

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?

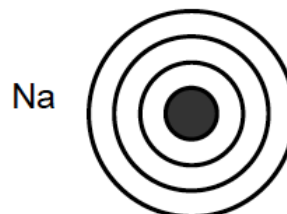
Periodic Law: the physical and chemical properties of the elements are periodic functions of their atomic numbers

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



group (family): vertical columns

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

Li $1s^2 \underline{2s^1}$

Na $1s^2 2s^2 2p^6 \underline{3s^1}$

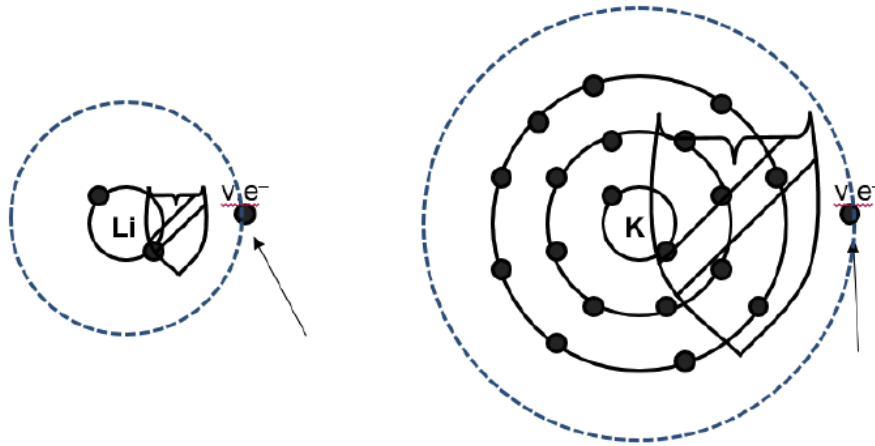
O $1s^2 \underline{2s^2 2p^4}$

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

electron shielding: _____ electrons “shield” _____

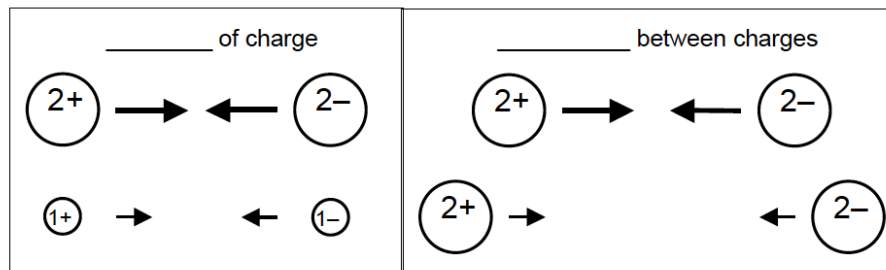
electrons from the attractive force of the nucleus

- *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...

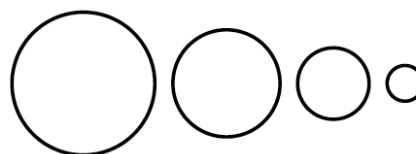


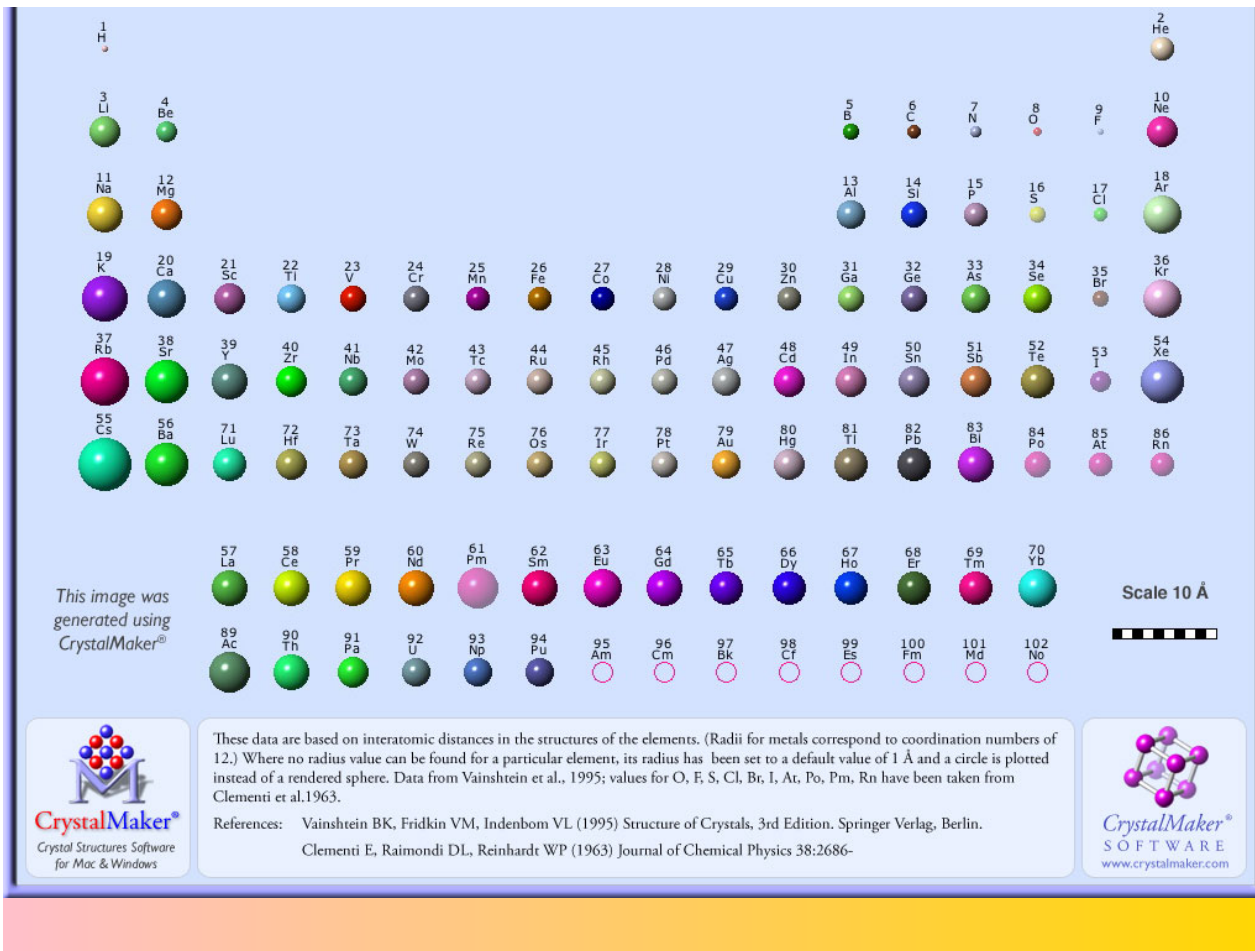
effective nuclear charge: the magnitude of the *electrostatic*

attraction between negative _____ and positive _____ in the nucleus

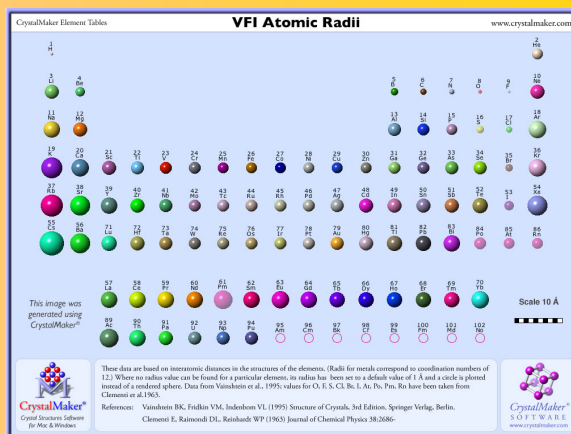
- Across the periodic table, effective nuclear charge (Z) _____, *because...*

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



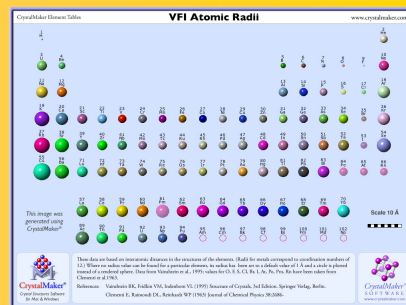
Why would this be difficult to measure?

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

Atomic Radius:

*Analyze trend
... across periods?*

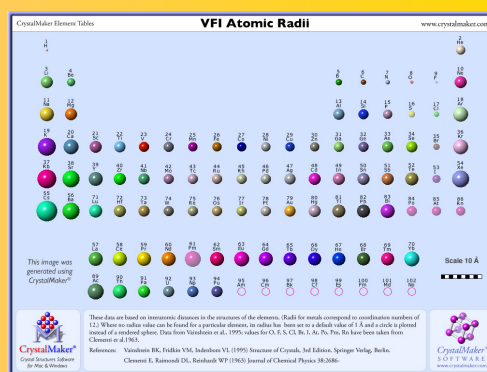
within the same energy level,
effective nuclear charge increases as you
move across the period because there are
a greater number of protons & electrons
= strong attraction between the nucleus
and electrons / electrons are held more
closely to the nucleus



Atomic Radius:

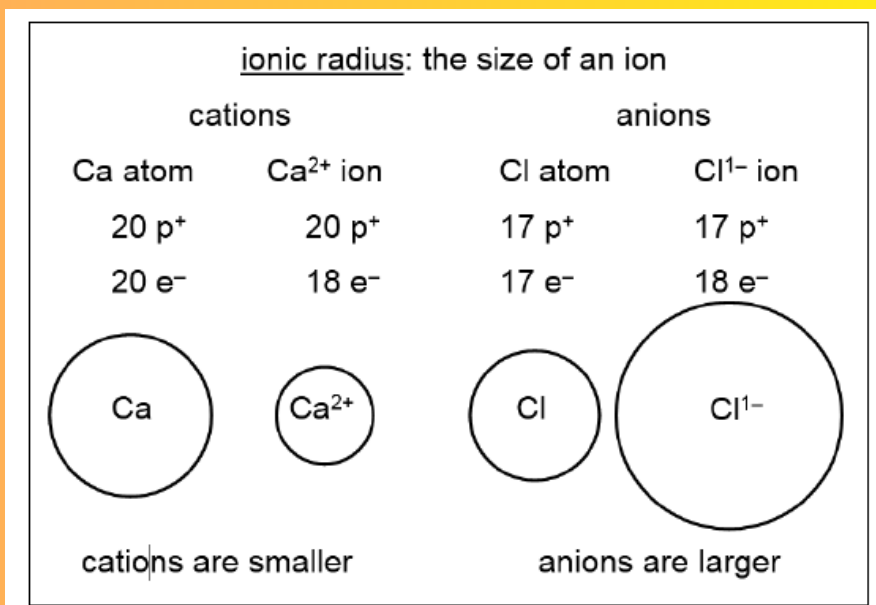
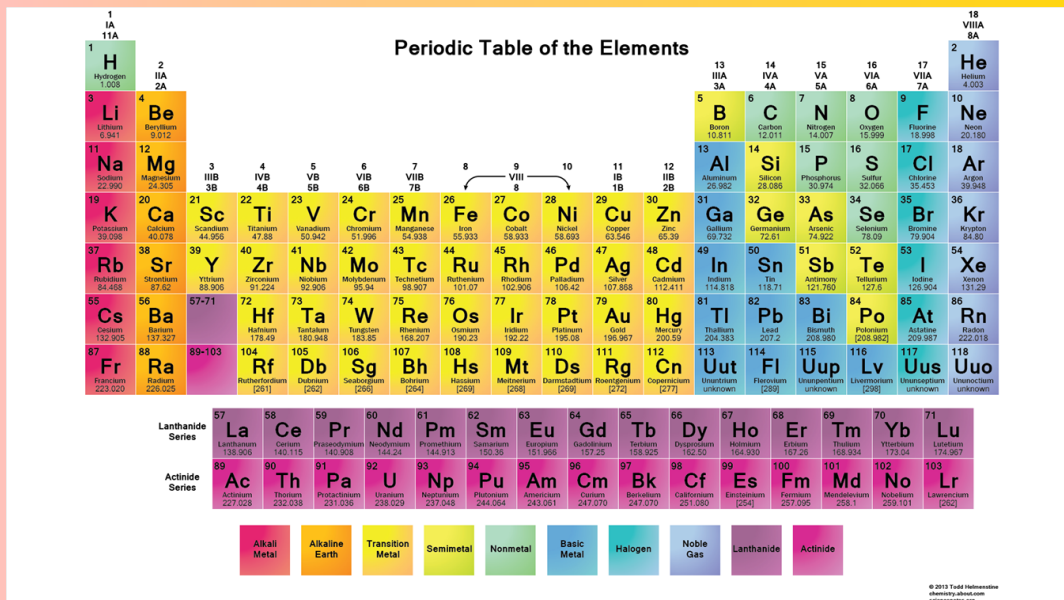
*Analyze the trend
... down groups?*

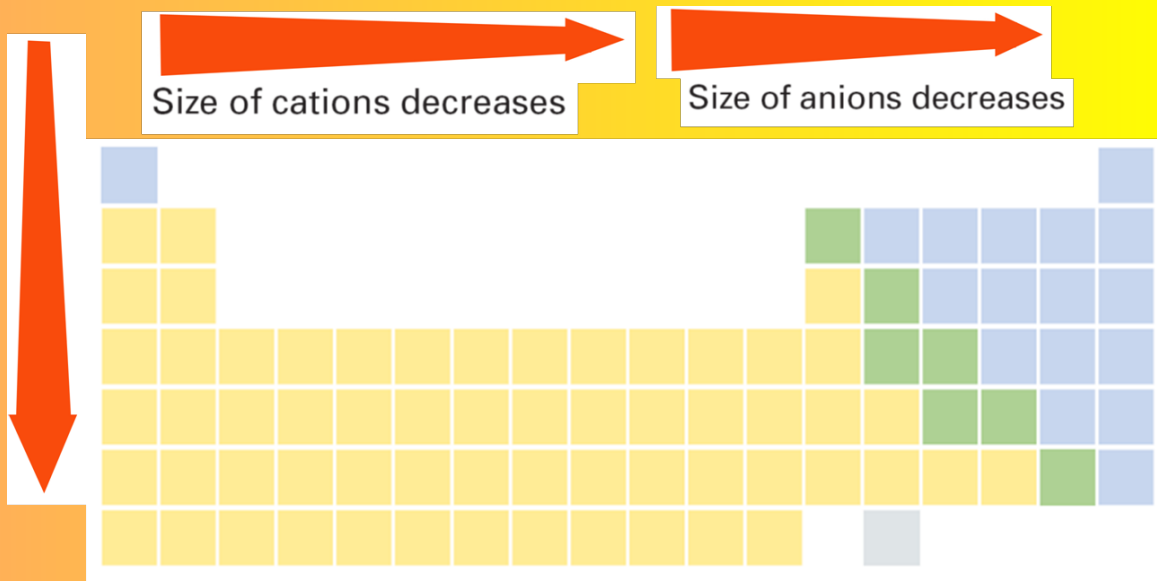
radius increases as electron
shielding increases because there
are **MORE ENERGY LEVELS**



Rank the elements in order of increasing radius:

Na, Cl, Al, SBe, Ba, Ca, Mg, Sr





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

a. S or O

b. Ca or Ca^{2+}

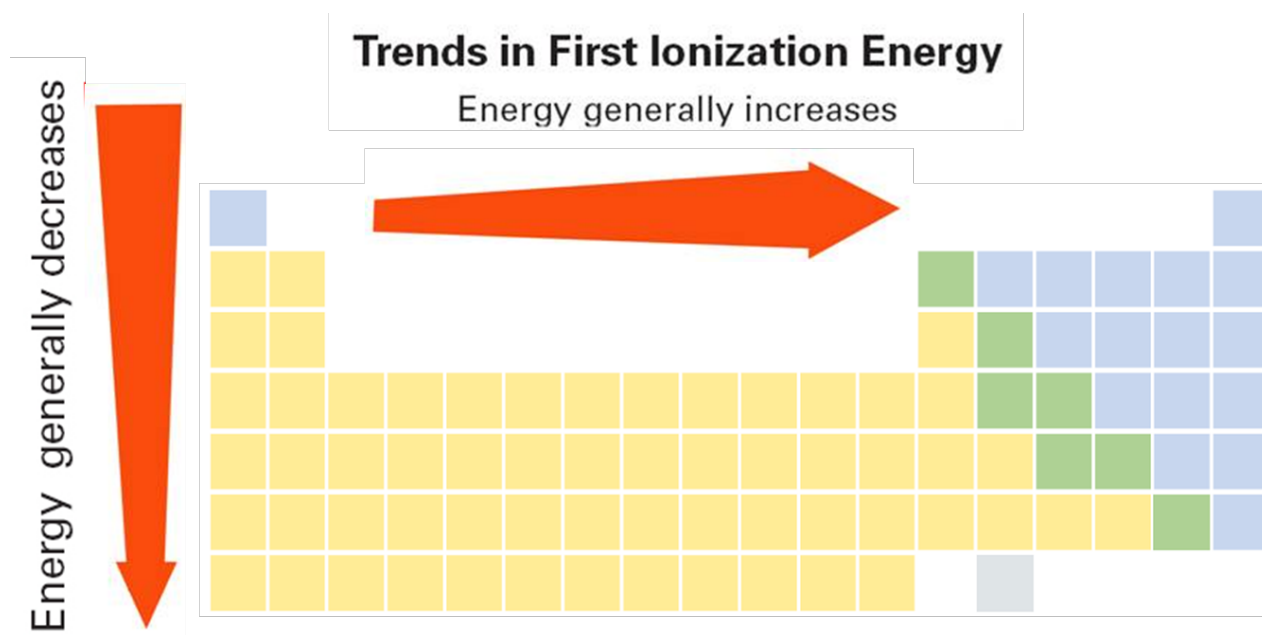
g. K^{+1} or Ca^{2+}

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

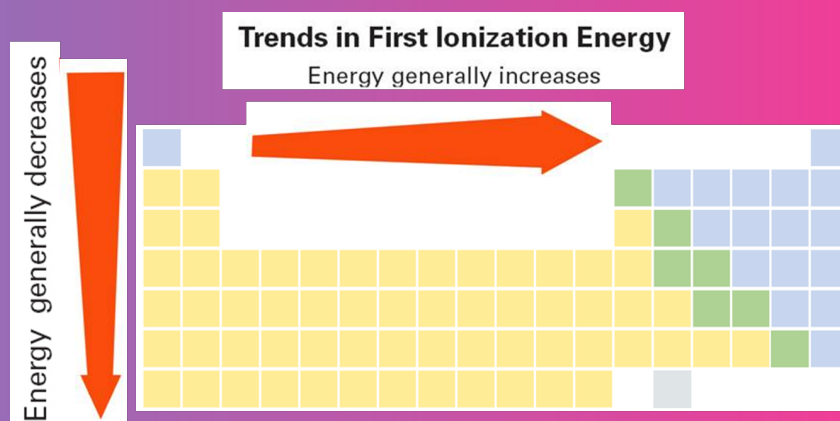
Periodic Table of the Elements

1 1IA H Hydrogen 1.008	2 IIA He Helium 4.003																	18 VIII A He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	
11 Na Sodium 22.990	12 Mg Magnesium 24.305	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948											18 VIII A Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 84.80	
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 208.980	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [209]	86 Rn Radon 222.018	
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [285]	113 Uut Ununtrium [288]	114 Fl Flerovium [289]	115 Uup Ununpentium [289]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]	
		57 La Lanthanum 138.905	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967		
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [252]	100 Fm Fermium 257.095	101 Md Mendelevium [258]	102 No Nobelium 259.101	103 Lr Lawrencium [262]		
		Alkali Metal	Alkaline Earth	Transition Metal	Semimetal	Nonmetal	Basic Metal	Halogen	Noble Gas	Lanthanide	Actinide							

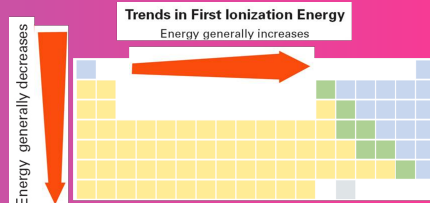
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Ionization energy is defined as the minimum energy required to remove an electron from the ground state of a gaseous atom or ion.



Ionization Energy



Metals form _____ by _____ electrons.

Nonmetals form _____ by _____ electrons.

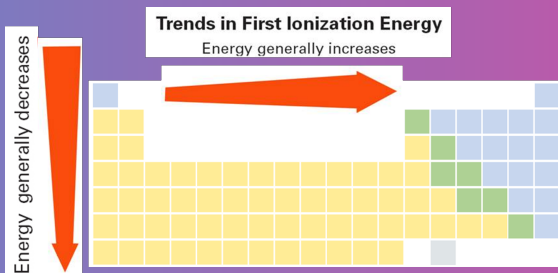
1 IA H 1.00794	2 IIA He 4.00260																	13 IIIA B 10.811	14 IIIA C 12.0107	15 VA N 14.0064	16 VIA O 15.9994	17 VIIA F 18.9984	18 VIIIA Ne 20.1797	
3 IIIA Li 6.941	4 IIA Be 9.0122											11 IB Cu 63.546	12 IIB Zn 65.38	13 IIIA Al 26.9815	14 IIIA Si 28.0855	15 VA P 30.9738	16 VIA S 32.06	17 VIIA Cl 35.453	18 VIIIA Ar 39.948					
19 IA K 39.0983	20 IIA Ca 40.078	21 IIIB Sc 44.9559	22 IIIB Ti 47.88	23 IIIB V 50.9415	24 IIIB Cr 51.9961	25 IIIB Mn 54.938	26 IIIB Fe 55.845	27 IIIB Co 58.9332	28 IIIB Ni 58.6934	29 IIIB Cu 63.546	30 IIIB Zn 65.38	31 IIIB Ga 69.723	32 IIIB Ge 72.630	33 IIIB As 74.9216	34 IIIB Se 78.96	35 IIIB Br 79.904	36 IIIB Kr 83.80							
37 IA Rb 85.4678	38 IIA Sr 87.62	39 IIIB Y 88.9058	40 IIIB Zr 91.224	41 IIIB Nb 92.9064	42 IIIB Mo 95.94	43 IIIB Tc 98.9062	44 IIIB Ru 101.07	45 IIIB Rh 102.9055	46 IIIB Pd 106.42	47 IIIB Ag 107.8682	48 IIIB Cd 112.411	49 IIIB In 114.818	50 IIIB Sn 118.710	51 IIIB Sb 121.757	52 IIIB Te 127.6	53 IIIB I 126.905	54 IIIB Xe 131.29							
55 IA Cs 132.905	56 IIA Ba 137.327	57-71 IIIB La-Lu	72 IIIB Hf 178.49	73 IIIB Ta 180.948	74 IIIB W 183.84	75 IIIB Re 186.207	76 IIIB Os 190.23	77 IIIB Ir 192.222	78 IIIB Pt 195.084	79 IIIB Au 196.967	80 IIIB Hg 200.59	81 IIIB Tl 204.383	82 IIIB Pb 207.2	83 IIIB Bi 208.980	84 IIIB Po 209	85 IIIB At 210	86 IIIB Rn 222							
87 IA Fr 223	88 IIA Ra 226																	112 IIIB Cn 285	113 IIIB Nh 286	114 IIIB Fl 287	115 IIIB Uup 288	116 IIIB Lv 289	117 IIIB Uus 290	118 IIIB Uuo 291
Lanthanide Series		58 La 138.905	59 Ce 140.12	60 Pr 140.908	61 Nd 144.24	62 Pm 144.913	63 Sm 150.36	64 Eu 151.964	65 Gd 157.25	66 Tb 158.925	67 Dy 162.50	68 Ho 164.930	69 Er 167.259	70 Tm 168.930	71 Lu 174.967									
Actinide Series		88 Ac 227	89 Th 232.0377	90 Pa 231.036	91 U 238.02891	92 Np 237.04817	93 Pu 244.06422	94 Am 243.0613	95 Cm 247.07715	96 Bk 247.07715	97 Cf 251.07958	98 Es 252.0832	99 Fm 257.10	100 Md 258.10	101 No 259.10	102 Lr 262.10								
		Alkali Metal	Alkaline Earth	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal	Transition Metal							

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

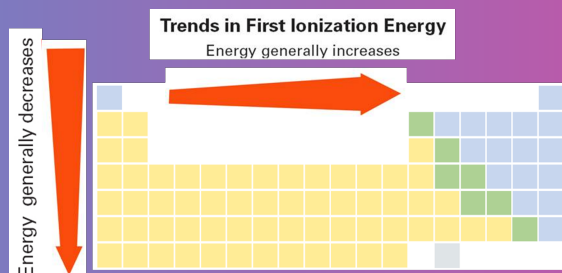
Ionization Energy

analyze the trend across a period...

Think: metals LOSE electrons to form cations

nonmetals GAIN electrons to form anions

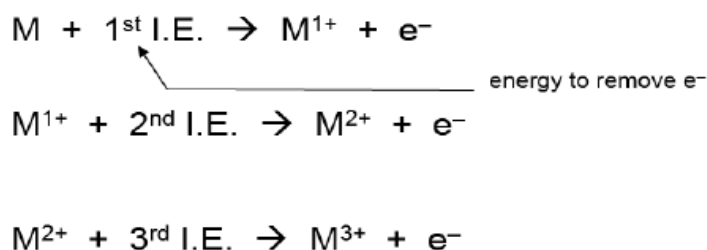
metals (left side, <4 valence e-)
more easily LOST valence electrons
to form ions with stable octets, so
this would require LOW energy to
lose an e-



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

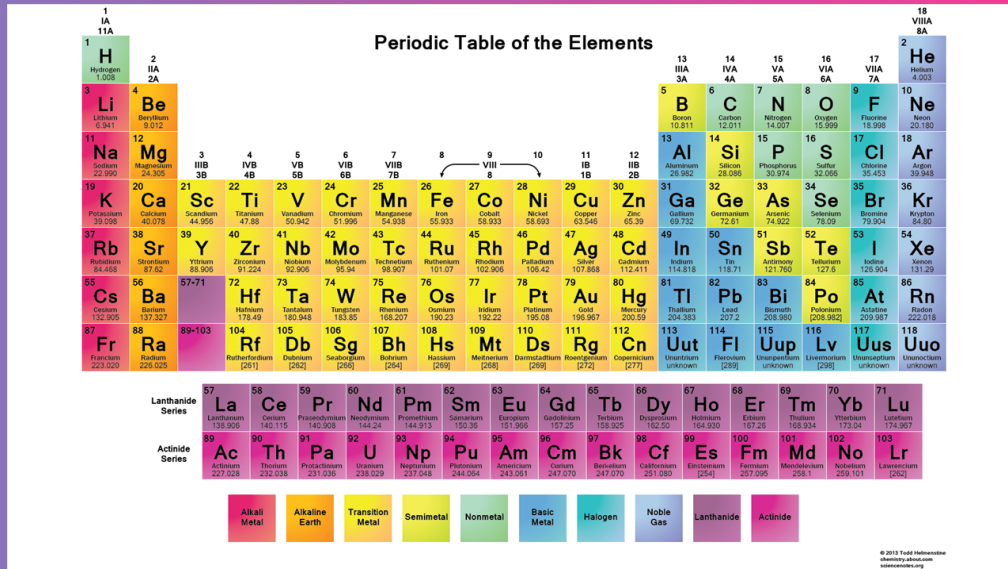
Why do the second, third, or each successive ionization energy require more energy than the previous one?



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

Ionization Energy

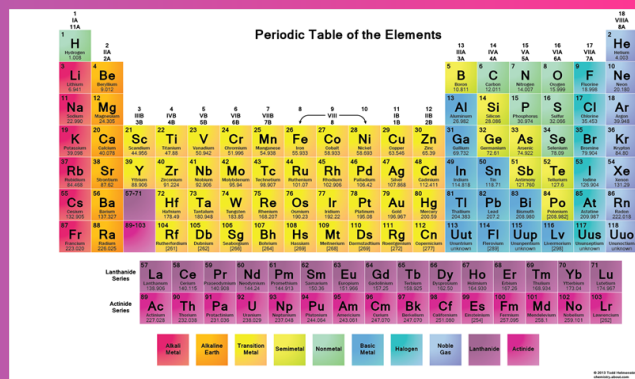
Which element has the highest first ionization energy: Sn, As, or S?



Arrange the following in order of increasing ionization energy.

a) Na, Cl, Al, S
 $\text{Na} < \text{Al} < \text{S} < \text{Cl}$

b) Be, Ba, Ca, Mg, Sr



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

A metal gives electron(s) to a non-metal. The metal becomes positive and the non-metal becomes negative. They now attract each other.

Metals **NON-METALS**

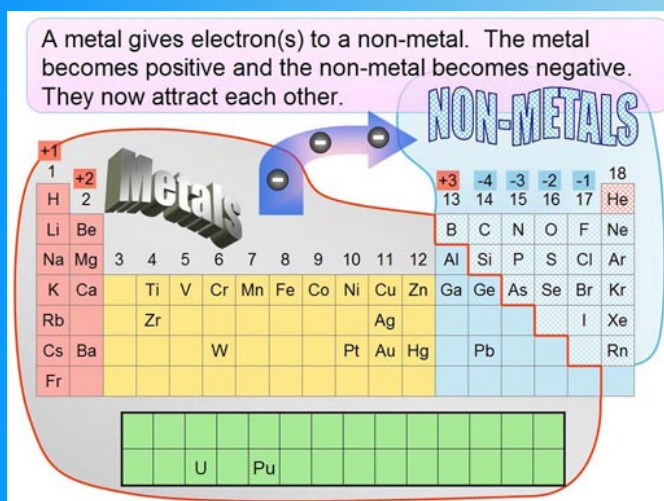


a measure of how much an element pulls electrons towards itself

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

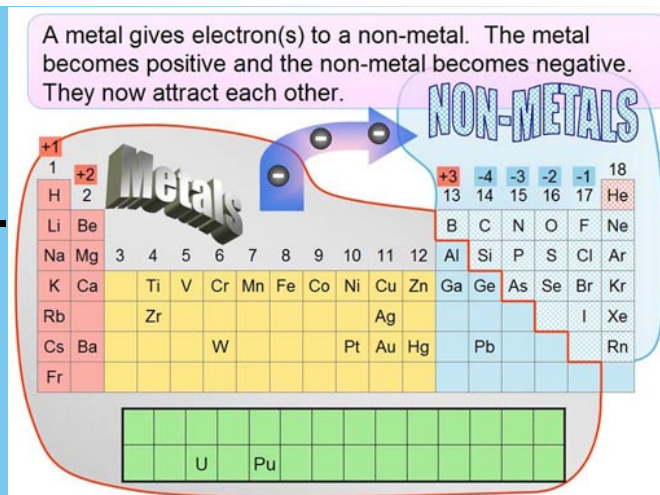
greater distance to nucleus/ size of the atom with increasing energy levels

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

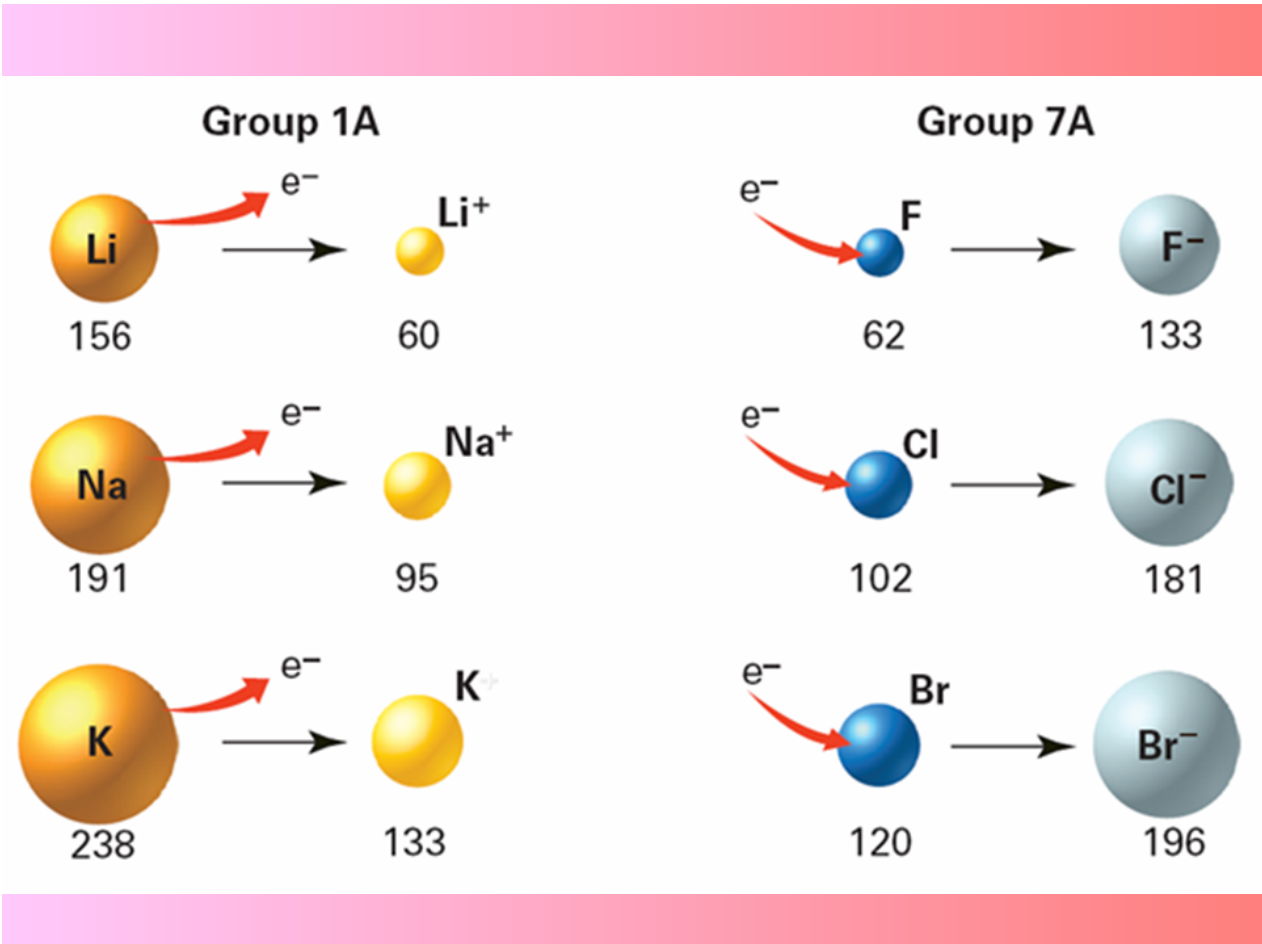
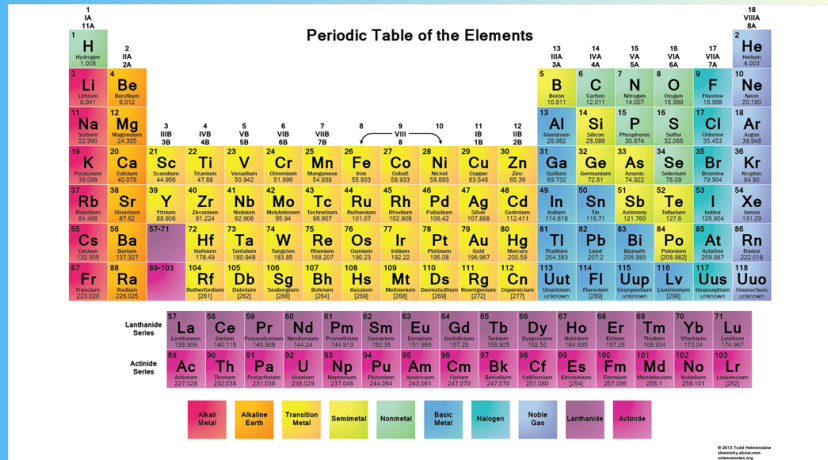
conversely, if the valence shell is more than half full (>4), it is easier to pull an electron into the valence shell than to lost an electron



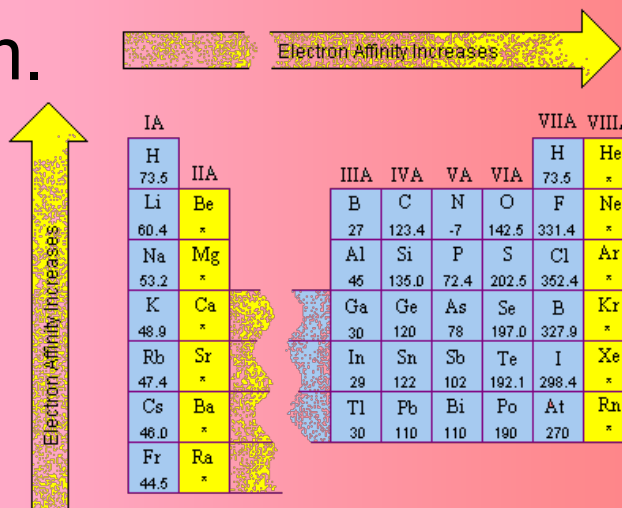
Rank the elements in order of increasing electronegativity

Ba, Br, Fe

O, Se, K

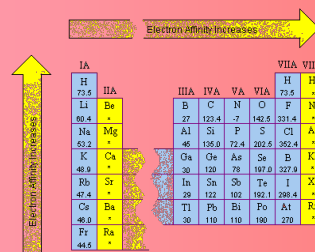


Electron affinity is defined as the energy change that occurs when an electron is added to a gaseous atom.



Electron Affinity

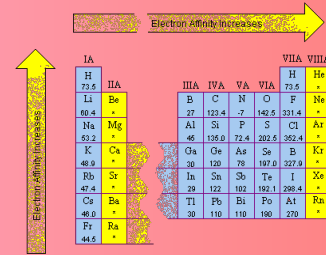
across a period...



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...

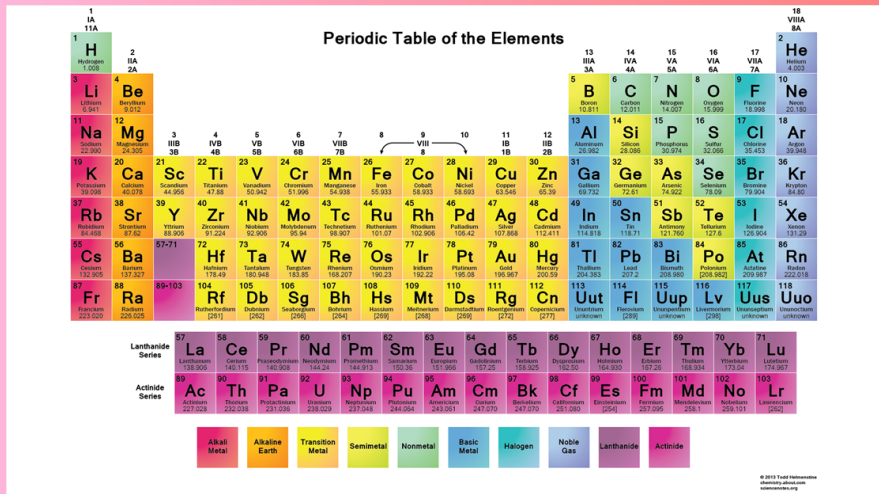


electron affinity decreases down a group because there is a greater number of energy levels (periods) so there is more ELECTRON SHIELDING so a weaker force of attraction between electrons and protons in the nucleus (greater distance)

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