Why do elements in the group/family have similar properties?

Why are the alkali metals so violently reactive?

Why are the halogens the most reactive nonmetals?

Periodic Law: the physical and chemical properties of the elements are periodic functions of their atomic numbers

period: the horizontal rows (represents ________ ________)

each period has one more occupied energy level with valence electrons:

Li → 2nd E.L. / 2nd period

Na → 3rd E.L. / 3rd period

Li 

Na 

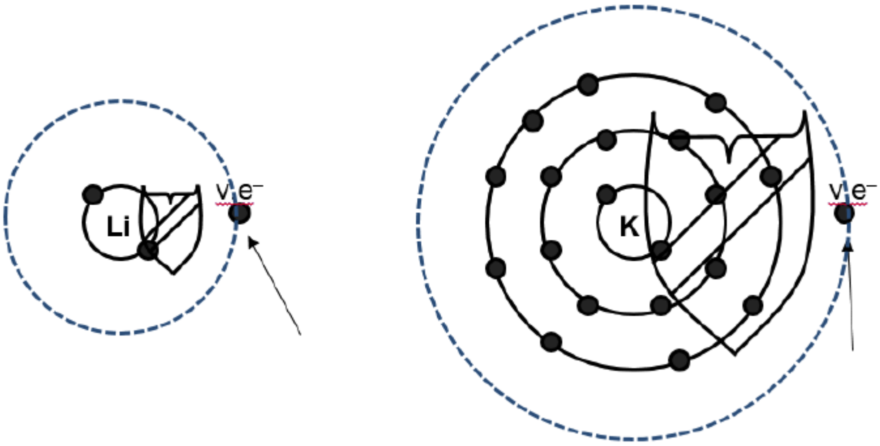
group (family): vertical columns

- *main groups* have similar properties *because…*

Li	$1s^2$ $\underline{2s^1}$	Na	$1s^2$ $2s^2$ $2p^6$ $\underline{3s^1}$
O	$1s^2$ $\underline{2s^2 2p^4}$	S	$1s^2$ $2s^2$ $2p^6$ $\underline{3s^2 3p^4}$

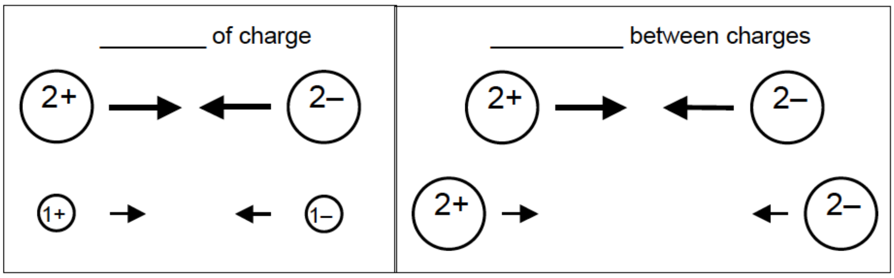
electron shielding: __________ electrons “shield” __________ electrons from the attractive force of the nucleus

- *caused by* kernel and valence electrons repelling each other
- the electron shielding effect ___________ DOWN a group



Coloumbic attractions: attraction between _____ and _____ charges (ions)

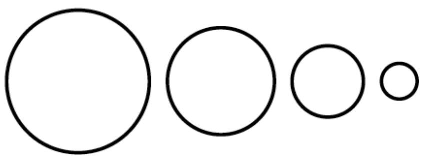
Coloumbic attractions depends on…

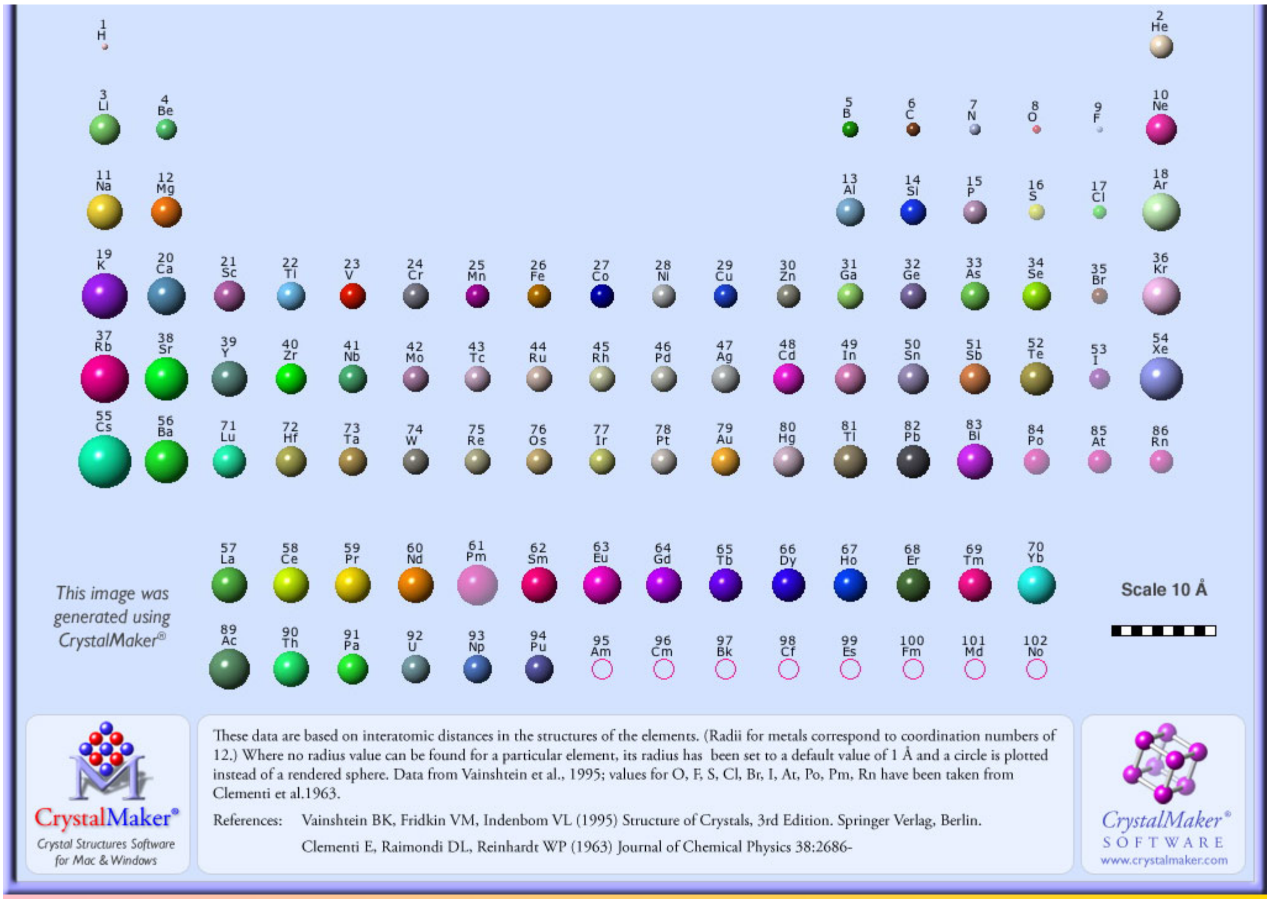


effective nuclear charge: the magnitude of the *electrostatic* attraction between negative ___________ and positive ___________ in the nucleus

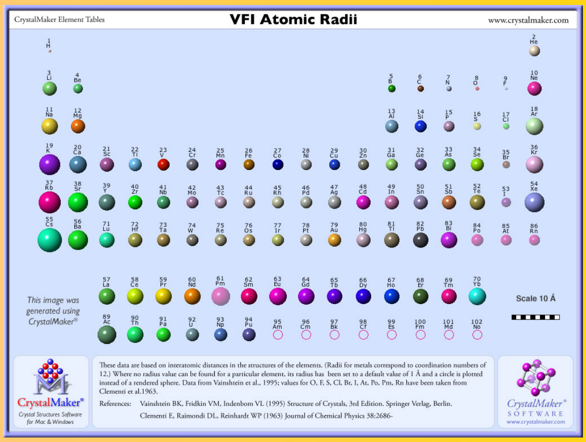
- Across the periodic table, effective nuclear charge (Z) ___________, *because…*

within the same energy level, shielding does not have a role in trends, so effective nuclear charge increases because the number of protons and electrons increases as atomic number across across the periodic table





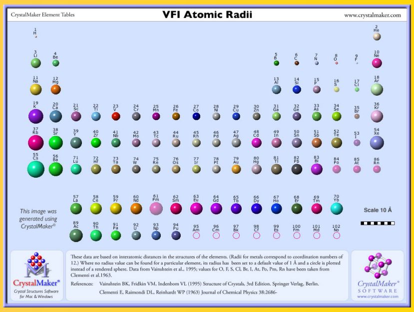
Atomic Radius: measures the size of atoms the distance from the nucleus to the boundary of the electron cloud



Why would this be difficult to measure?

Analyze trend ... across periods?
... down groups?

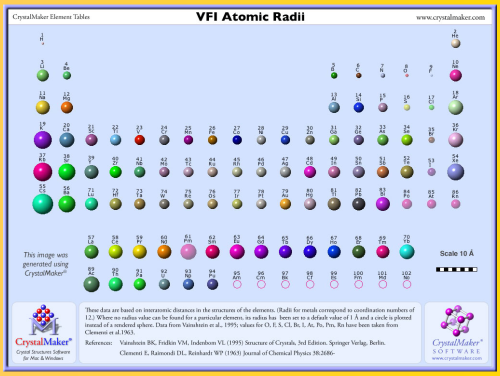
Atomic Radius:



Analyze trend
... across periods?

within the same energy level,
effective nuclear charge increases as you move across the period because there are a greater number of protons & electrons
= strong attraction between the nucleus and electrons / electrons are held more closely to the nucleus

Atomic Radius:



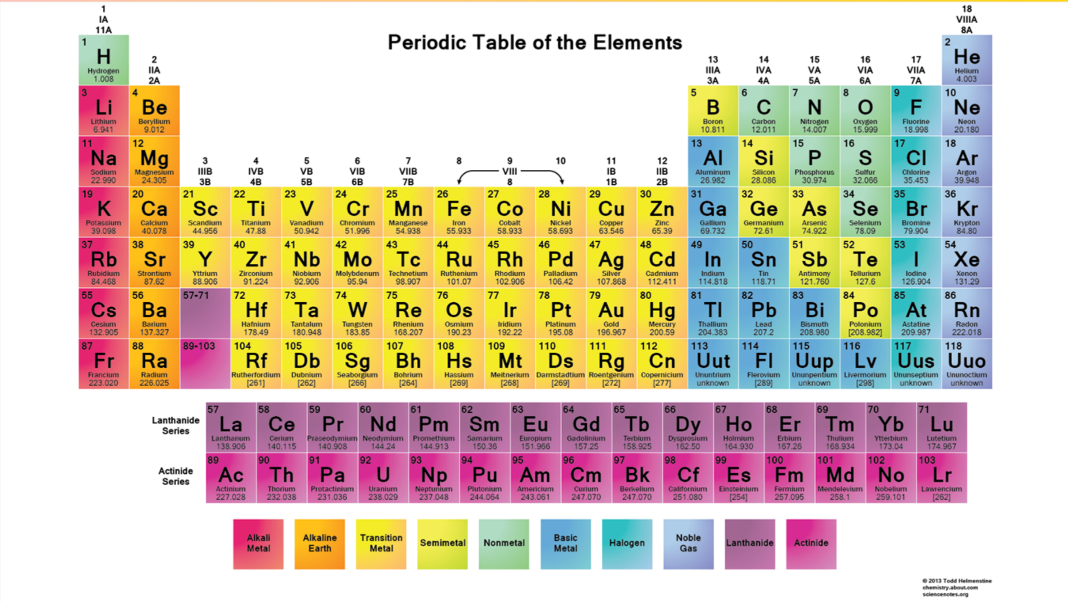
Analyze the trend

... down groups?

radius increases as electron shielding increases because there are MORE ENERGY LEVELS

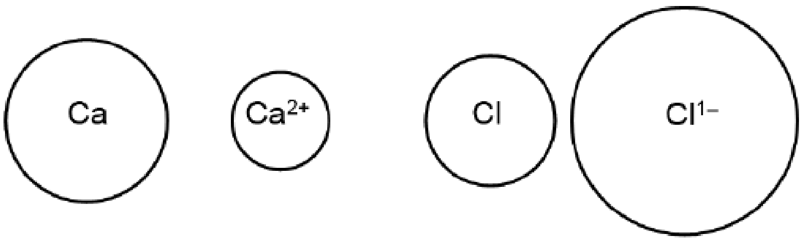
Rank the elements in order of increasing radius:

Na, Cl, Al, S Be, Ba, Ca, Mg, Sr



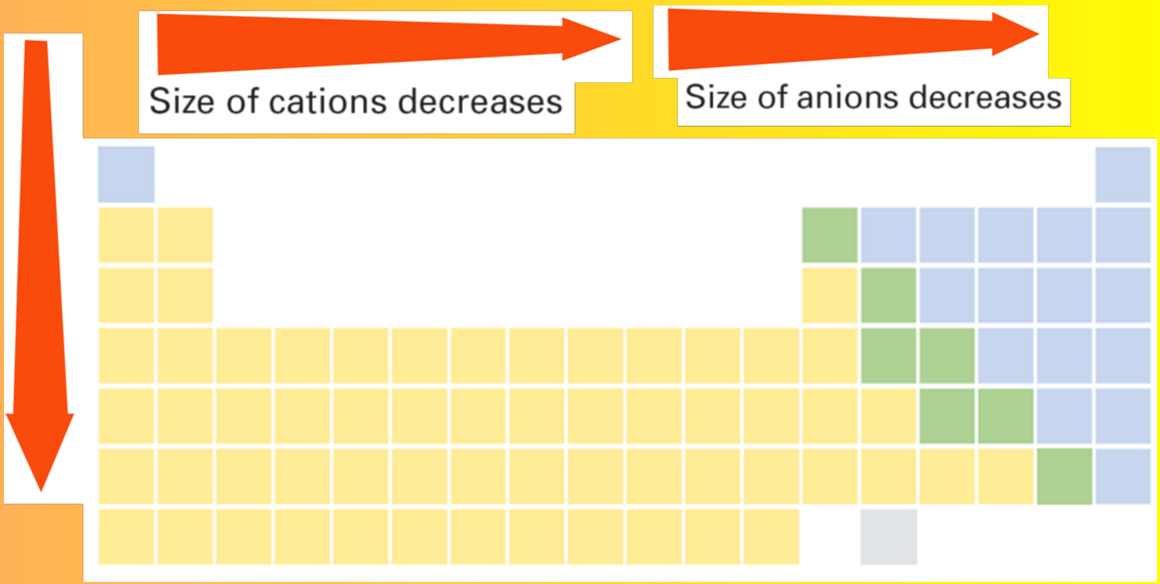
ionic radius: the size of an ion

cations		anions	
Ca atom	Ca^{2+} ion	Cl atom	Cl^{1-} ion
20 p^+	20 p^+	17 p^+	17 p^+
20 e^-	18 e^-	17 e^-	18 e^-



cations are smaller

anions are larger



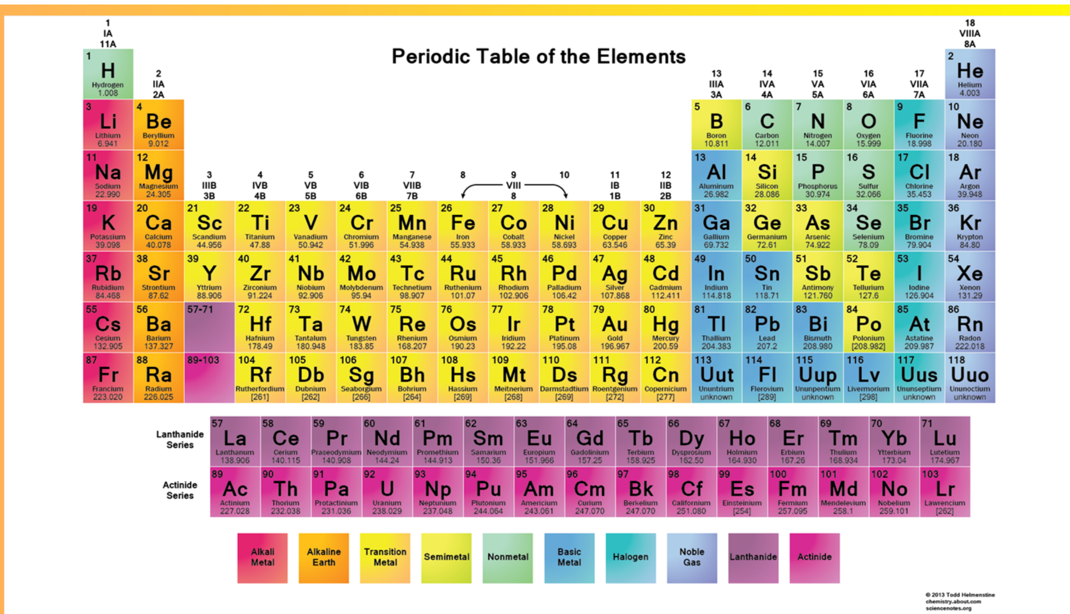
7. For each pair, circle which atom or ion has the larger radius:

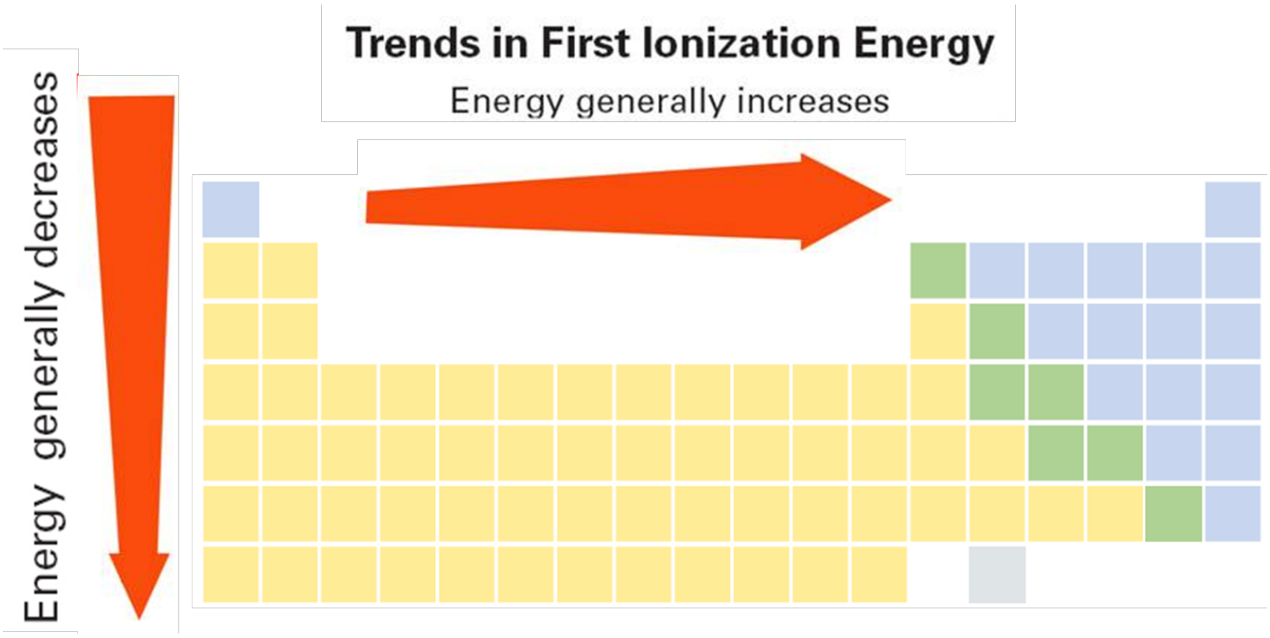
a. S or O

b. Ca or Ca^{2+}

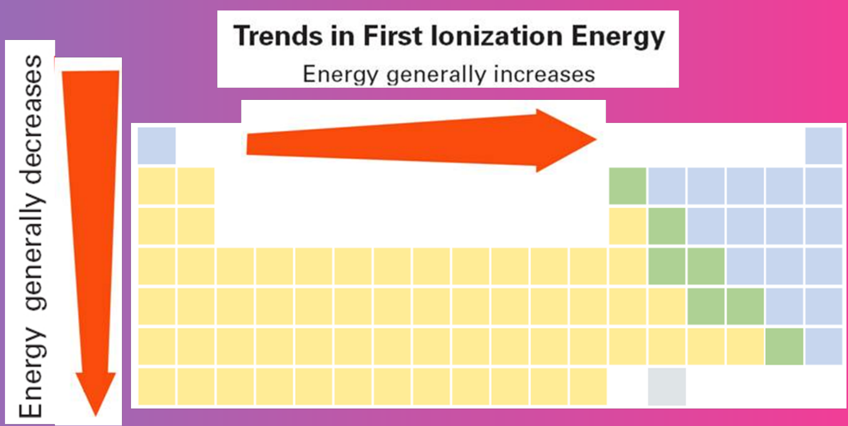
g. K^{+1} or Ca^{2+}

h. F^{-1} or Cl^{-1}

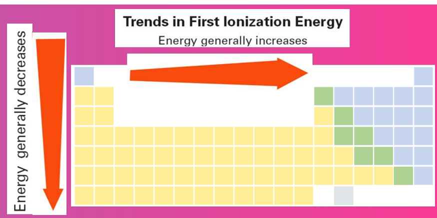




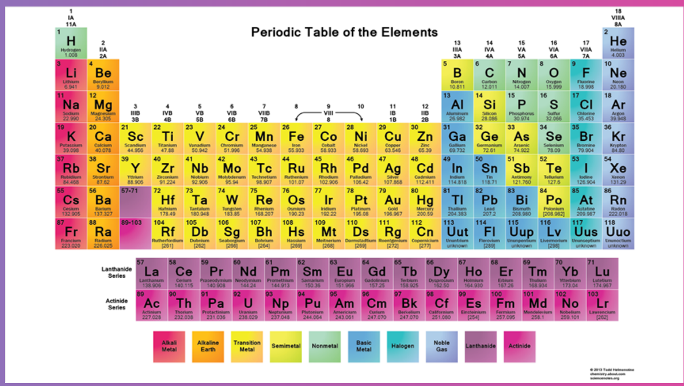
Ionization energy is defined as the minimum energy required to remove an electron from the ground state of a gaseous atom or ion.



Ionization Energy



Metals form _________ by ___________ electrons.
Nonmetals form _________ by ___________ electrons.

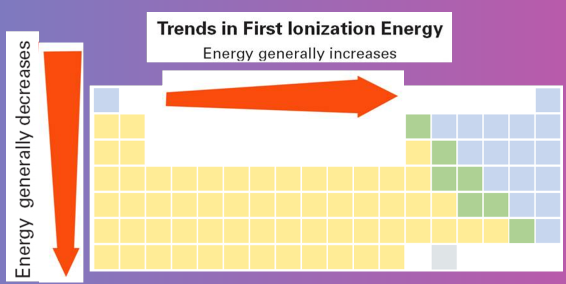


Which takes more energy, removing an electron from an atom where the nucleus has a tight hold on its electrons, or a weak hold on its electrons?

Ionization Energy

analyze the trend DOWN a group...

Think: Which takes more energy, removing an electron from an atom where the nucleus has a tight hold on its electrons, or a weak hold on its electrons?



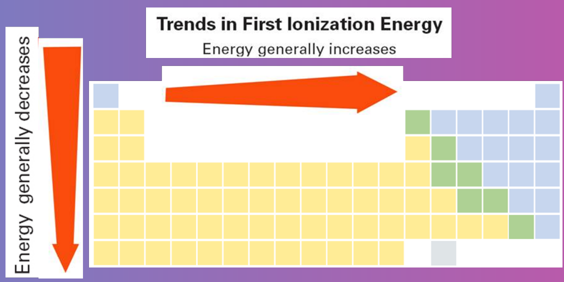
electron shielding increases DOWN a group, so it is be easier to remove a valence electron from an element in a higher period (higher energy level) because the valence electron is further away from the nucleus and shielded by more kernel electrons

Ionization Energy

analyze the trend across a period...

Think: metals LOSE electrons to form cations

nonmetals GAIN electrons to form anions



metals (left side, <4 valence e-) more easily LOST valence electrons to form ions with stable octets, so this would require LOW energy to lose an e-

nonmetals (right side, >4 valence e-) typically GAIN electrons to form ions with stable octets, so it would require A LOT of energy to REMOVE e-

Ionization Energy

Why do the second, third, or each successive ionization energy require more energy than the previous one?

$M + 1^{st}\ I.E. \rightarrow M^{1+} + e^-$

(1st I.E. = energy to remove e^-)

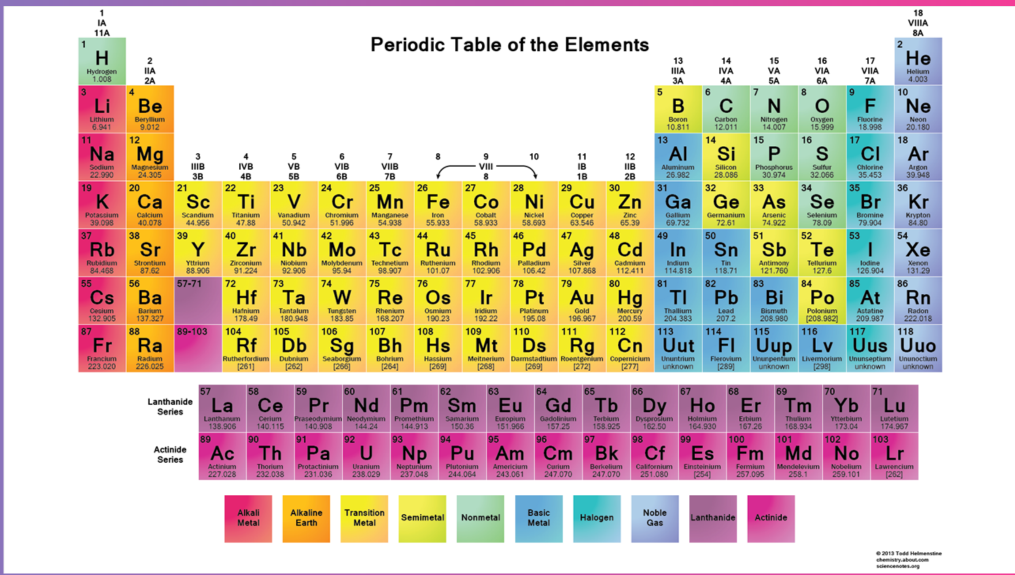
$M^{1+} + 2^{nd}\ I.E. \rightarrow M^{2+} + e^-$

$M^{2+} + 3^{rd}\ I.E. \rightarrow M^{3+} + e^-$

EFFECTIVE NUCLEAR CHARGE increases... more positive protons in the nucleus will have an increasing pull on the fewer number of electrons

Ionization Energy

Which element has the highest first ionization energy: Sn, As, or S?

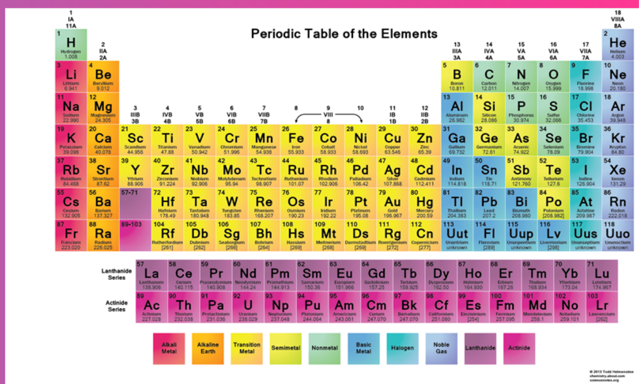


Arrange the following in order of increasing ionization energy.

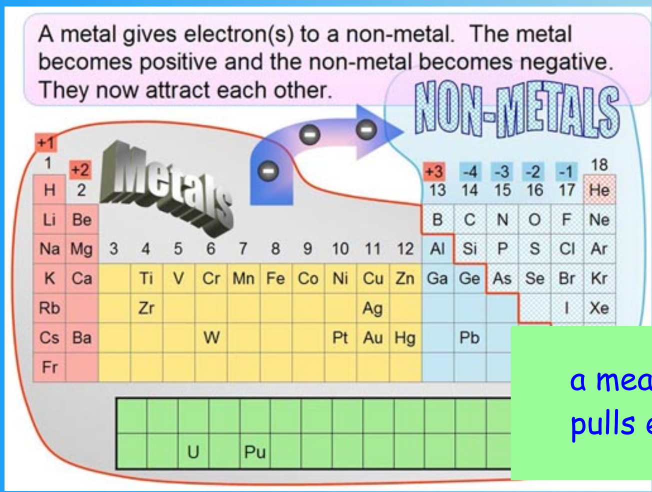
a) Na, Cl, Al, S

Na < Al < S < Cl

b) Be, Ba, Ca, Mg, Sr



Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons.

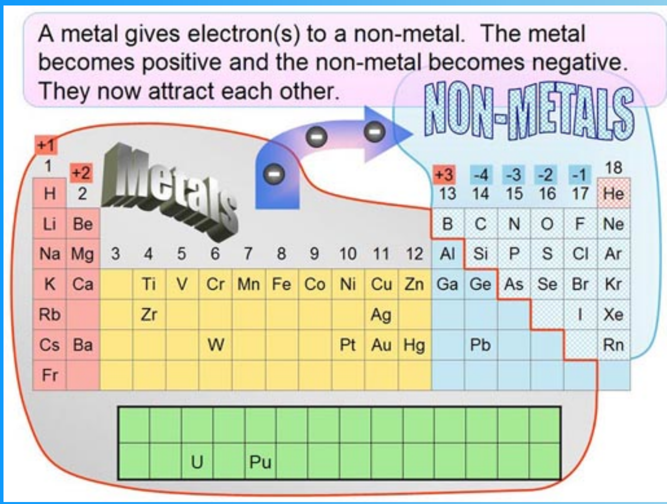


a measure of how much an element pulls electrons towards itself

Electronegativity Values for Selected Elements

H 2.1						
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	Tl 1.8	Pb 1.9	Bi 1.9		

Electronegativity Trends down the groups...

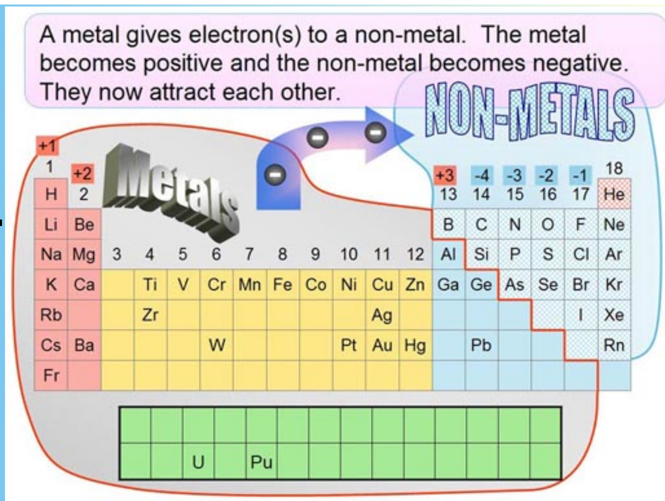


as you progress down the group, the valence electrons are further away from the nucleus

greater distance to nucleus/ size of the atom with increasing energy levels

Electronegativity

across the periods...



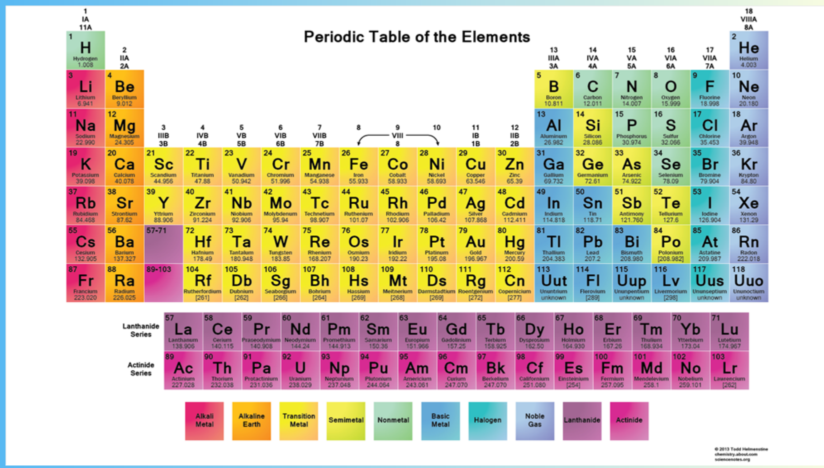
if the valence shell of an atom is less than half full (<4), it is easier (less energy) to lose an electron than gain one

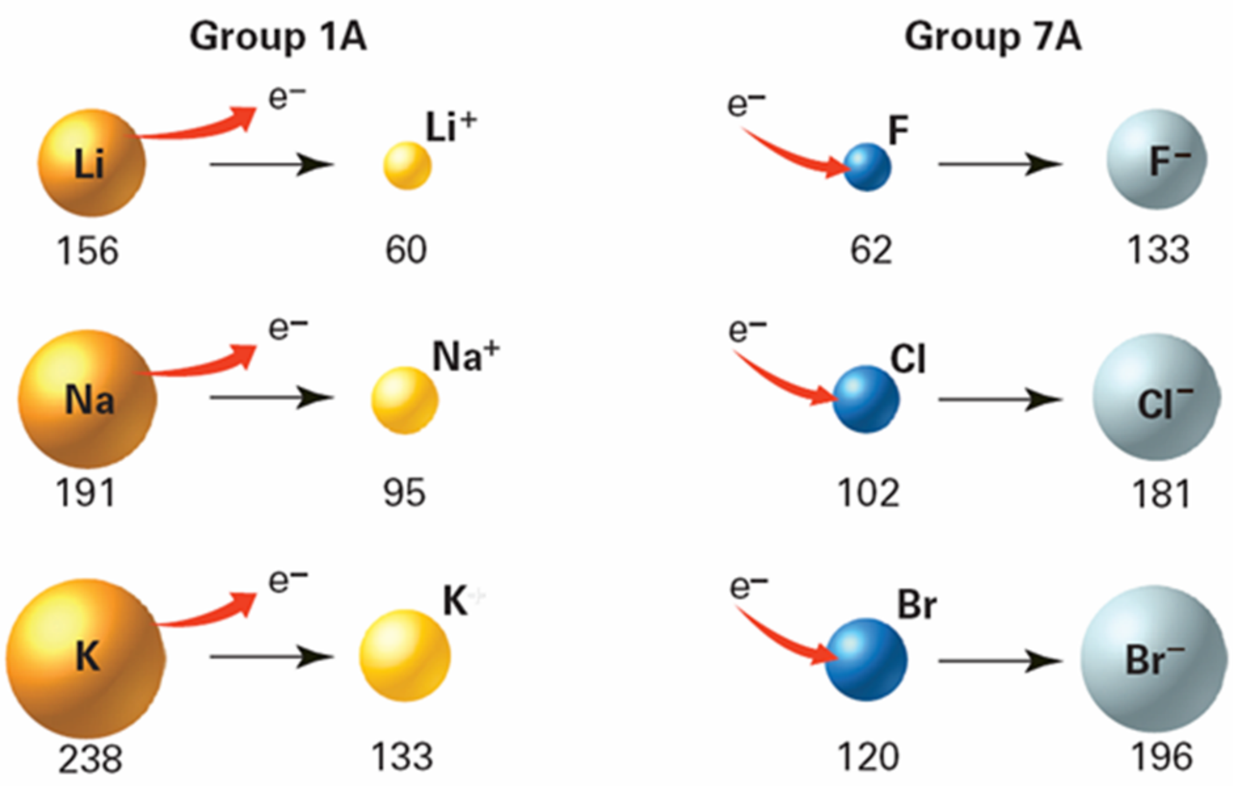
conversely, if the valence shell is more than half full (>4), it is easier to pull an electron into the valence shell than to lost an electron

Rank the elements in order of increasing electronegativity

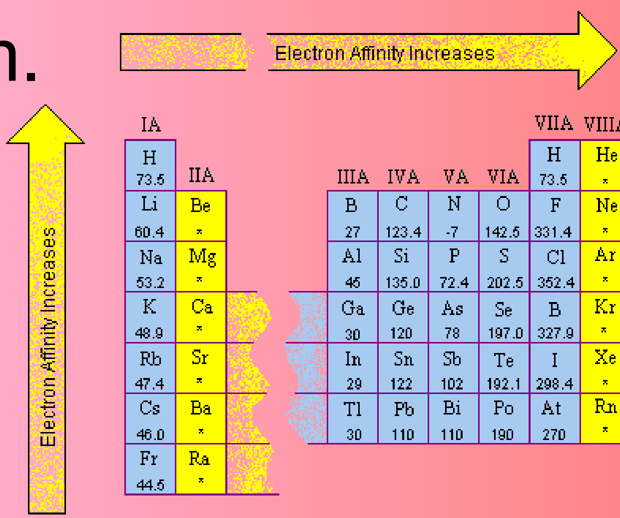
Ba, Br, Fe

O, Se, K



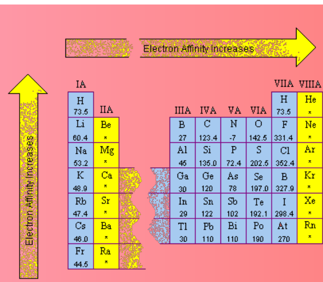


Electron affinity is defined as the energy change that occurs when an electron is added to a gaseous atom.



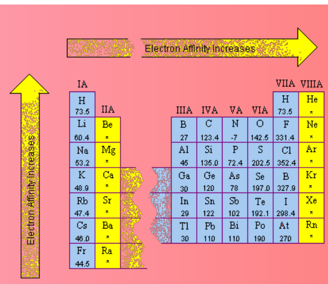
Electron Affinity

across a period...



as you move across the period, atoms become smaller, so the force of attraction between the valence electrons and nucleus becomes stronger

Electron Affinity



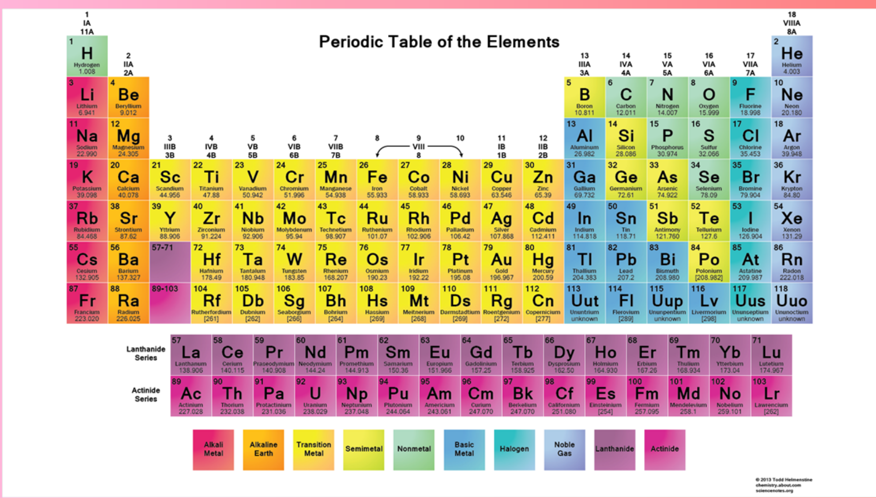
trend down a group...

electron affinity decreases down a group because there is a greater number of energy levels (periods) so there is more ELECTRON SHIELDING so a weaker force of attraction between electrons and protons in the nucleus (greater distance)

Rank the elements in order of increasing electron affinity

Ba, Br, Fe

O, Se, K



Academic HW

Accomplished/ Exemplary: #2, 3, or 4 on page 154

Beginning/ Developing: Read pages 117-123, answer Q's 1, 2, 7, 9, 11, 14, 17 on page 123

And read 125-131 on metals and answer Qs #1-4 on page 131

Honors HW:

Developing/Beginning

Read 134-141 and answer questions

#4, 6, 7, 8, 9, 10, 11, 13, 14, 15

Accomplished/Exemplary:

Excel Graphing