Homework 19.

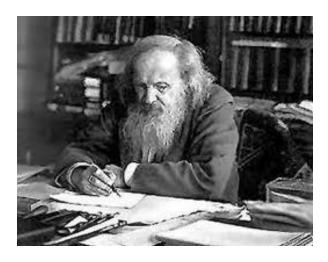
Periodic table of elements.

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*.

hydrogen 1	Ī -		(85)	95%	1/5	6	150	ē	85	10	56.	\$ T	#EX	700 0	86%	707	## T	helium 2 He
1.0079 lithium	beryllium	i										í	boron	carbon	nitrogen	DID ITO D	fluorine	4.0026 neon
3	4												5	6	nitrogen 7	oxygen 8	9	10
Li	Be												В	С	N	0	F	Ne
6,941 sodium	9.0122 magnesium												10.811 aluminium	12.011 silicon	14.007 phosphorus	15.999 sulfur	18,998 chlorine	20.180 argon
11 NI	12 N/Lor												13 A I	14	15	16	17	18
Na 22.990	Mg												AI 26.982	Si 28.086	P 30,974	S 32,065	CI 35,453	Ar 39.948
potassium 19	calcium 20		scandium 21	titanium 22	vanadium 23	chromium 24	manganese 25	iron 26	cobalt 27	nickel 28	copper 29	zinc 30	gallium 31	germanium 32	arsenic 33	selenium 34	bromine 35	krypton 36
K	Ca		Sc	Τi	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.098	40.078		44.956	47.867	50.942	51.996	54.938	55.845	58.933	58.693	63.546	65.39	69.723	72.61	74.922	78.96	79.904	83.80
rubidium 37	strontium 38		yttrium 39	zirconium 40	niobium 41	molybdenum 42	technetium 43	ruthenium 44	rhodium 45	palladium 46	silver 47	cadmium 48	indium 49	tin 50	antimony 51	tellurium 52	iodine 53	xenon 54
Rb	Sr		Y	Zr	Nb	Мо	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	Ï	Xe
85.468	87.62		88.906	91.224	92.906	95.94	[98]	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.60	126.90	131.29
caesium 55	barium 56	57-70	lutetium 71	hafnium 72	tantalum 73	tungsten 74	rhenium 75	osmium 76	iridium 77	platinum 78	gold 79	mercury 80	thallium 81	lead 82	bismuth 83	polonium 84	astatine 85	radon 86
Cs	Ba	*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	TI	Pb	Bi	Po	At	Rn
132.91	137.33		174.97	178.49	180.95	183.84	186.21	190.23	192.22	195.08	196.97	200.59	204.38	207.2	208.98	[209]	[210]	[222]
francium 87	radium 88	89-102	lawrencium 103	rutherfordium 104	dubnium 105	seaborgium 106	bohrium 107	hassium 108	meitnerium 109	ununnilium 110	unununium 111	ununbium 112		ununquadium 114				
Fr	Ra	* *	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub		Uuq				
[223]	[226]		[262]	[261]	[262]	[266]	[264]	[269]	[268]	[271]	[272]	[277]		[289]				
Ianthanum certum praseodymium neodymium promethium samarium europium gadolinium terbium dysprosium holmium erbium thulium ytterbium																		
*Lantl	hanide	series	57	58	59	60	61	62	63	64	65	66	67	68	69	70		
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Но	Er	Tm	Yb		
			138.91 actinium	140.12 thorium	140.91 protactinium	144.24 uranium	[145] neptunium	150.36 plutonium	151.96 americium	157.25 curium	158.93 berkelium	162.50 californium	164.93 einsteinium	167.26 fermium	168.93 mendelevium	173.04 nobelium	9	
* * Actinide series			89	90	91	92	93	94	95	96	97	98	99	100	101	102		
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		
			[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]		

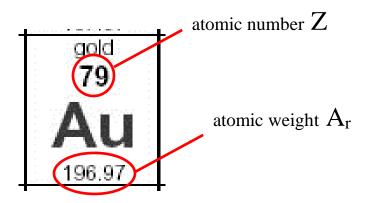
Periodic table of elements.

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 \mathbf{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* 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?