The Periodic Table

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Vocabulary

electron arrangement
(electron configuration)
shell
outer shell
valence electrons
energy level
orbital
charge
electronegativity
electron affinity
ionization potential

alkali metals
alkaline-earth metals
transition metals
halchogens
halogens
rare-earth elements

trend

Chemical elements

Non-metals

H – hydrogen

O – oxygen

N – nitrogen

B – boron

Si –silicon

P – phosphorus

S – sulfur, sulphur

F - fluorine

Cl - chlorine

Br - bromine

I - iodine

He -helium

Chemical elements

Metals

sodium – Na

potassium – K

magnesium - Mg

iron – Fe

copper – Cu

silver – Ag

zinc – Zn

tungsten – W

manganese – Mn

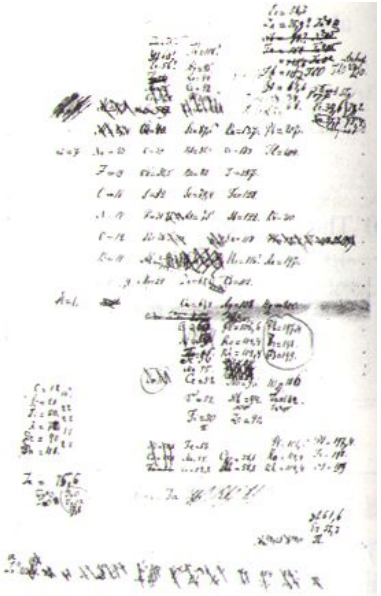
lead – Pb

tin – Sn

mercury - Hg

The Periodic Table of Chemical Elements

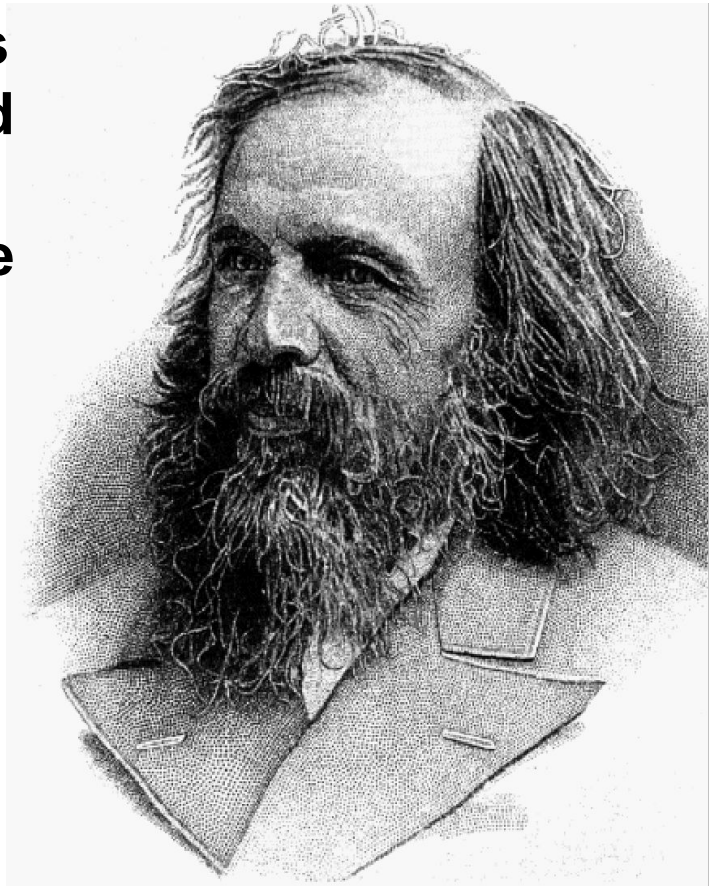
- **What is the Periodic table ?**
- **What information is obtained from the table ?**
- **How can elemental properties be predicted by means of the PT ?**



Dmitri Mendeleev (1869)

D.I.Mendeleev grouped elements according to their atomic mass, and as he did, he found that the families had similar chemical properties.
Blank spaces were left open to add the new elements he predicted would occur.

Row	Group I — R_2O	Group II — RO	Group III — R_2O_3	Group IV RH_4 RO_2	Group V RH_3 R_2O_5	Group VI RH_2 RO_3	Group VII RH R_2O_7	Group VIII — RO_4
1	H = 1							
2	Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 31	S = 32	Cl = 35.5	
4	K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63
5	(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140				
9								
10			?Er = 178	?La = 180	Ta = 182	W = 184		Os = 195, Ir = 197, Pt = 198, Au = 199
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12				Th = 231		U = 240		



Dmitri Mendeleev.

http://www.chem.msu.su/eng/misc/mendeleev/welcome.html

The Periodic Table

Henri Moseley (England,1887-1915) established that each elements has a unique atomic number, which is how the current Periodic table is organized.

Mendeleev:

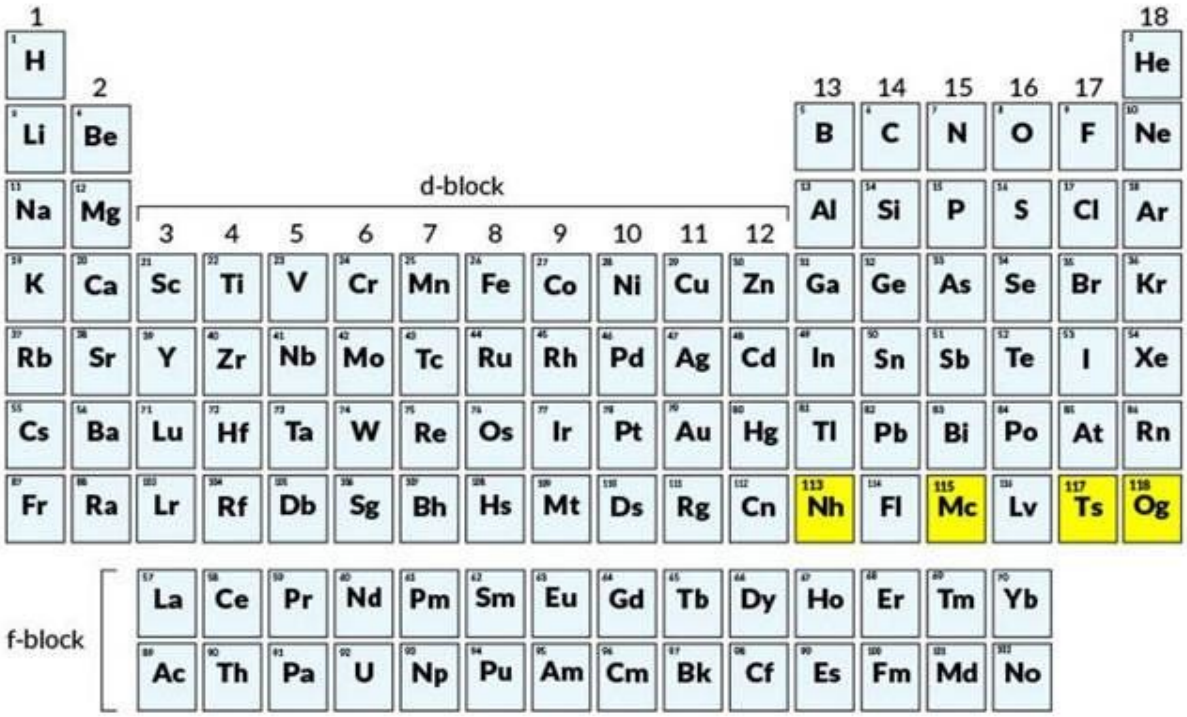
"The properties of elements, as well as its compounds are periodic function of the their atomic weight."

Modern formulation:

"The properties of chemical elements, as well as the forms and properties of the compounds of the elements are periodic function of the nuclear charge of atoms of the chemical elements".

Periodic changes of chemical properties of elements can be explained by the correct repetition of electronic configuration of external energy level (valence electrons) of their atoms with increasing charge of nucleus.

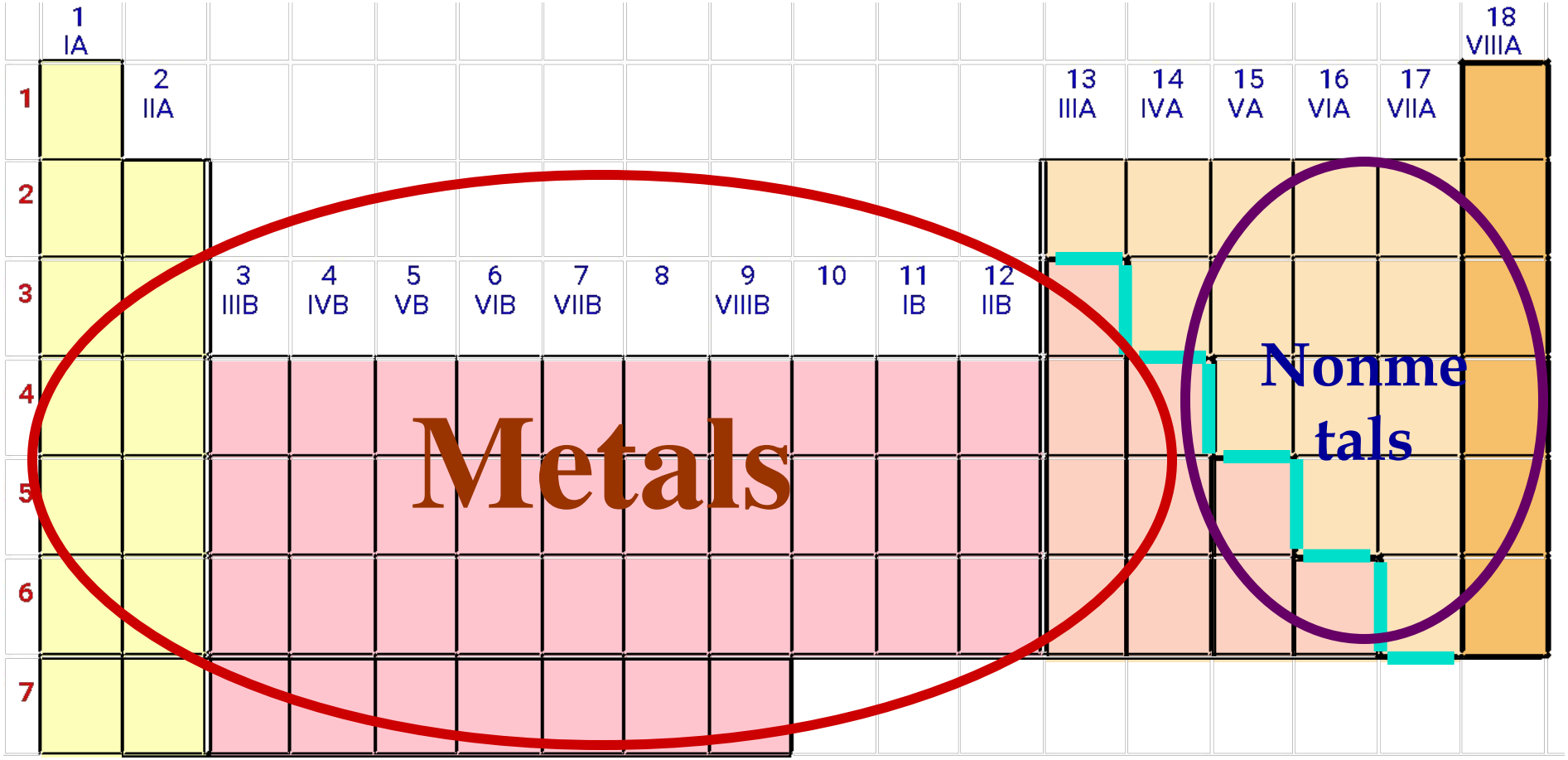
The latest version



The International Union of Pure and Applied Chemistry has announced the names of four elements in the Periodic table that were discovered in January 2016. Moscovium (Mc), nihonium (Nh), tennessine (Ts) and oganesson (Og) complete the seventh row of the table. The elements — with atomic numbers 113, 115, 117 and 118 — were discovered in a joint effort by American and Russian scientists.

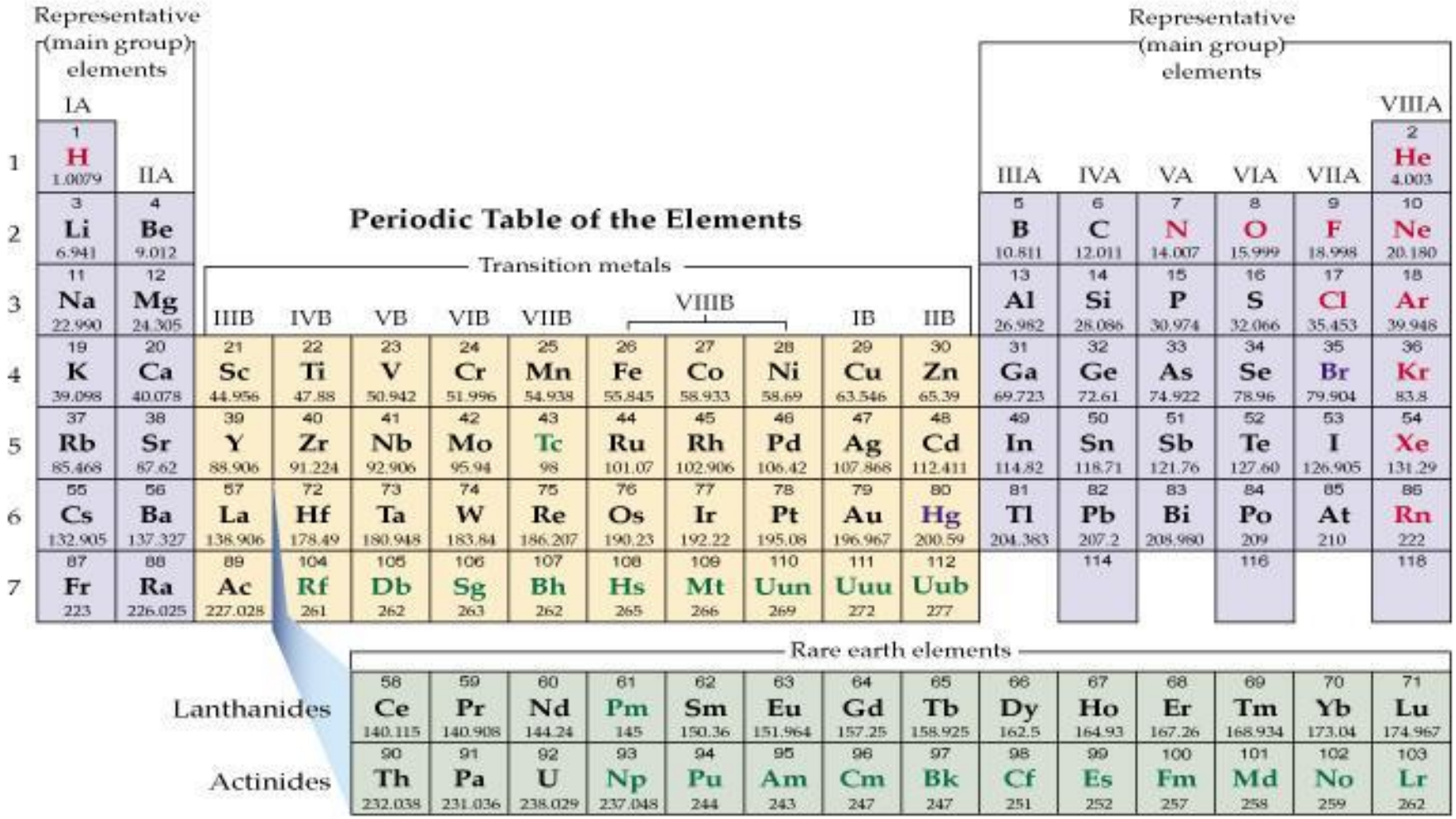
Periodic Table: Metallic arrangement

Layout of the Periodic Table: Metals vs. nonmetals



Periodic Table: The three broad Classes Main, Transition, Rare Earth

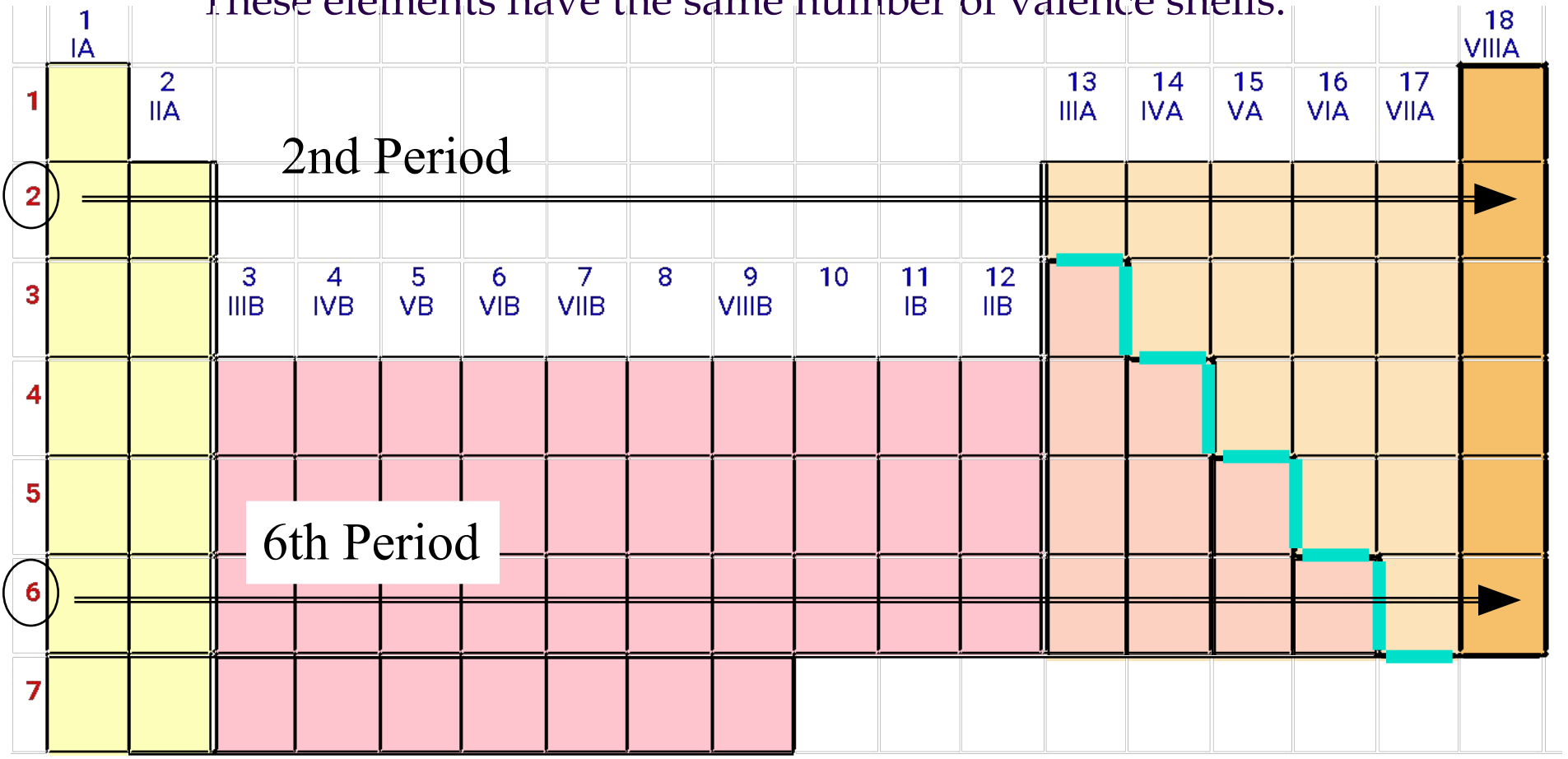
Main (Representative), Transition metals, lanthanides and actinides (rare earth)



Across the Periodic Table

Periods: are arranged horizontally across the periodic table (rows 1-7)

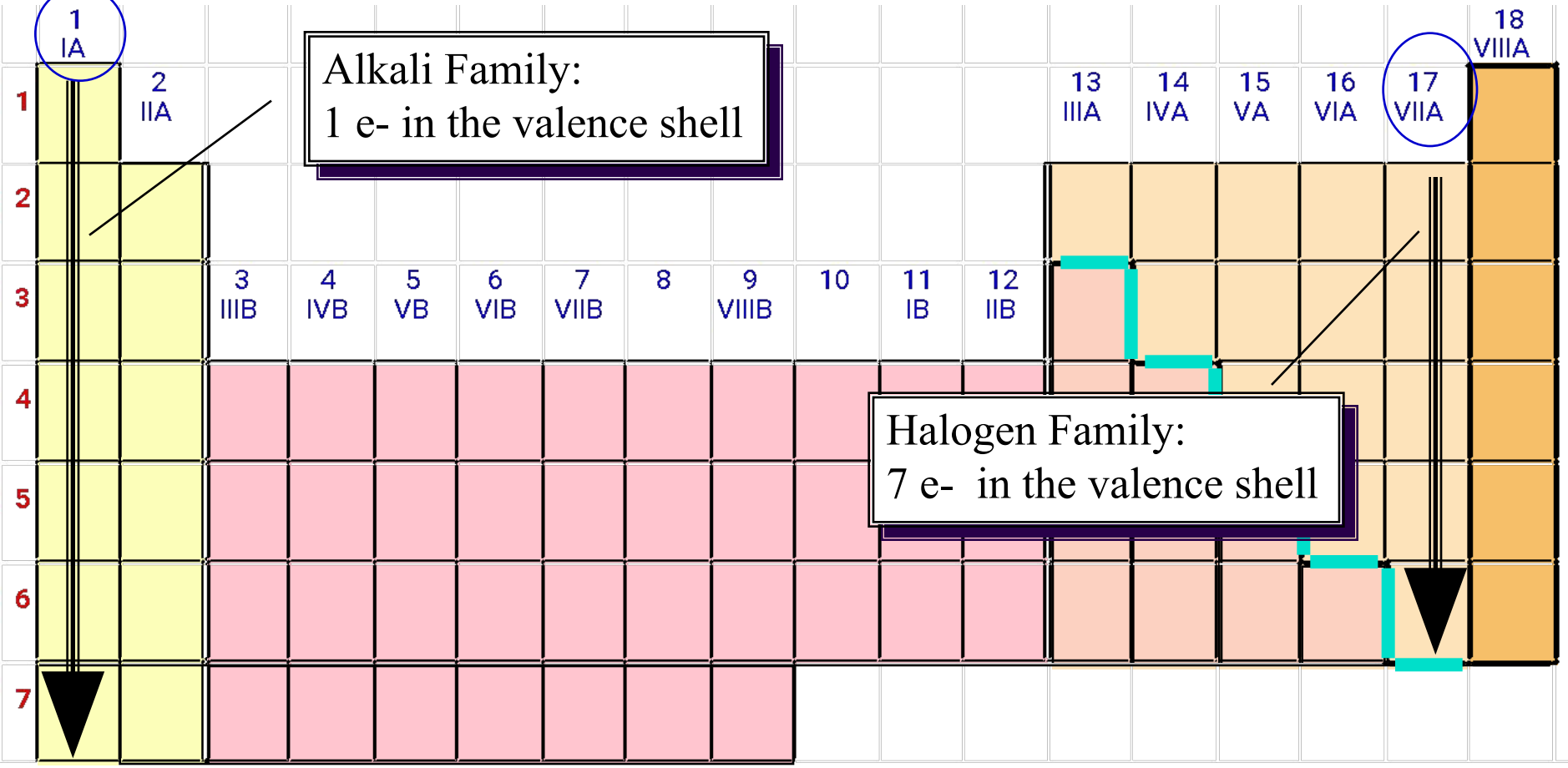
These elements have the same number of valence shells.



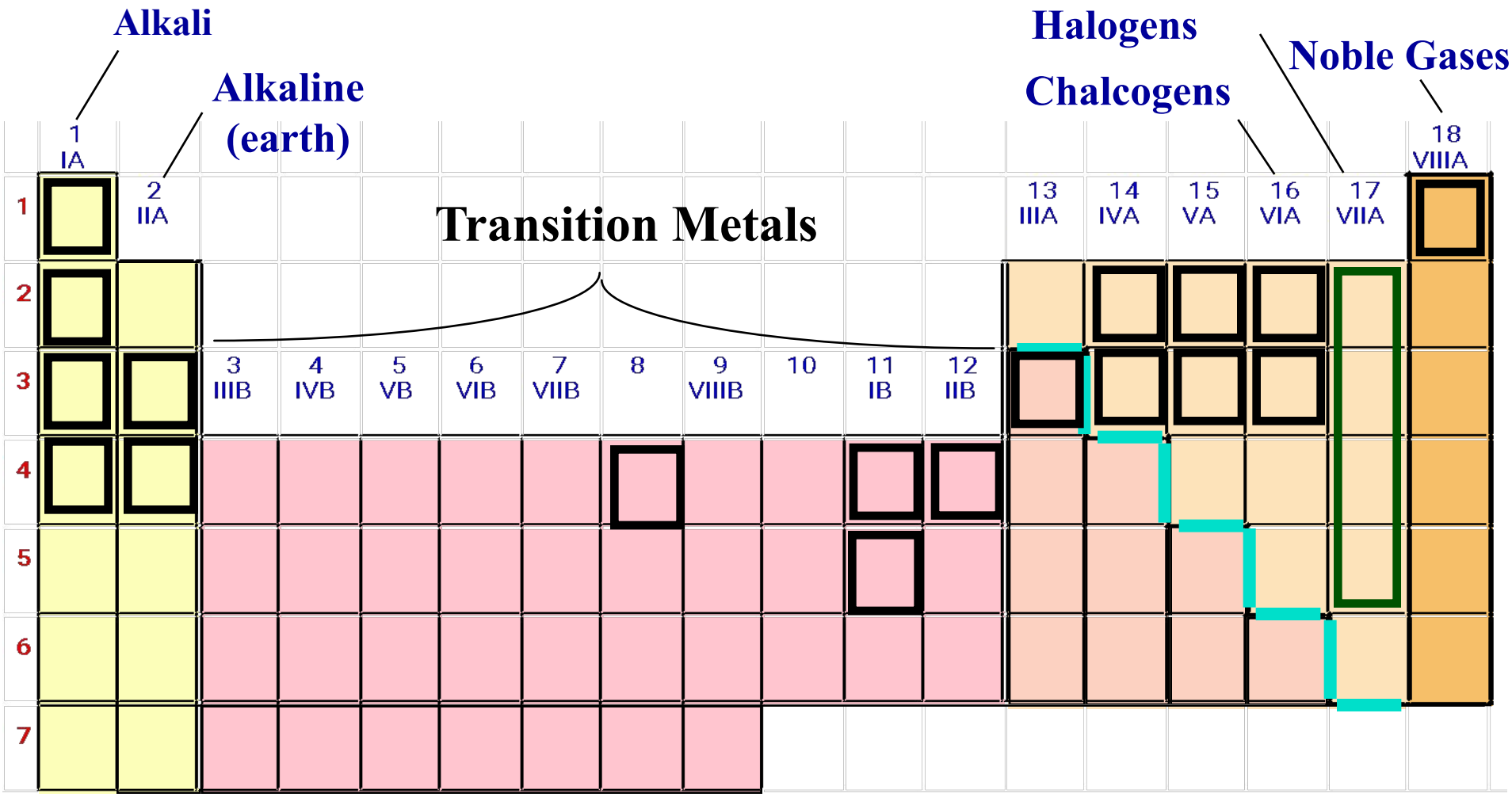
Down the Periodic Table

Families (groups) : are arranged vertically down the periodic table (1- 18 or 1-8 A,B)

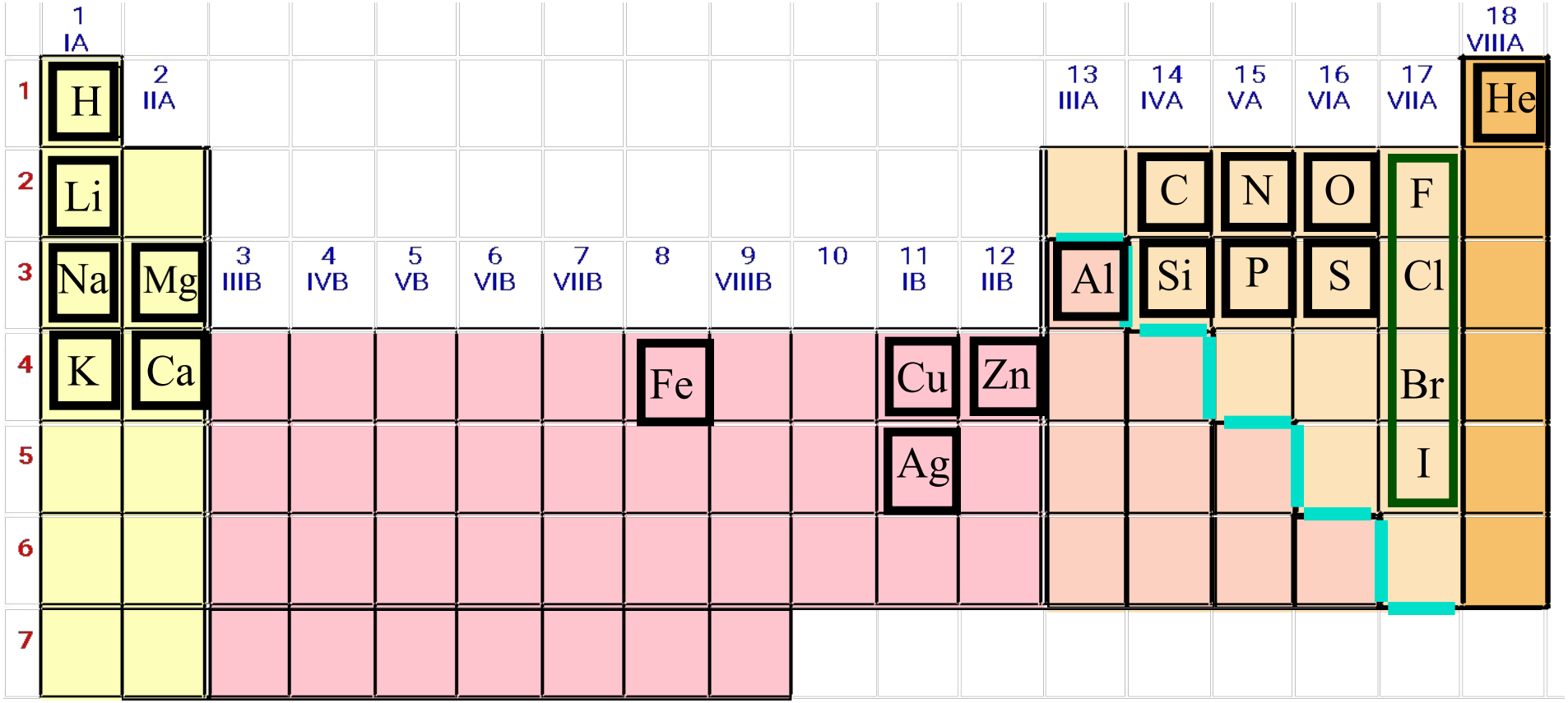
These elements have the same number electrons in the outer most shells, the valence shell.



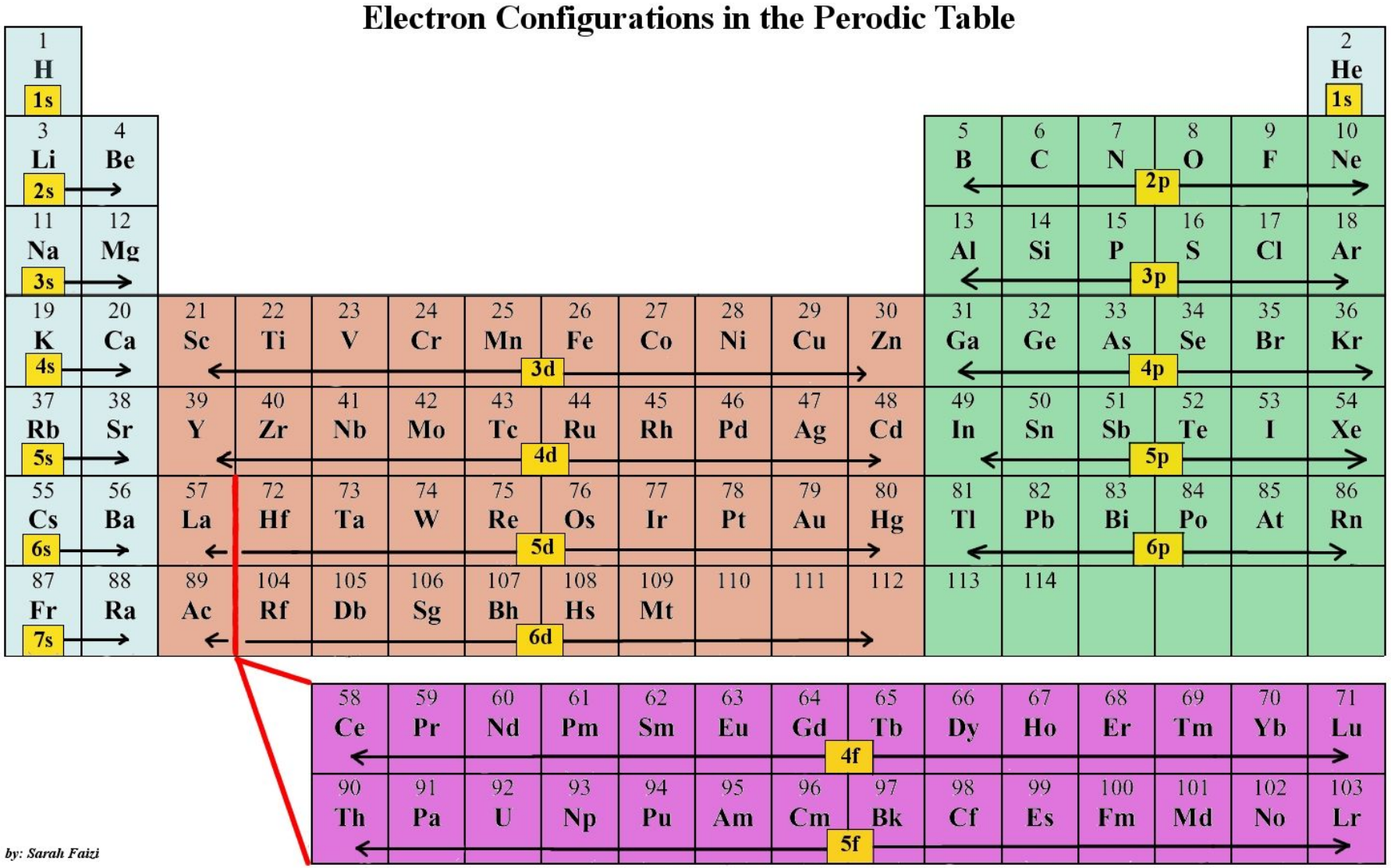
Notable Families of the Periodic Table



Important members - the Elements



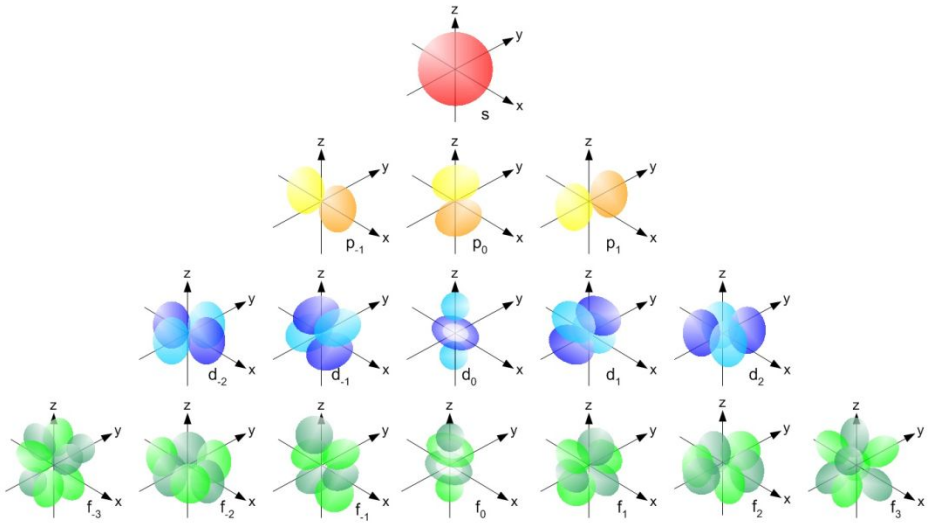
The Periodic Table



by: Sarah Faizi

Orbitals

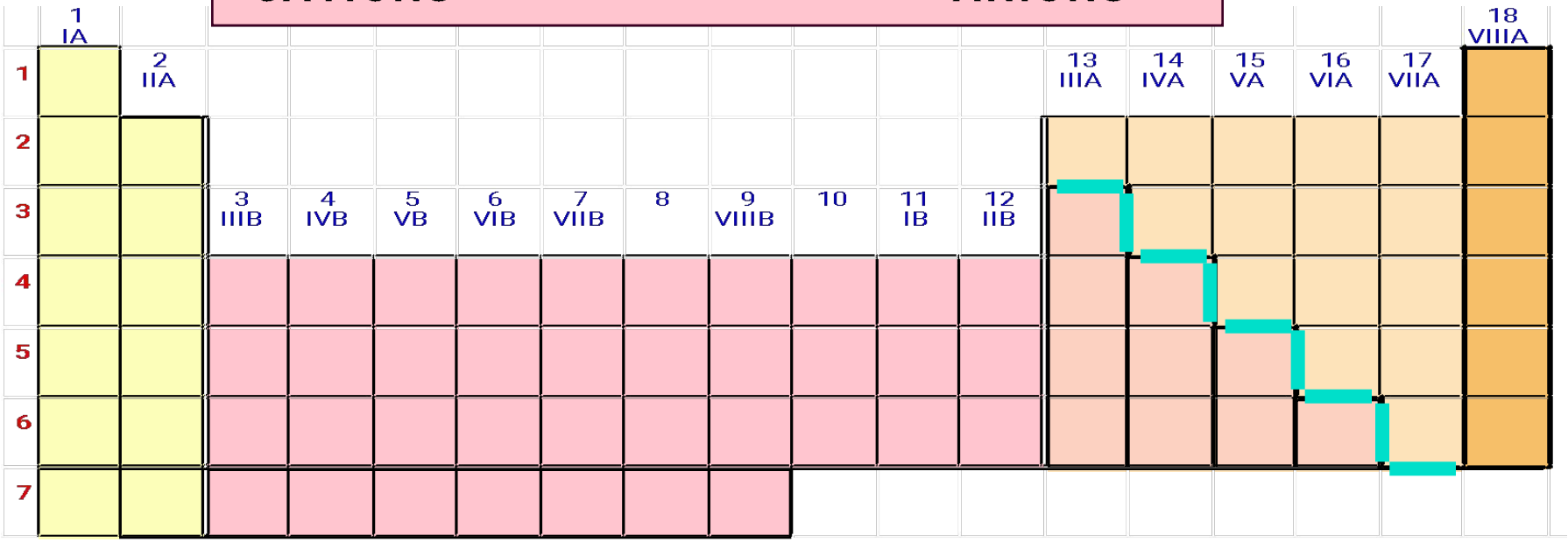
- An atom is composed of a nucleus containing neutrons and protons with electrons dispersed throughout the remaining space. **Electronic orbitals** are regions within the atom in which electrons have the highest probability of being found.
- Each orbital has its own specific energy level and properties. Because each orbital is different, they are assigned specific **quantum numbers**: 1s, 2s, 2p 3s, 3p,4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p. The numbers, (n=1,2,3, etc.) are called **principal quantum numbers** and can only be positive numbers. The letters (*s,p,d,f*) represent the *orbital angular* momentum quantum number.



Periodic Table: electron behavior

Elements can be classified by the behavior of their electrons

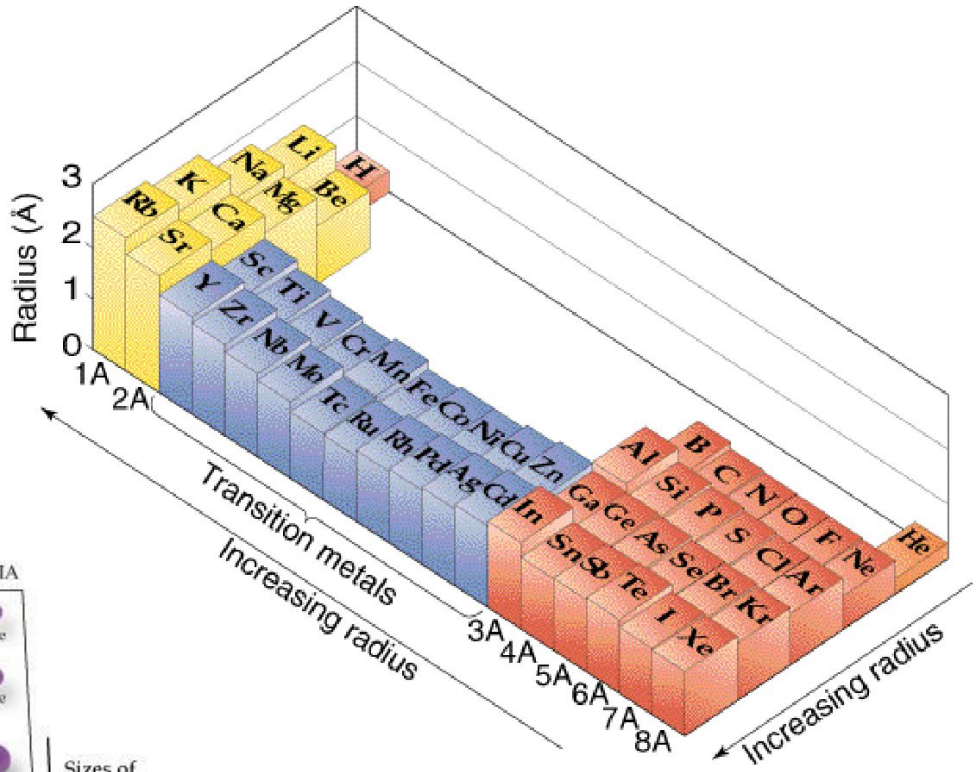
West (South) **METALS**	Mid-plains **METALLOID**	East (North) **NON-METALS**
Alkali Alkaline Transition		Noble gas Halogens Calcogens
These elements tend to **give up** e^- and form **CATIONS**	These elements will give up e^- or accept e^-	These elements tend to **accept** e^- and form **ANIONS**

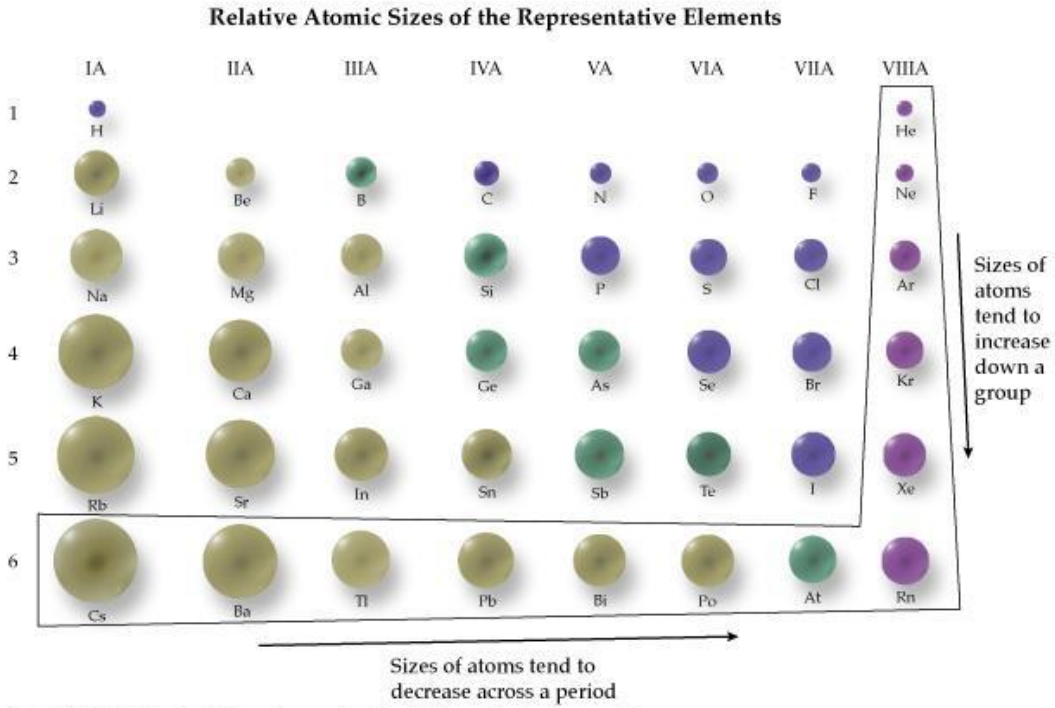


Trend in Atomic Radius

Atomic Radius:

The size of at atomic specie is determined by the boundaries of the valence e- layer. Largest atomic species are those found in the SW corner since these atoms have the largest n, but the smallest Z_{eff}.



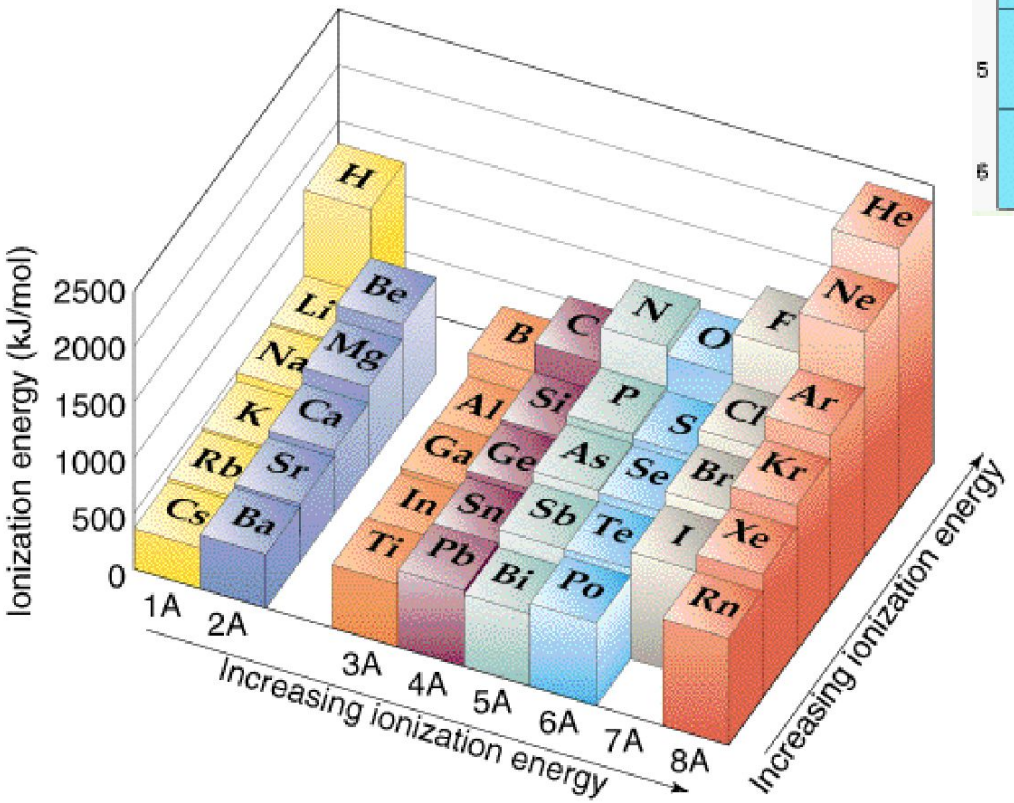


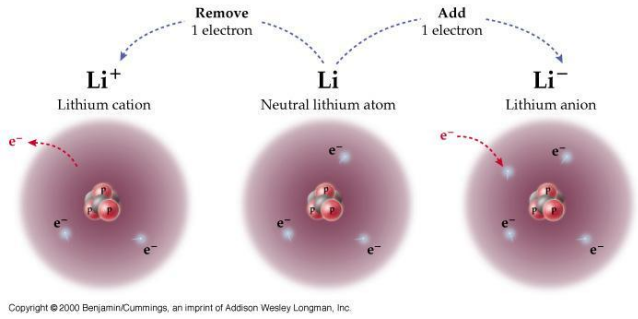
Trend in Ionization Potential

Ionization potential:

The energy required to remove the valence electron from an atomic specie. Largest toward NE corner of PT since these atoms hold on to their valence e- the tightest.

	IA							VIIIA
1	H 1312	IIA	IIIA	IVA	VA	VIA	VIIA	He 2372
2	Li 520	Be 899	B 801	C 1086	N 1402	O 1314	F 1681	Ne 2081
3	Na 496	Mg 738	Al 578	Si 786	P 1012	S 1000	Cl 1251	Ar 1521
4	K 419	Ca 590	Ga 579	Ge 762	As 947	Se 941	Br 1140	Kr 1351
5	Rb 403	Sr 549	In 558	Sn 709	Sb 834	Te 869	I 1008	Xe 1170
6	Cs 376	Ba 503	Tl 589	Pb 716	Bi 703	Po 812	At 926	Rn 1037

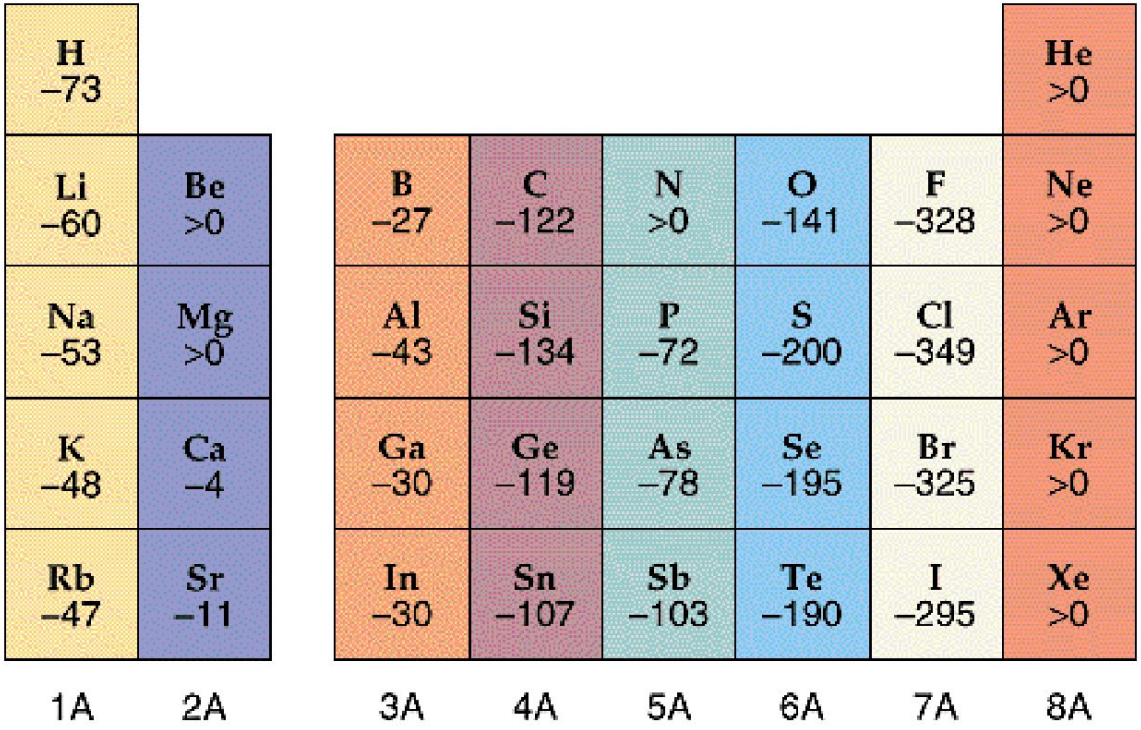




Trend in Electron Affinity

Electron Affinity:

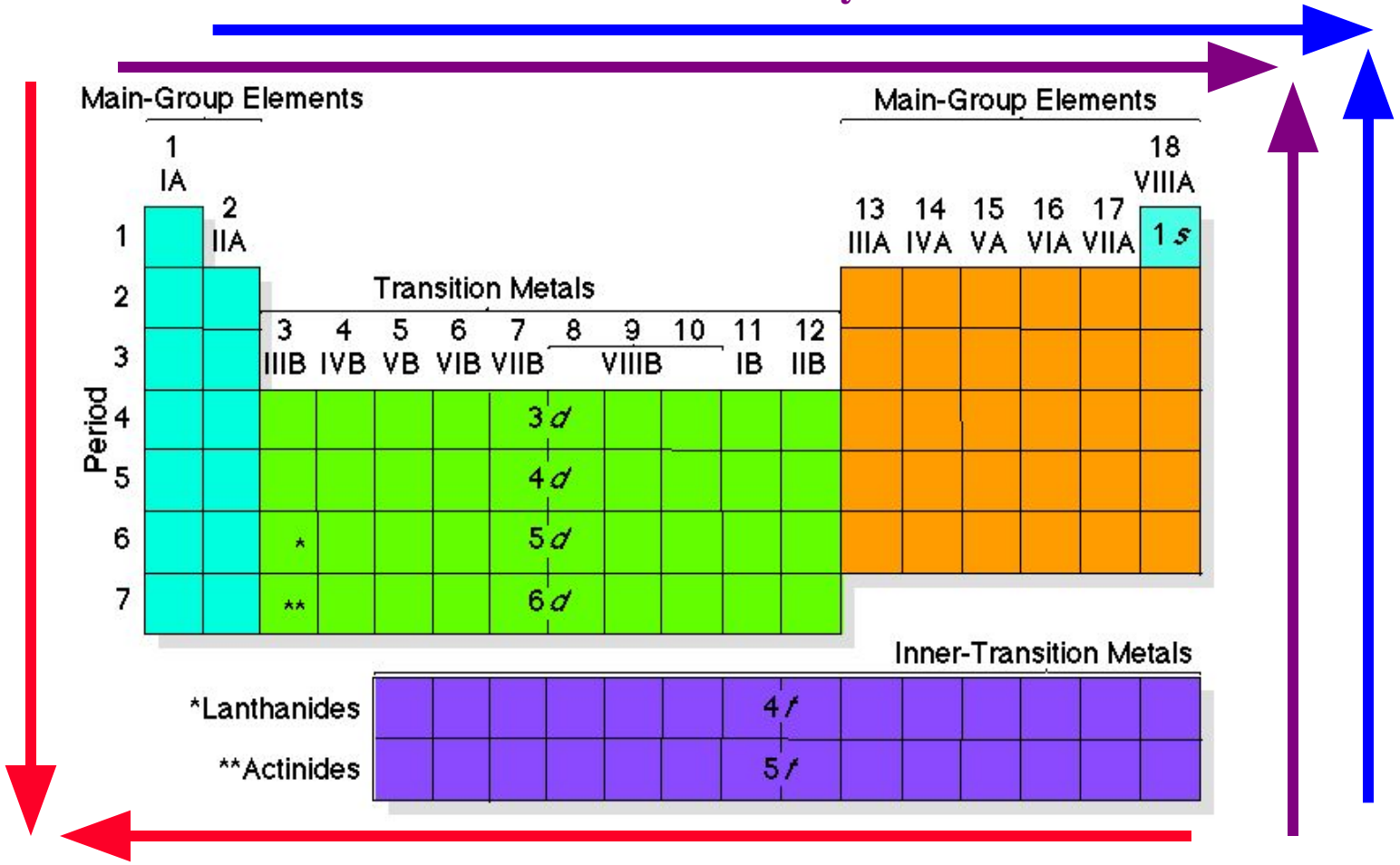
The energy release when an electron is added to an atom. Most favorable toward NE corner of PT since these atoms have a great affinity for e-.



Summary of Trends

Ionization Energy: Largest toward NE of PT

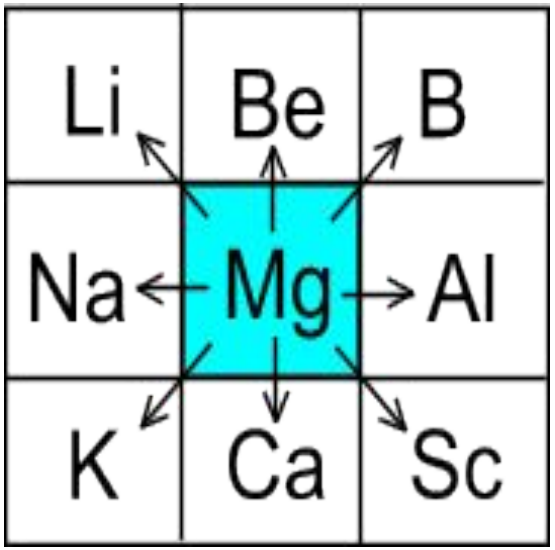
Electron Affinity: Most favorable NE of PT



Atomic Radius: Largest toward SW corner of PT

Summary of Trends

On the position of element in the Periodic system possible to forecast its basic properties, as average of all its neighbors:



Summary

Periodic Table: Map of the Building blocks of matter

Types: Metals and Nonmetals

Families: Elements in the same column have similar chemical properties because of similar electronic configuration of the outer shell.

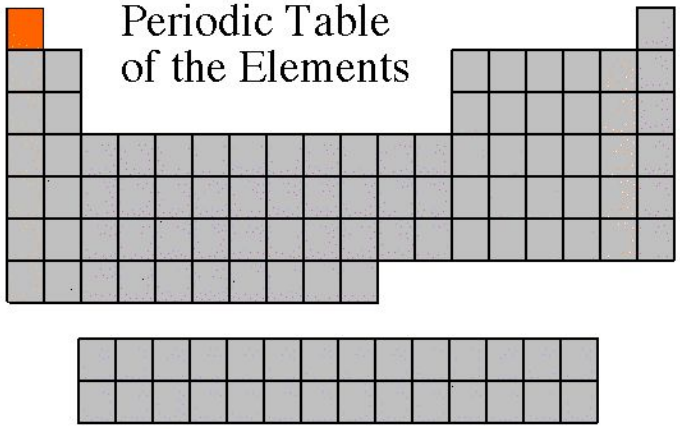
Alkali, Alkaline, chalcogens, halogens, noble gases

Periods: Elements in the same row have valence electrons in the same shell.

Groups: Elements in the same group have the same number of valence electrons .

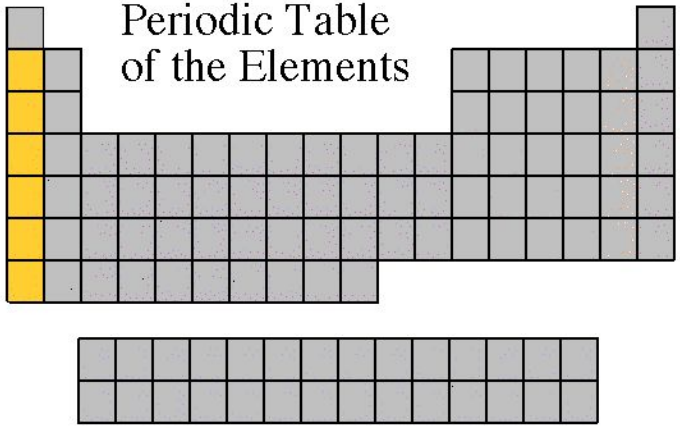
Hydrogen

- The hydrogen square sits atop Family AI, but it is not a member of that family. Hydrogen is in a class of its own.
- It's a gas at room temperature.
- It has one proton and one electron in its one and only energy level (s-orbital).
- Hydrogen only needs 2 electrons to fill up its valence shell.



Alkali metals

- The alkali family is found in the first column of the Periodic table.



- Atoms of the alkali metals have a single electron in their outermost level, in other words, 1 valence electron.

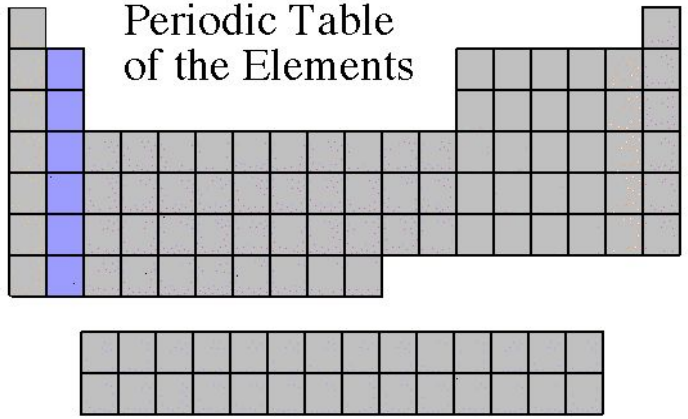
- They are shiny, have the consistency of clay, and are easily cut with a knife.

- They are the most reactive metals.
- They react violently with water.

- Alkali metals are never found as free elements in nature. They are always bonded with another element.

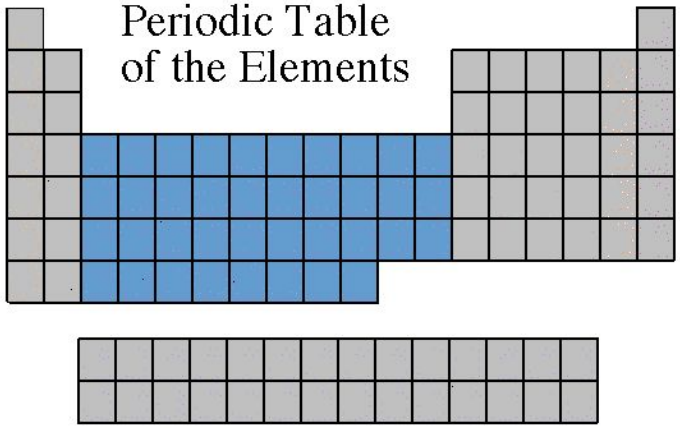
Alkaline Earth Metals

- Alkaline earth metals include magnesium and calcium, among others.
- They have 2 valence electrons.
- They are active metals.
- They are never found uncombined in nature.



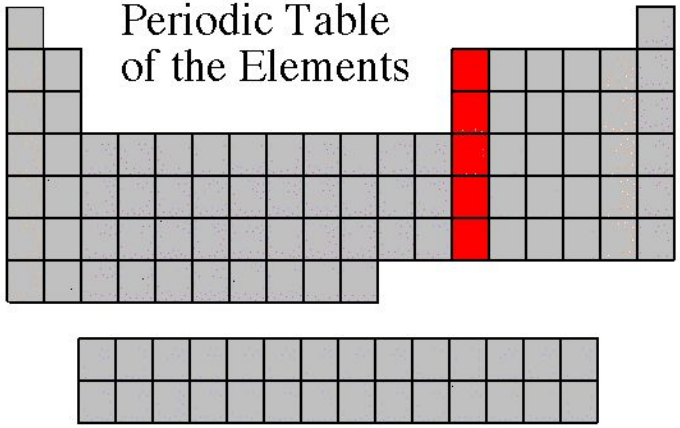
Transition Metals

- **Transition Elements include those elements in the B families.**
- **Transition elements have 1 or 2 valence electrons, which they lose when they form bonds with other atoms. Some transition elements can lose electrons in their next-to-outermost level.**
  - **Low ionization energies**
  - **Positive oxidation states, multiple oxidation states, since there is a low energy gap between them**
  - **Very hard**
  - **Exhibit metallic luster**
  - **High melting and boiling points**
  - **High electrical conductivity**
  - **High thermal conductivity**
  - **Malleable**
  - **Form colored compounds, due to d-d electronic transitions**
  - **Typically exhibit high catalytic activity**



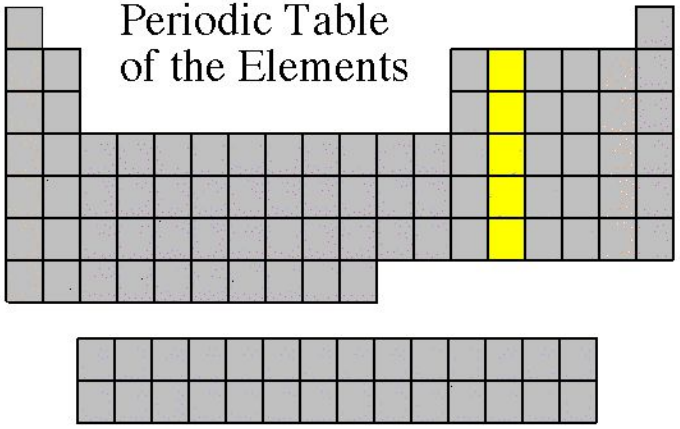
Boron Family

- The Boron Family is named after the first element in the family.
- Atoms in this family have 3 valence electrons.
- This family includes a metalloid (boron), and the rest are metals.
- This family includes the most abundant metal in the Earth's crust (aluminum).



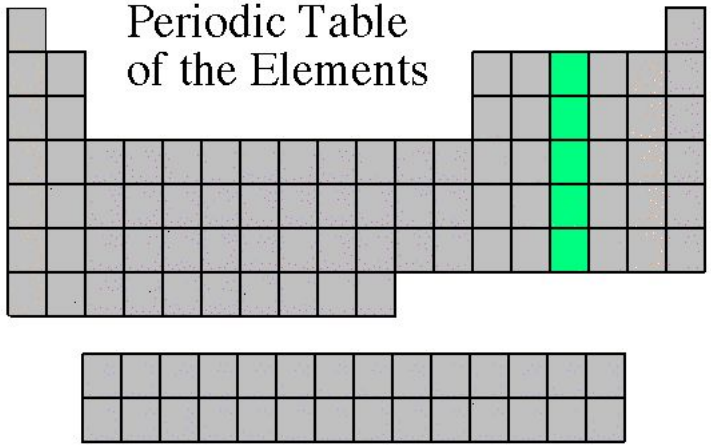
Carbon Family

- Atoms of this family have **4 valence electrons.**
- This family includes **non-metals (carbon and silicon) and metals.**
- The element carbon is called the "basis of life." There is an entire branch of chemistry devoted to carbon compounds called organic chemistry.



Nitrogen Family

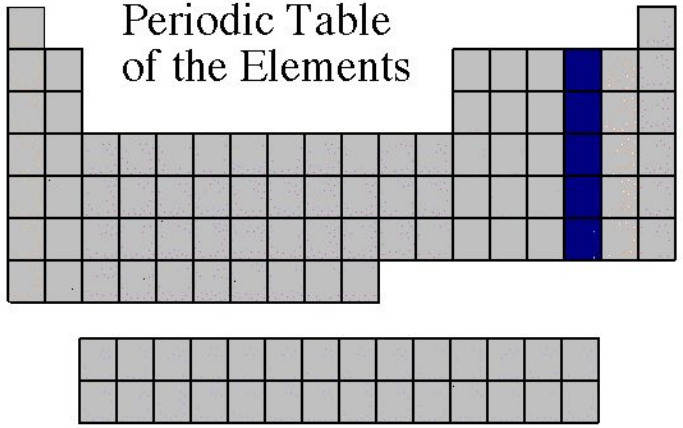
- The nitrogen family is named after the element that makes up 78% of our atmosphere. Other elements in this family are phosphorus, arsenic, antimony, and bismuth.



- Atoms in the nitrogen family have **5 valence electrons**. They tend to share electrons when they bond.
- This family includes **non-metals and metals.**

Oxygen Family

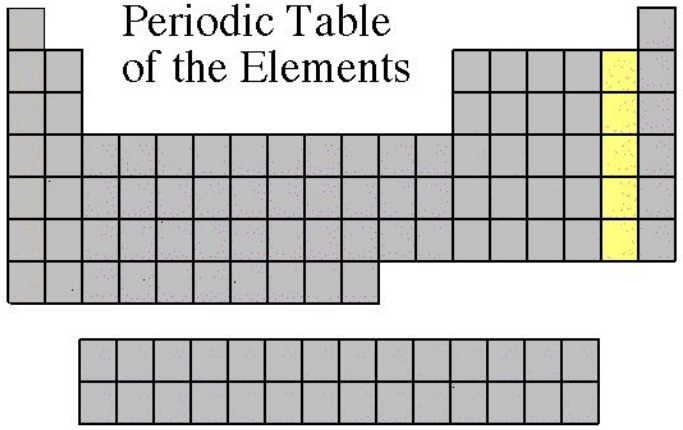
- Atoms of this family have **6 valence electrons.**
- Most elements in this family share electrons when forming compounds.
- Oxygen is the most abundant element in the earth's crust. It is extremely active and combines with almost all elements.



Halogen Family

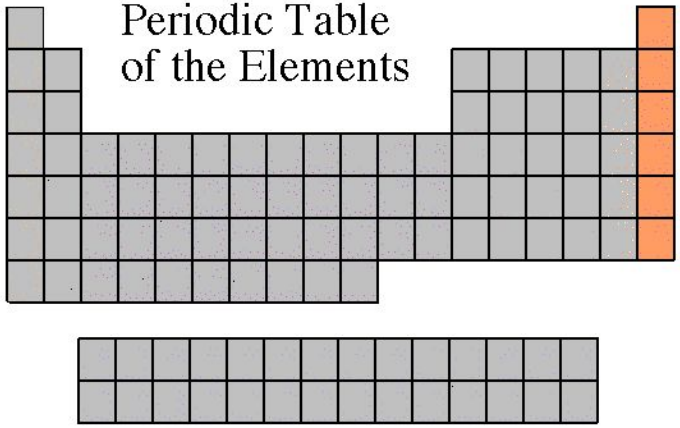
- Halogens have 7 valence electrons, which explains why they are the most active non-metals. Halogen atoms only need to gain 1 electron to fill their outermost energy level.

- They are never found free in nature.



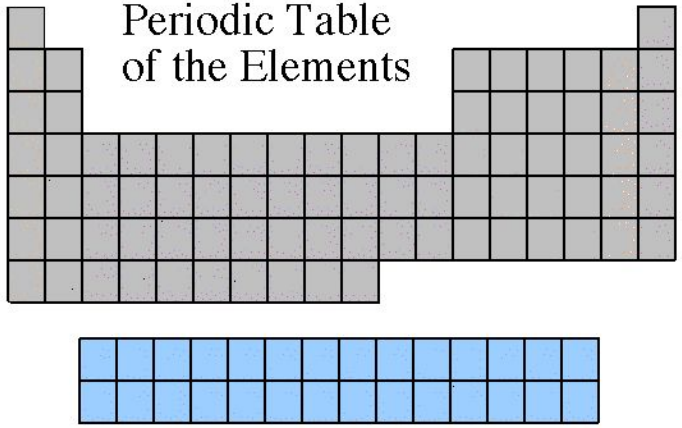
Noble Gases

- Noble gases are colorless gases that are extremely un-reactive.
- They are inactive because their outermost energy level is full (8 electrons).
- Because they do not readily combine with other elements to form compounds, the noble gases are called inert.
- Noble gases are found in small amounts in the earth's atmosphere.



Rare Earth Elements

- The thirty rare earth elements are composed of the lanthanide and actinide series.
- One element of the lanthanide series and most of the elements in the actinide series are called trans-uranium, which means synthetic or man-made.



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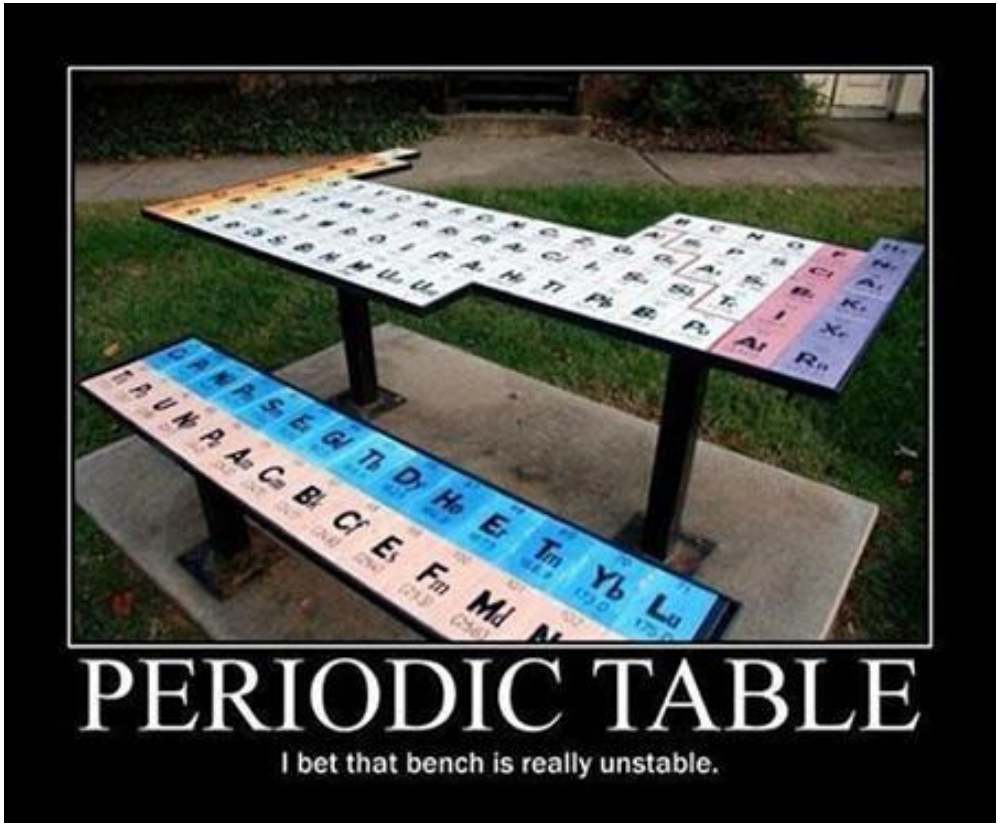

http://www.periodictable.com/