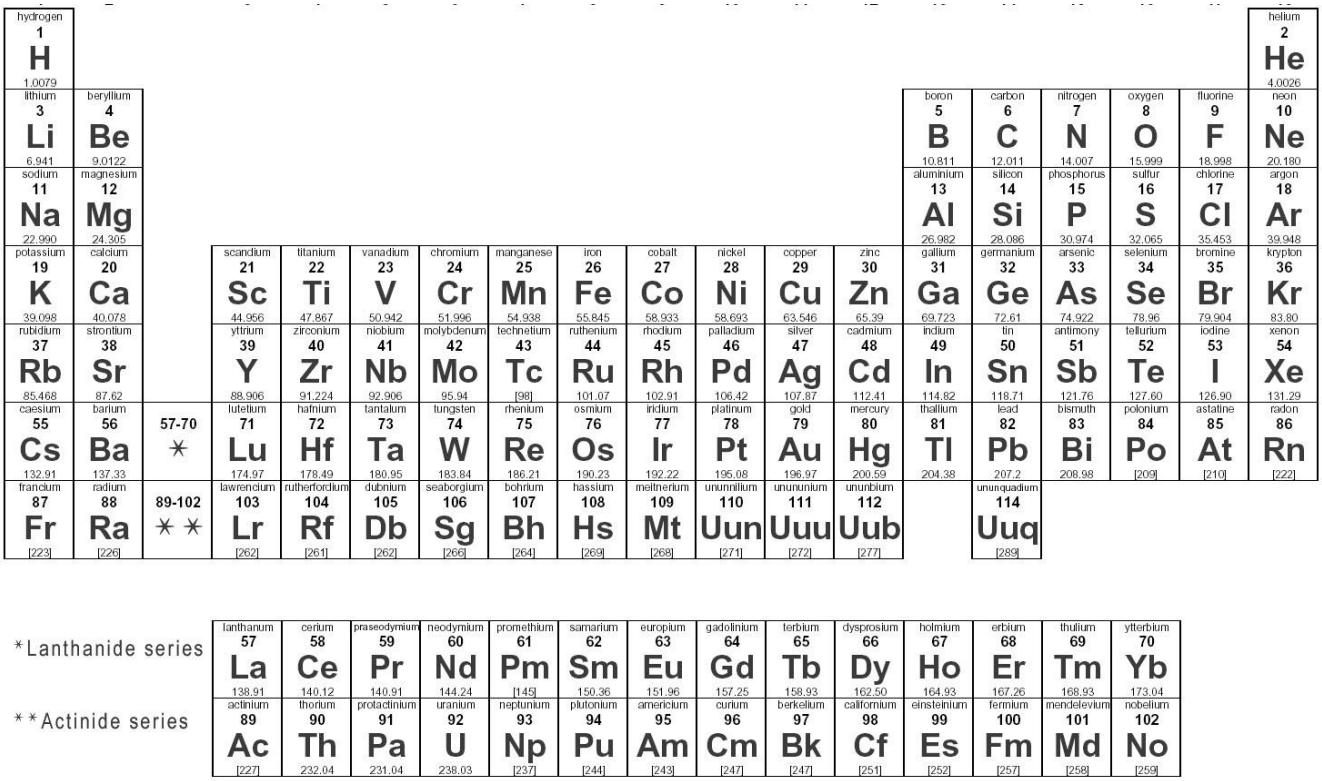
Homework 23

During last class we started discussing periodic table of elements. Chemical elements are the "building blocks" of nature. All the objects around us are "constructed" from chemical elements. In spite of great variety of the objects and substances around us there are only 118 chemical elements (some of them are not shown in the table below). They are systematized and arranged in the table which is called *periodic table of elements*.

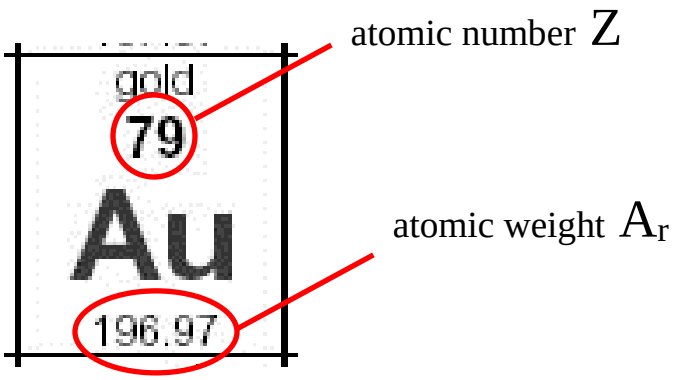


Periodic table of elements.

The periodic table was first suggested by a Russian chemist Dmitri Mendeleev in 1869. He found that if the chemical elements are arranged according their atomic weight, their chemical properties exhibit periodicity, that is why it is called "periodic".

Dmitri Mendeleev (1834-1907).

Only two of the chemical elements – mercury and bromine - are liquids at normal conditions (T=300K, atmospheric pressure), eleven elements are gases. The other elements are solids except nine elements (109-111 and 113-118) in the end of the table whose chemical properties are still unknown. The most important parameter which determines chemical properties of an element is the atomic number *Z*. The atomic number is the number of protons in the atomic nucleus.



The number of neutrons in the nucleus is denoted as ***N***. The sum of ***Z*** and ***N*** gives the mass number ***A***.

$$N+Z=A$$

Since the proton and neutron have approximately same mass we can estimate the mass of the atom by multiplying the atomic number A to the proton (or neutron) mass. In this estimation we neglected the total mass of electrons (which is much smaller than the mass of protons) and another correction which is called "mass defect". The number of neutrons in the atomic nucleus has just a weak effect on the chemical properties of the substance. Atoms having same ***Z*** but different ***N*** are called isotopes. A typical way to refer to a certain isotope is to place the mass number after the element's name. For example: *iodine-131* or *uranium-238*. Since the number of protons is the same

in all isotope nuclei of a certain element, we can find in the periodic table as an atomic number. For example, this number for the isotope uranium-238 is 92. So this particular isotope has 238-92=146 neutrons.

Most of the natural elements are mixture of isotope atoms which have different mass. Average of the atomic masses of the isotopes gives *atomic weight* $\boldsymbol{A_r}$.

Atomic weights are given in the periodic table (see figure above). In what units are they expressed? The unit which is used is called "unified atomic mass unit". It is equal to 1/12 of free atom of a carbon isotope *carbon-12* which is 1.66×10^{-27}kg.

1. Find the number of protons and neutrons in the nucleus of Caesium-137.
2. One of the alchemist dreams was making gold (Au) out of lead (Pb). How we should change the atom of lead to obtain the atom of gold?
3. What element we will obtain if we merge nuclei of two isotopes helium-3 and helium 4?