

Periodic Trends

Atomic Radius, Ionization Energy, Electronegativity, Ionic Size, and Reactivity

Periodic Properties

- ⊗ The periodic variation in properties is based on electron configuration
- ⊗ Eight (8) electrons in the valence level makes an atom very stable and generally unreactive
- ⊗ Filled and half-filled sublevels also add stability
- ⊗ Atoms react to become more stable

Four Factors to Consider

1. Number and arrangement of valence electrons
 - Most feasible way to obtain a stable octet (gain, lose or share)
2. Coulombic Attractions
 - Attraction of positive nucleus for negative electrons
3. Number of energy levels
 - Distance from nucleus
4. Shielding
 - The number of energy levels between the nucleus and valence level which reduces the pull of the nucleus

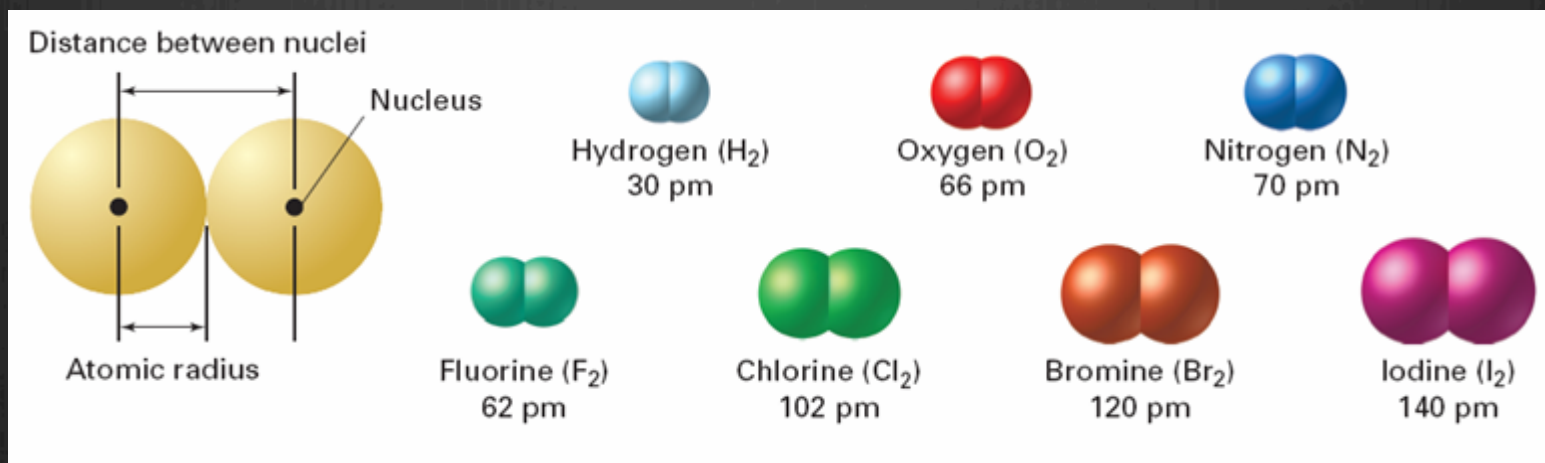
Periodic Trends

- ⊗ Many trends of elements can be explained by electron configuration and position on the periodic table.

- ⊗ Trends to be examined:
 - ⊗ *Atomic Radius*
 - ⊗ *Ionization Energy*
 - ⊗ *Electronegativity*
 - ⊗ *Ionic Radius*
 - ⊗ *Electron Affinity*

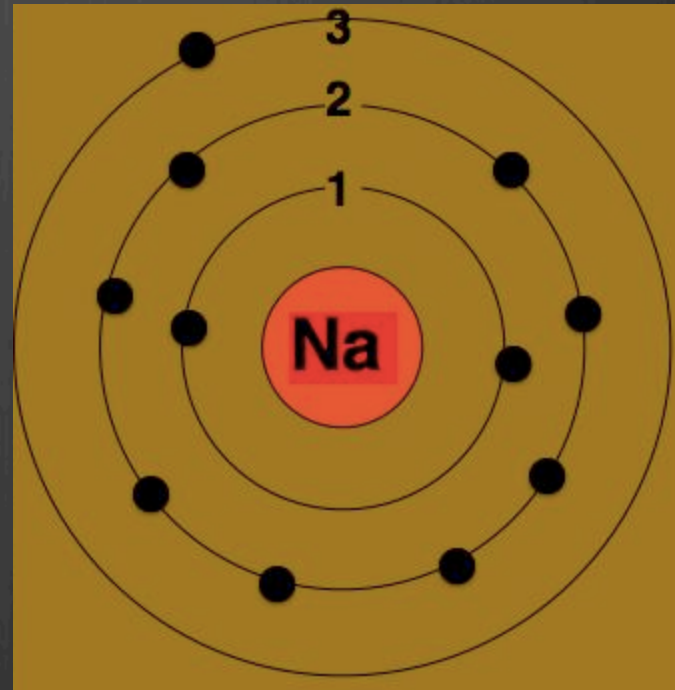
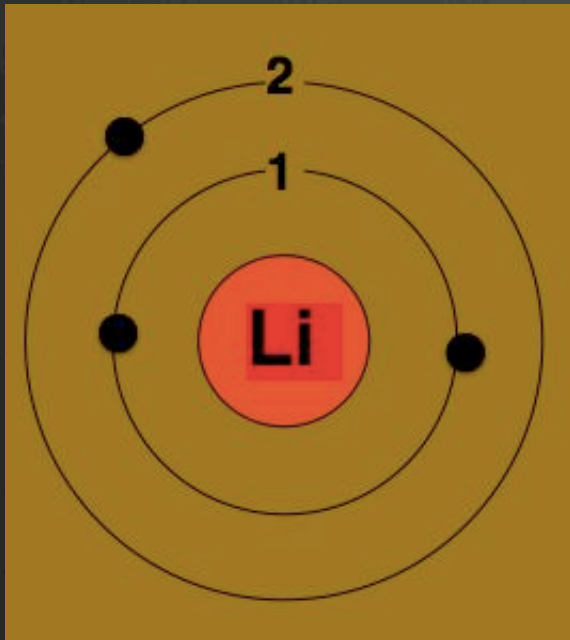
Atomic Radius

- One half of the distance between the nuclei of two atoms of the same element when the atoms are joined together



Atomic Radius – Down a group

- ⊗ In general, as you go down a group, atomic size increases from top to bottom due to more energy levels

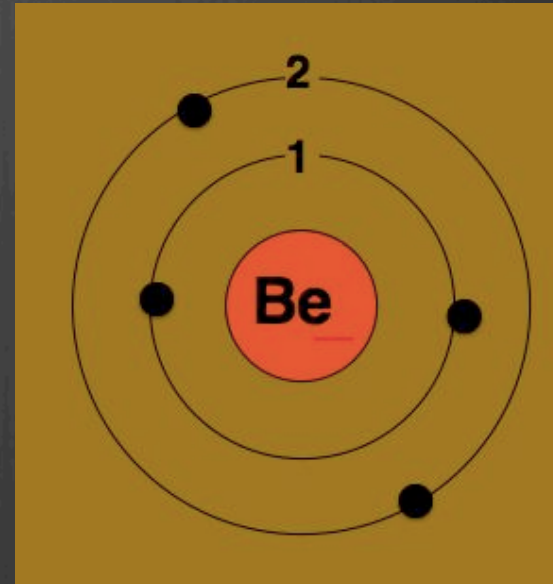
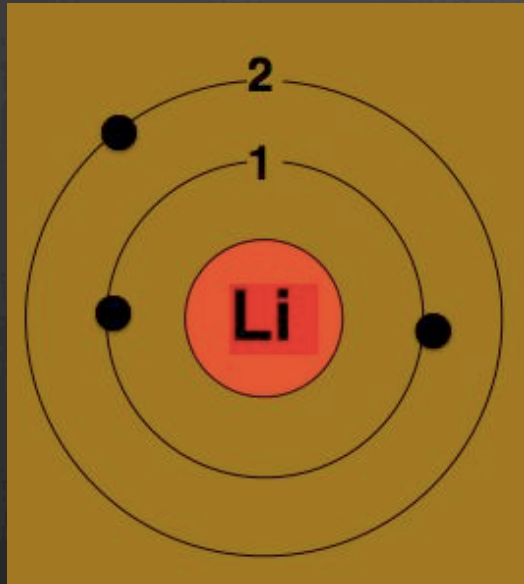


Atomic Radius – Down a Group

- ⊗ Atomic radius increases down a group due to:
 - ⊗ Higher energy levels = farther away from the nucleus so atoms get bigger
 - ⊗ Shielding = core e- block the attraction between the nucleus and valence e-

Atomic Radius – Across a Period

- ⊗ As you move across a period from Left to Right, atomic radius decreases



- ⊗ As you go from L to R, e- are put into the same orbital, but more p+ and e- total (more attraction = smaller size)











































Decrease in Atomic Radius



Increase in Atomic Radius



											H												He
Li	Be											B	C	N	O	F	Ne						
Na	Mg											Al	Si	P	S	Cl	Ar						
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
Cs	Ba	*Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
Fr	Ra	+Lr																					
		*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb							
		+	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No							

	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Period 1	 H							 He
Period 2	 Li	 Be	 B	 C	 N	 O	 F	 Ne
Period 3	 Na	 Mg	 Al	 Si	 P	 S	 Cl	 Ar
Period 4	 K	 Ca	 Ga	 Ge	 As	 Se	 Br	 Kr
Period 5	 Rb	 Sr	 In	 Sn	 Sb	 Te	 I	 Xe
Period 6	 Cs	 Ba	 Tl	 Pb	 Bi	 Po	 At	 Rn

Question?

- ⊗ Which has the largest atomic radius?
 - ⊗ Chlorine
 - ⊗ Fluorine
 - ⊗ Iodine
 - ⊗ Bromine
 - ⊗ Answer: Iodine
- ⊗ Why?
 - ⊗ Answer: Iodine has the most energy levels (furthest down the periodic table)

Ionization Energy

- ⊗ The ability of an atom to hold onto its outer most electron
- ⊗ The bigger the value the harder to lose (the stronger it is holding its electron!)
- ⊗ The energy required to remove the first electron from an atom is called the first ionization energy
 - ⊗ The energy required to remove an electron from an ion with a 1+ charge is called the second ionization energy

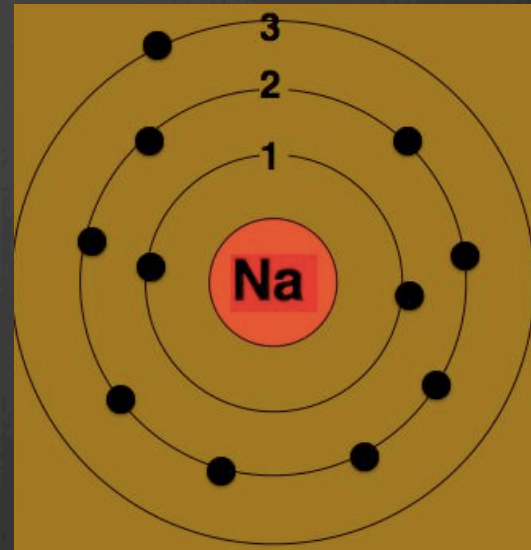
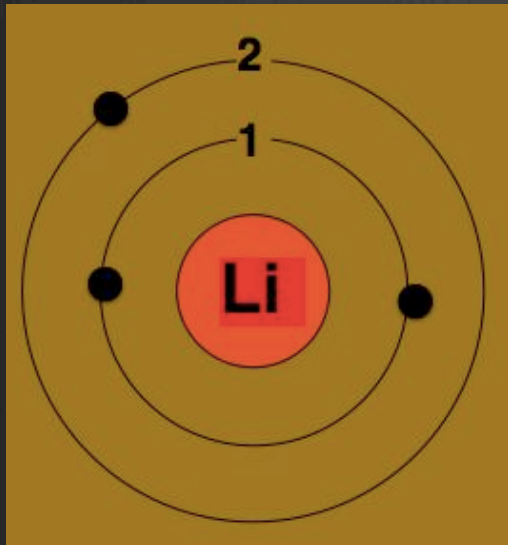
Ionization Energy Trends

- ⊗ Group Trend:

- ⊗ As you go down a group, ionization energy decreases.

- ⊗ Why?

- ⊗ As you go down, atomic size is increasing (less attraction), so easier to remove an e-



Ionization Energy Trends

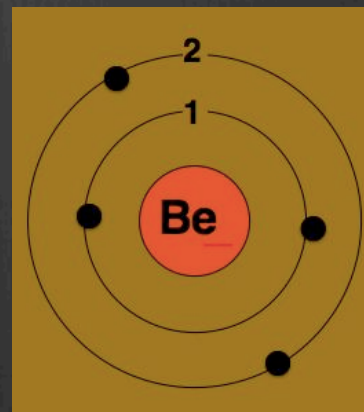
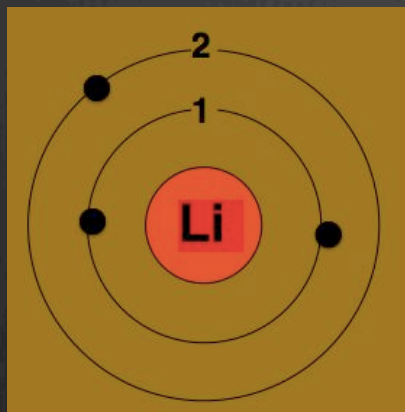
- ⊗ Periodic Trend:

- ⊗ As you go across a period (L to R), ionization energy increases

- ⊗ Why?

- ⊗ As you go L to R, atomic size is decreasing (more attraction), so more difficult to remove an e-

- ⊗ Also, there are the same number of energy levels, but there are more protons pulling stronger on the outer most electrons



Increase in Ionization Energy →

↓ Decrease in Ionization Energy

		H																He
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	*Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	+Lr																
			*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	
			+	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	

Question?

⊗ Which has the lowest ionization energy?

⊗ Chlorine

⊗ Sodium

⊗ Magnesium

⊗ Argon

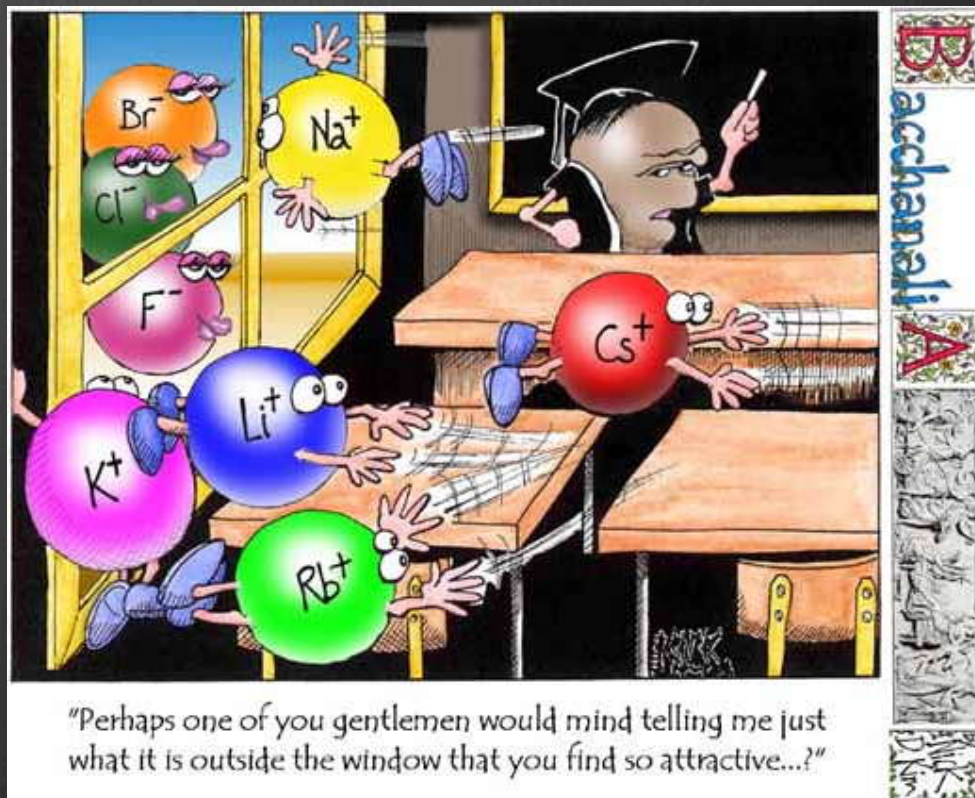
⊗ Answer: Sodium

⊗ Why?

⊗ Answer: They all have the same number of energy levels, but sodium has the least protons therefor the least strength to hold an outer electron

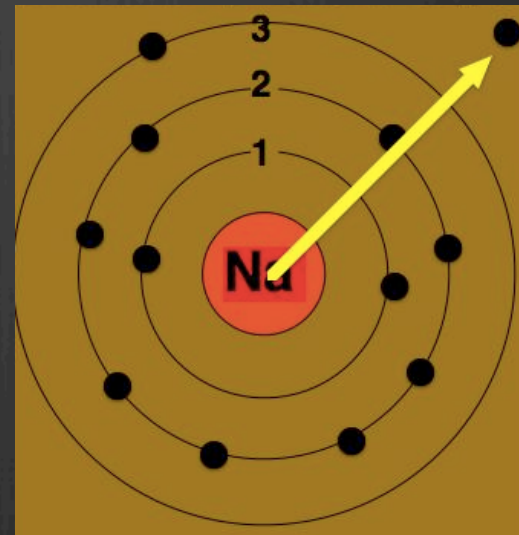
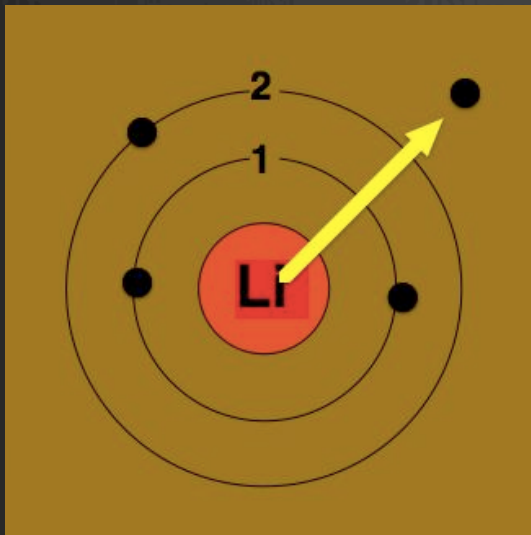
Electronegativity

- ⦿ The ability of an atom to steal an electron from another atom (electron thieves)



Electronegativity – Down a Group

- ⊗ Group Trend:
 - ⊗ As you go down a group, electronegativity decreases
 - ⊗ Why?
 - ⊗ As you go down, atomic size is increasing, so less attraction to its own e- and other atom's e-



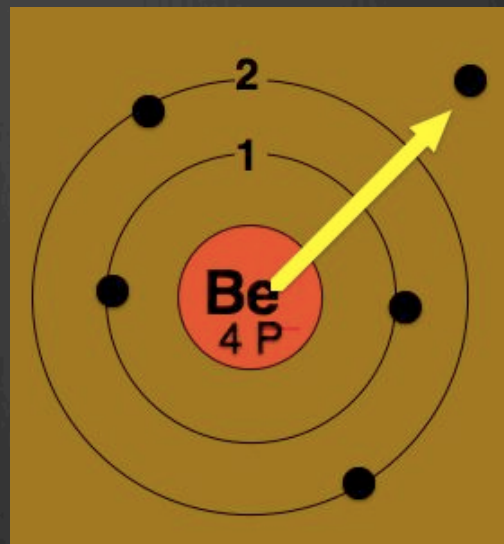
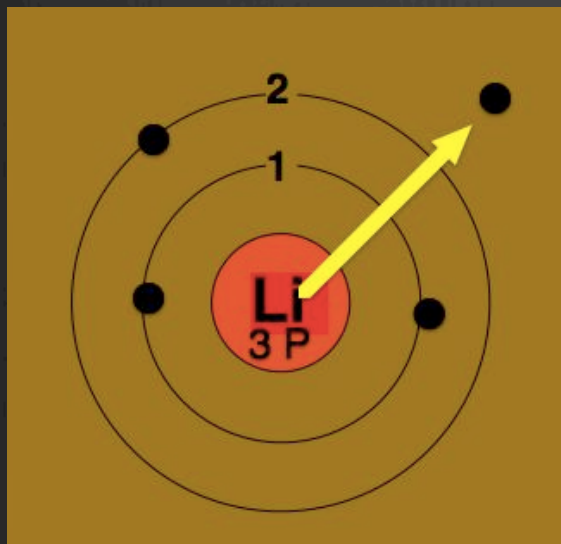
Electronegativity – Across a Period

- ⊗ Periodic Trend:

- ⊗ As you go across a period (L to R), electronegativity increases

- ⊗ Why?

- ⊗ AS you go L to R, atomic size is decreasing, so there is more attraction to its own e- and other atom's e-



Increase in Electronegativity



Decrease in Electronegativity



											H						He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	*Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	+Lr																
			* La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb		
			+ Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		

Question?

- ⊗ Which has the largest electronegativity?
 - ⊗ Chlorine
 - ⊗ Sodium
 - ⊗ Magnesium
 - ⊗ Argon
 - ⊗ Answer: Chlorine
- ⊗ Why?
 - ⊗ They all have the same number of energy levels, but chlorine has the most protons therefor the most strength to steal an electron. Remember not Argon, because it is a nobel gas and have a full outer shell already!

