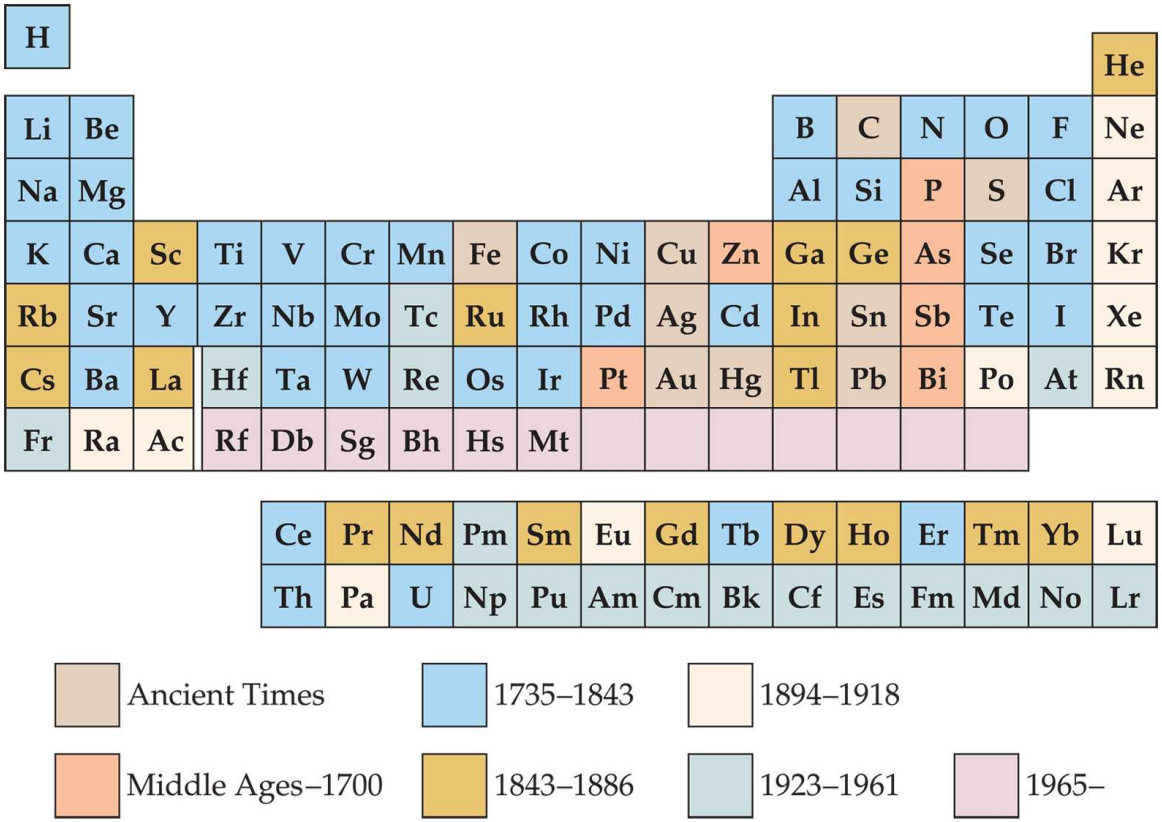
Chapter 7 : Periodic Properties of the Elements

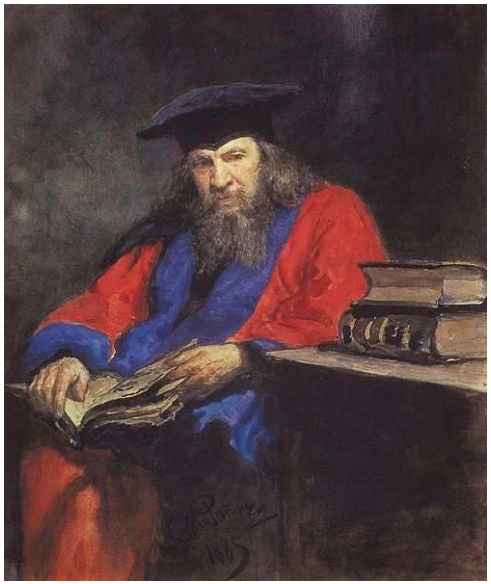
Sizes of atoms and ions.

Ionization energy – How much energy is required to remove an e-

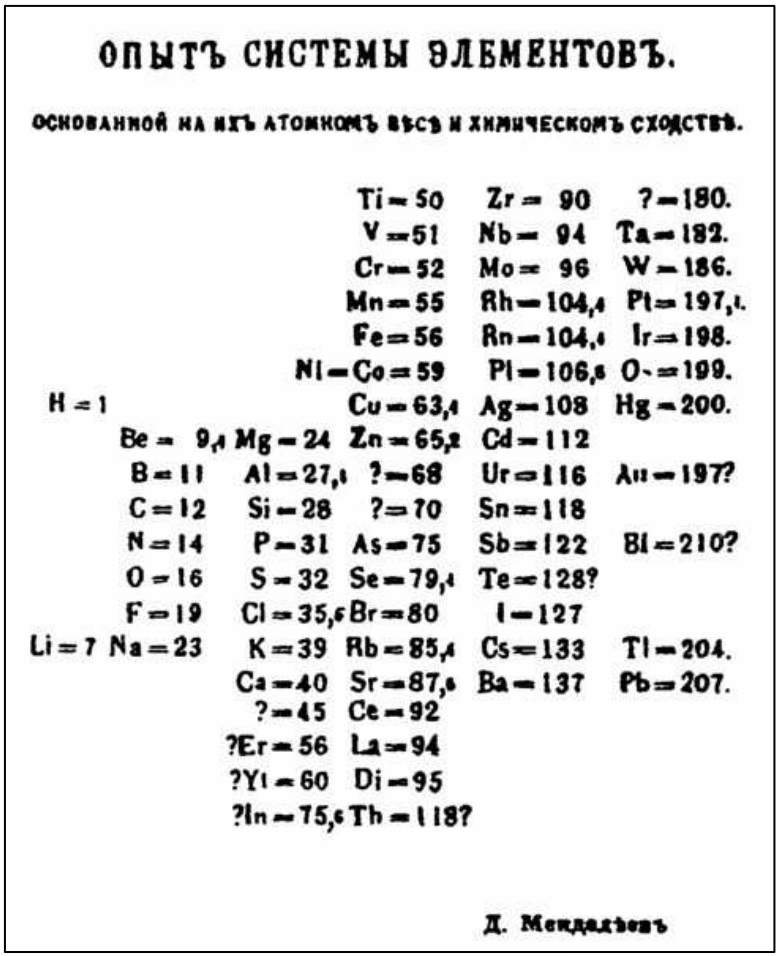
Electron affinity – How much an atom wants to gain an e^-



Mendeleev's Predictions



http://en.wikipedia.org/wiki/Periodic_table



ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.

ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

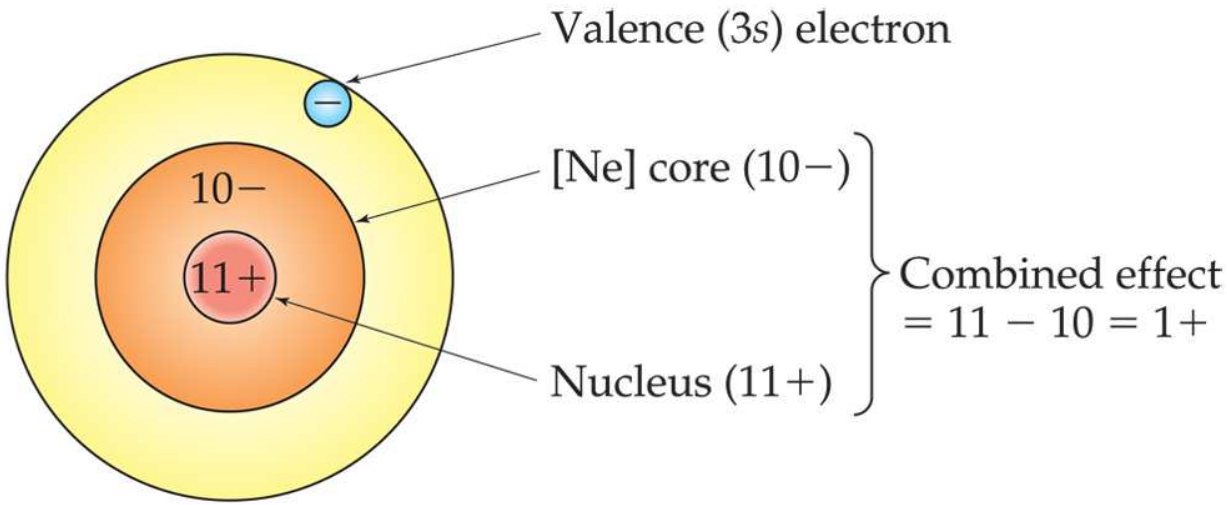
			Ti = 50	Zr = 90	? = 180.
			V = 51	Nb = 94	Ta = 182.
			Cr = 52	Mo = 96	W = 186.
			Mn = 55	Rh = 104,4	Pt = 197,1.
			Fe = 56	Ru = 104,4	Ir = 198.
			Ni = Co = 59	Pl = 106,6	Os = 199.
H = 1			Cu = 63,4	Ag = 108	Hg = 200.
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,4	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,6	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204.
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

Д. Менделѣевъ

Property	Ekaaluminum	Gallium
atomic mass	68	69.72
density (g/cm^3)	6.0	5.904
melting point (°C)	Low	29.78
oxide's formula	Ea_2O_3 (density - 5.5 g cm^{-3}) (soluble in both alkalis and acids)	Ga_2O_3 (density - 5.88 g cm^{-3}) (soluble in both alkalis and acids)
chloride's formula	Ea_2Cl_6 (volatile)	Ga_2Cl_6 (volatile)

Effective Nuclear Charge

Na atom:



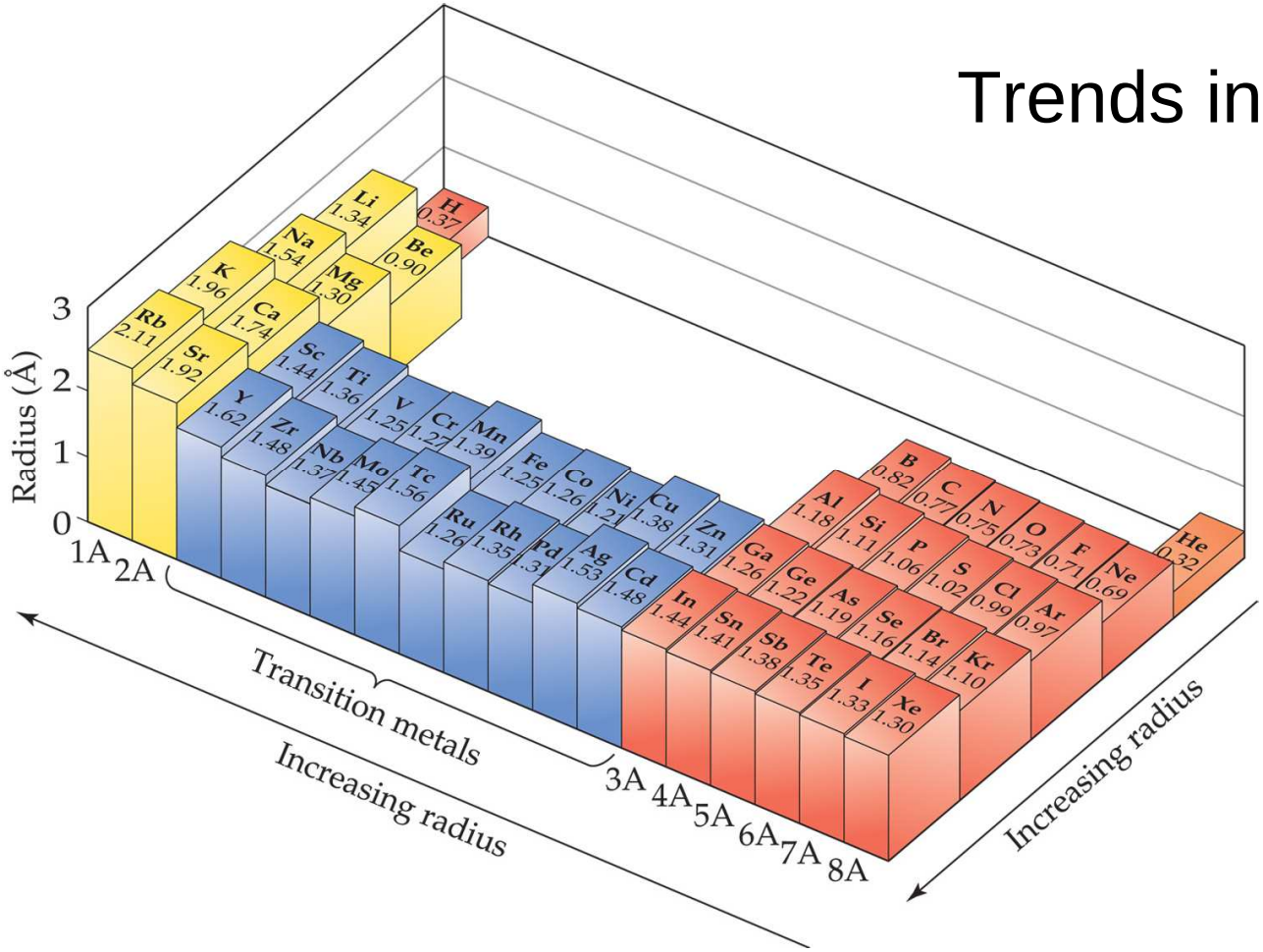
The attraction of valence electrons to the nucleus is weakened by core electrons, which they repel

The effective nuclear charge, *Z*eff, is found this way:

$$Z\text{eff} = Z - S$$

where *Z* is the atomic number and *S* is a screening constant, usually close to the number of inner electrons.

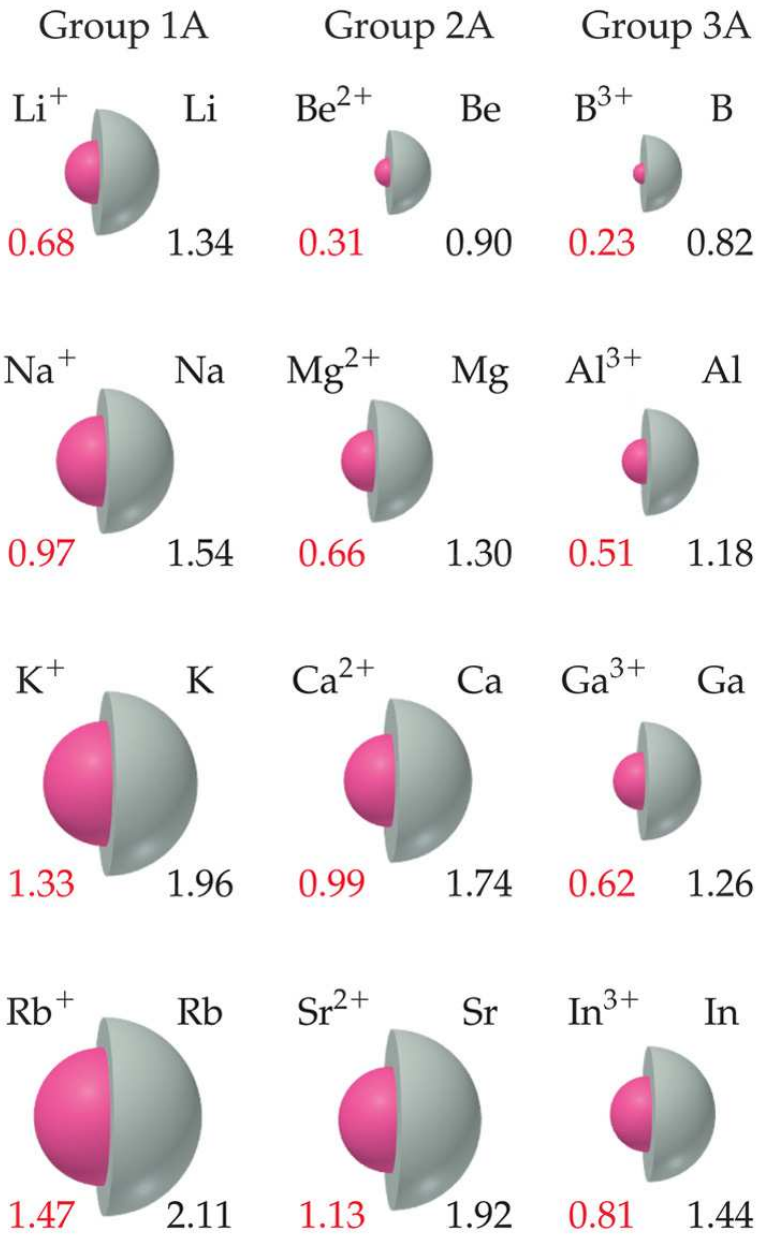
Trends in Atomic Radius



Atomic radius tends to decrease from left to right across a row due to increasing *Z*eff.

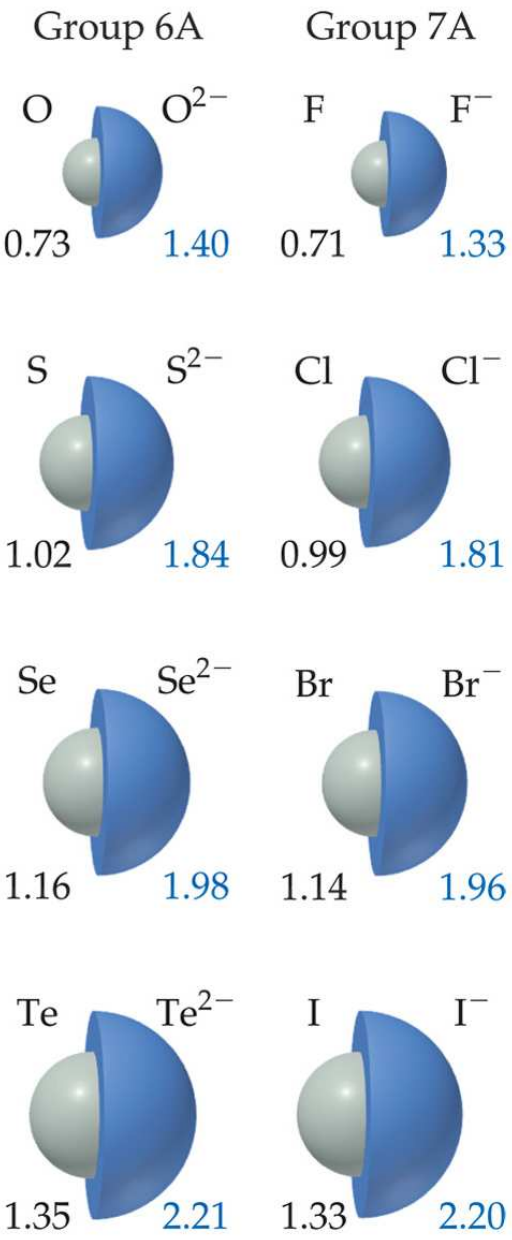
Atomic radius increases from the top to the bottom of a column due to increasing value of *n*

Cations are smaller than neutral atoms



The outermost electron is removed and electron repulsions are reduced.

Anions are larger than neutral atoms



Electrons are added and repulsions are increased.

Ionization Energy

1st ionization: $Na(g) \rightarrow Na^{+}_{(g)} + e^{-}$

2nd ionization: $Na^{+}(g) \rightarrow Na^{+2}_{(g)} + e^{-}$

Energy required to remove an electron from an atom in the gas phase

1st ionization energy < 2nd ionization energy

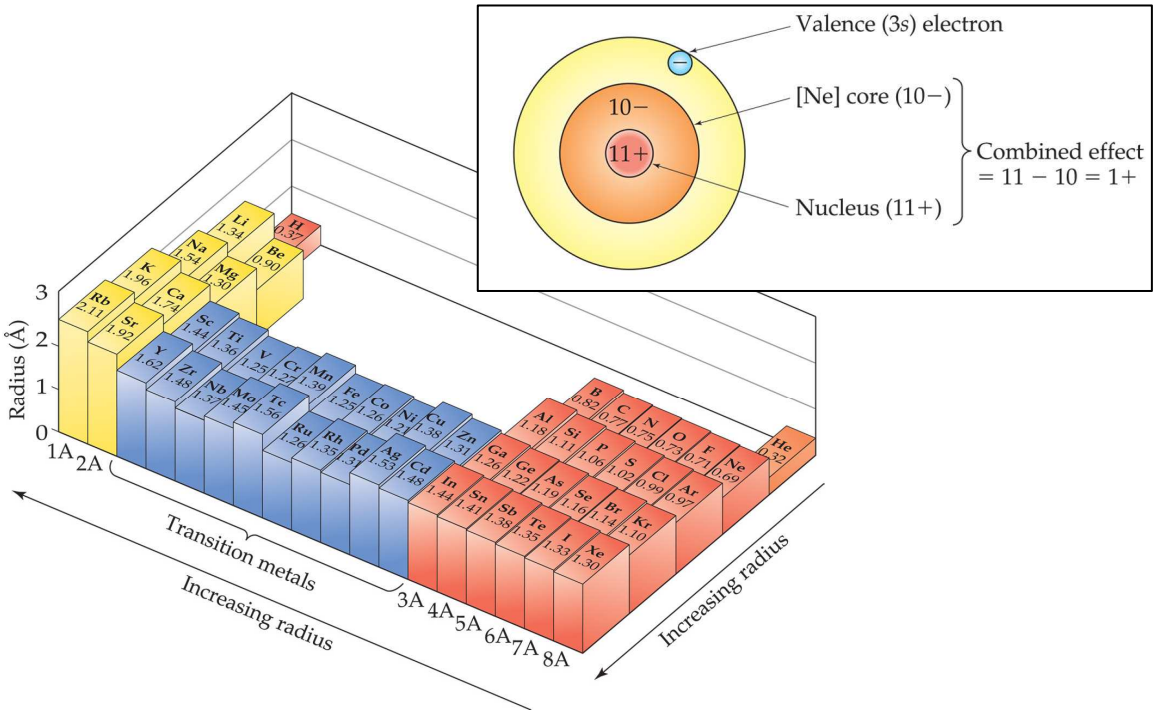
What trend will ionization energy follow?

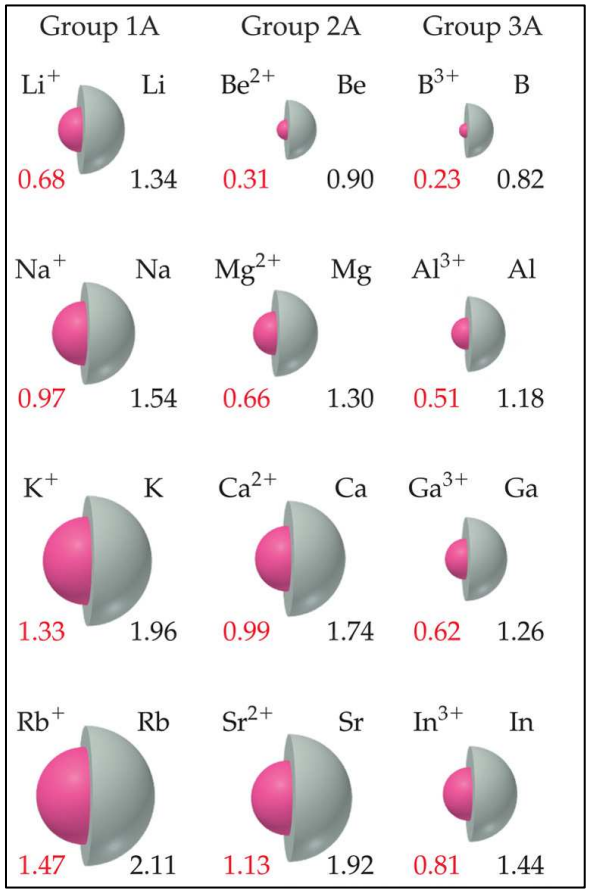
A. Lower ionization energy with increasing atomic radius

B. Lower ionization energy with larger cation radius

C. Lower ionization energy with larger effective shielding

D. All of the above

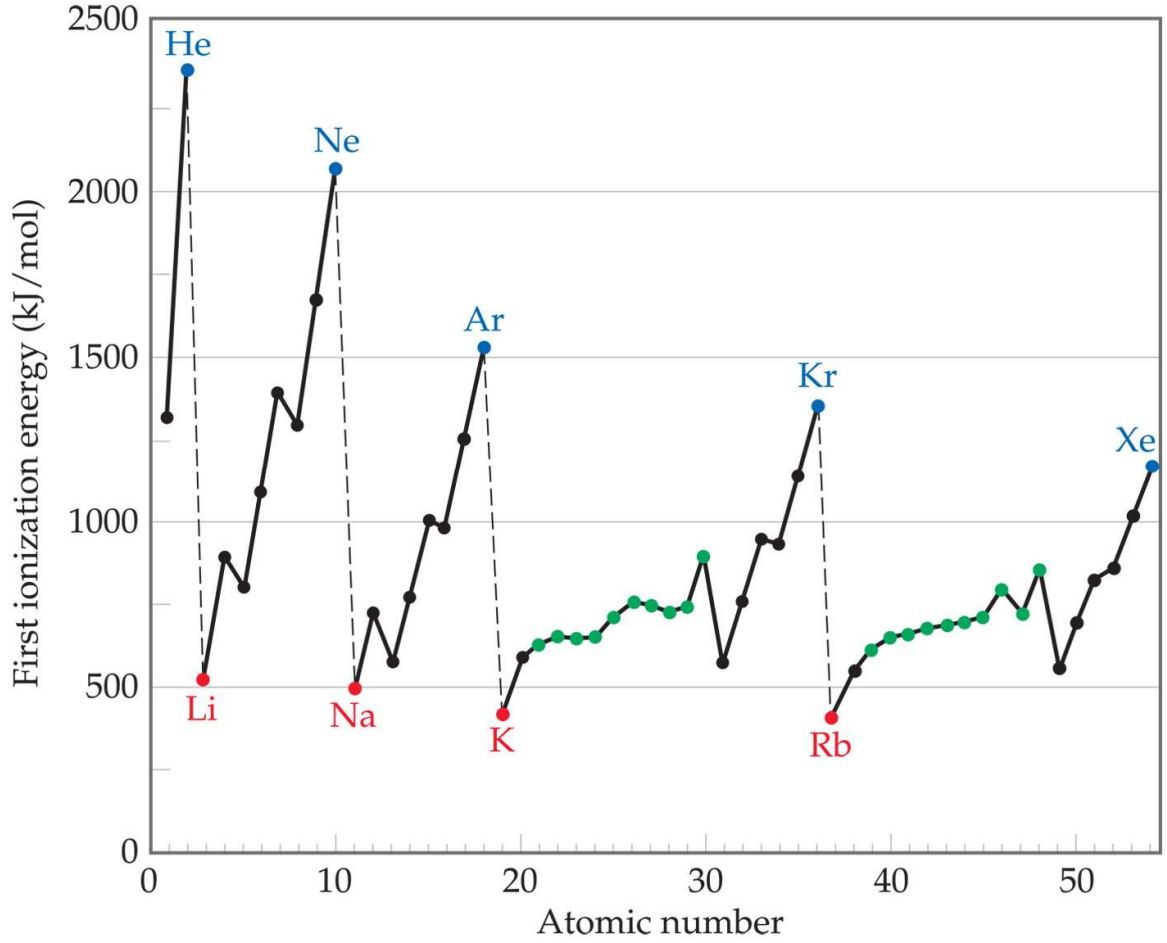




Trend in Ionization Energy

1st ionization:

$Na(g) \rightarrow Na^{+}_{(g)} + e^{-}$



Electron Affinity

$Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}$

Measures the attraction or affinity of an atom for an electron

1A	2A	3A	4A	5A	6A	7A	8A
H −73							He > 0
Li −60	Be > 0	B −27	C −122	N > 0	O −141	F −328	Ne > 0
Na −53	Mg > 0	Al −43	Si −134	P −72	S −200	Cl −349	Ar > 0
K −48	Ca −2	Ga −30	Ge −119	As −78	Se −195	Br −325	Kr > 0
Rb −47	Sr −5	In −30	Sn −107	Sb −103	Te −190	I −295	Xe > 0

Generally electron affinity increases left to right
And decreases from the top down.

Fluorine has the highest electron affinity

Metals, Nonmetals, and Metalloids

- Metals tend to lose e^-

- Metals tend to be shiny, malleable, and ductile

- Metals are good conductors of heat and electricity

- Nonmetals tend to gain e^-

- Nonmetals usually are not shiny, and are brittle

- Nonmetals are poor conductors of heat and electricity

Au Bars

Metalloids have a mixture of all these traits

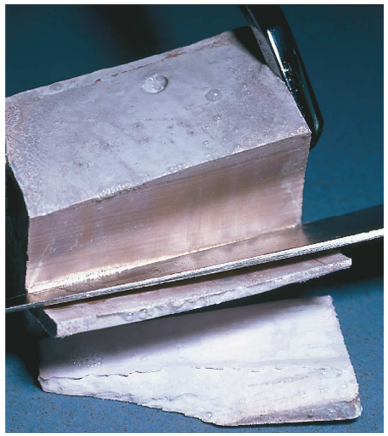
Silicon

C powder

Group Properties

- Alkali and Alkali Earths easily ionize to for cations

- Alkali are very soft and light, Alkali Earth slightly harder and more dense



- Noble gases, because their orbitals are completely full, don't react with anything and exist as monoatomic gases

- Halogens exist as diatom molecules $F_{2(g)}$, $Cl_{2(g)}$, $Br_{2(l)}$, $I_{2(s)}$