1.1 Effective Nuclear Charge

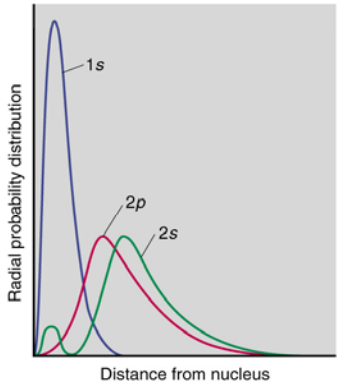
- The interaction between the nuclear charge and the valence electrons (how many? how far away?) is critical
- The nuclear charge experienced by the valence electrons (Z_{eff}) impacts how tightly the valence electrons are held
- How tightly the valence electrons are held influences atomic size, ionization energy, electron affinity, and reactivity

1.2 Effective Nuclear Charge

- Z_{eff} = nuclear charge actually experienced by an electron
- Simplest approximation
  - Z_{eff} = Z - # core electrons
- Assumption
- Examples

1.3 Effective Nuclear Charge

- Slater's rules acknowledge the imperfect shielding caused by orbital penetration



1.4 Slater's Rules

- Slater's rules assume imperfect shielding
- $Z_{eff} = Z - \sigma$ where σ is calculated using Slater's rules

1. Group the orbitals in order:
   (1s) (2s,2p) (3s,3p) (3d) (4s,4p) (4d) (4f) (5s,5p)…

2. To determine σ, sum up the following contributions for the electron of interest:

a. 0 (zero) for all electrons in groups outside (to the right of) the one being considered
b. 0.35 for each of the other electrons in the same group (except for 1s group where 0.30 is used)
c. If the electron is in a (ns,np) group, 0.85 for each electron in the next innermost (to the left) group
d. If the electron is in a (nd) or (nf) group, 1.00 for each electron in the next innermost (to the left) group
e. 1.00 for each electron in the still lower (farther in) groups

1.5 Using Slater's Rules

- What do the 1.0, 0.85 and 0.35 factors mean?
- Some examples
  - Na
  - F

1.6 Using Slater's Rules

- Fluorine's Z_{eff} calculated using the simple approximation = 7 and using Slater's rules = 5.20. Why is the Slater Z_{eff} value lower?
- What is Z_{eff} for a "core" electron?

1.7 Using Slater's Rules

- Z_{eff} trend across a period (Li to Ne)

1.8 Using Slater's Rules

- Z_{eff} trend down a group (Li to K)
- Z_{eff} trend down a group (F to Br)

Periodic Trends

2.1 Atomic Radius, IE, EA, EN

- Atomic radius: distance from nucleus to outermost electrons
- IE: energy change when an electron is removed from a gaseous atom or ion

$$A(g) \rightarrow A^+(g) + e^-$$

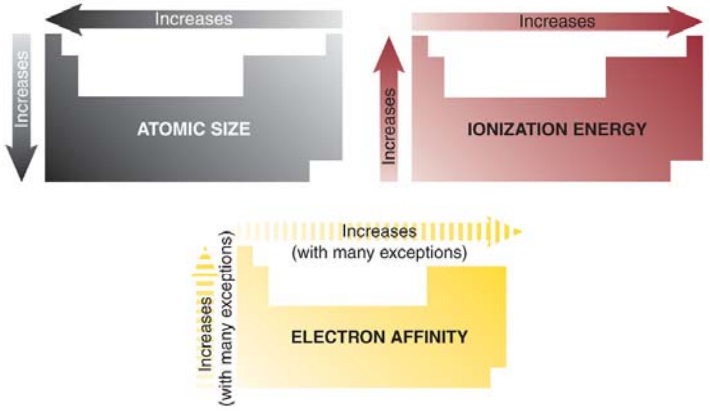
- EA: energy change when an electron is added to a gaseous atom or ion

$$A(g) + e^- \rightarrow A^-(g)$$

- Electronegativity (EN): the tendency of an atom to draw shared electrons (in a chemical bond) toward itself

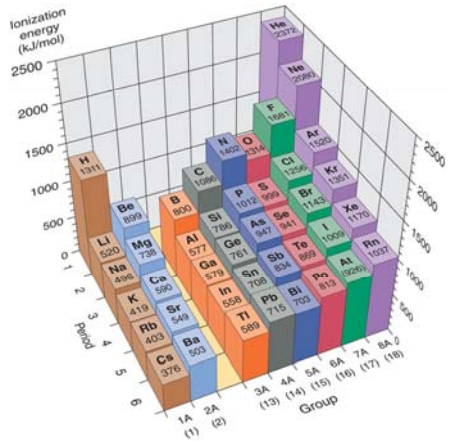
Periodic Trends

2.2 Periodic Trends



Periodic Trends

2.3 Ionization Energy



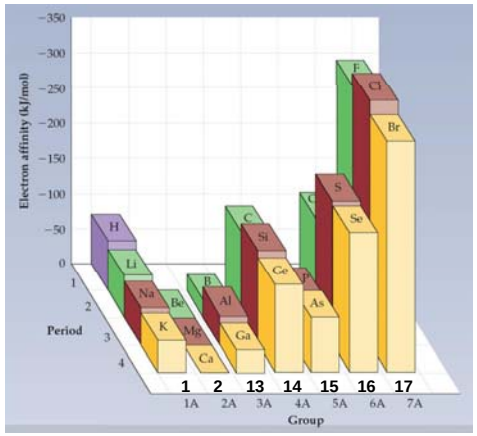
Periodic Trends

2.4 Ionization Energy

- Some exceptions to the general trend
- Be and B
- N and O

Periodic Trends

2.5 Electron Affinity



Periodic Trends

2.6 Electron Affinity

1A (1)	2A (2)	3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	8A (18)
H −72.8							He (0.0)
Li −59.6	Be ≤0	B −26.7	C −122	N +7	O −141	F −328	Ne (+29)
Na −52.9	Mg ≤0	Al −42.5	Si −134	P −72.0	S −200	Cl −349	Ar (+35)
K −48.4	Ca −2.37	Ga −28.9	Ge −119	As −78.2	Se −195	Br −325	Kr (+39)
Rb −46.9	Sr −5.03	In −28.9	Sn −107	Sb −103	Te −190	I −295	Xe (+41)
Cs −45.5	Ba −13.95	Tl −19.3	Pb −35.1	Bi −91.3	Po −183	At −270	Rn (+41)

Periodic Trends

2.7 Electron Affinity

- Some exceptions to the general trend
- Li and Be
- C and N

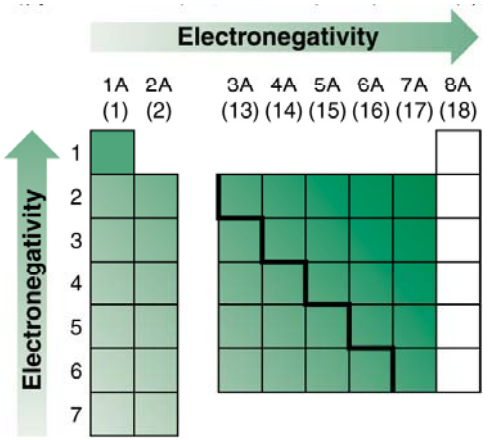
Periodic Trends

2.8 Electron Affinity

- Another exception to the general trend
- F and Cl (O and S)

Periodic Trends

2.9 Electronegativity



Periodic Trends

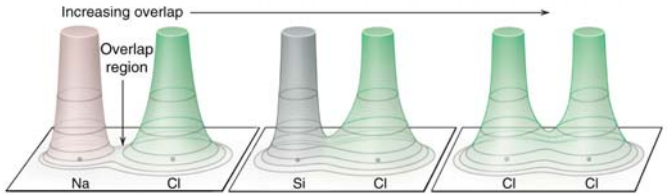
2.10 Ionic Radii

- $Cs^+ > K^+ > Na^+$
- $I^- > Br^- > Cl^-$
- Na versus Na^+
- What about sulfide, chloride and potassium ions?

Periodic Trends

3.1 Chemical Bonding

- Covalent
- Ionic

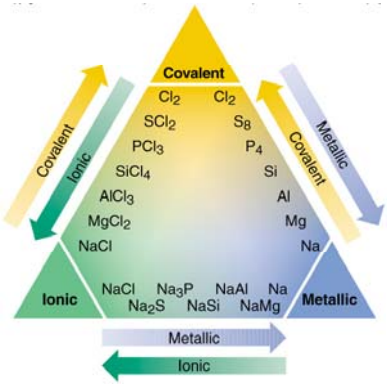


- Metallic

Periodic Trends

3.2 Chemical Bonding

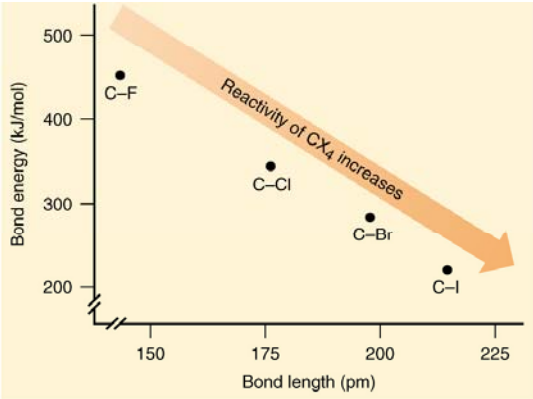
- Covalent
- Ionic
- Metallic



Periodic Trends

3.3 Chemical Bonding

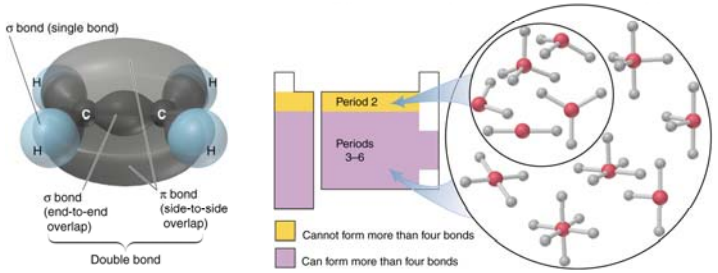
- Bond length, bond energy, reactivity



Periodic Trends

3.4 Chemical Bonding

- Orbitals involved in overlap



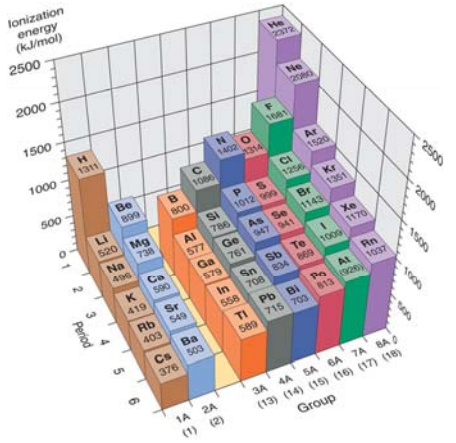
Periodic Trends

4.1 Uniqueness Principle

- Chemical properties of second period elements are different from those of higher period elements

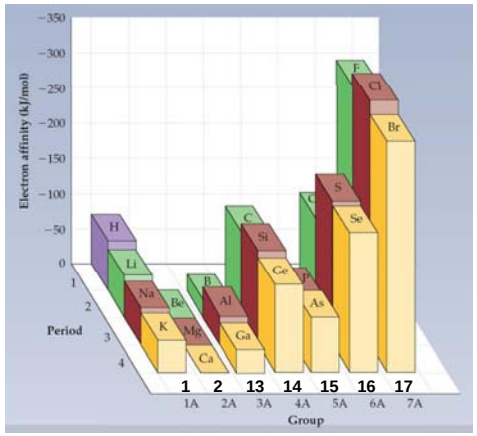
Periodic Trends

2.3 Ionization Energy



Periodic Trends

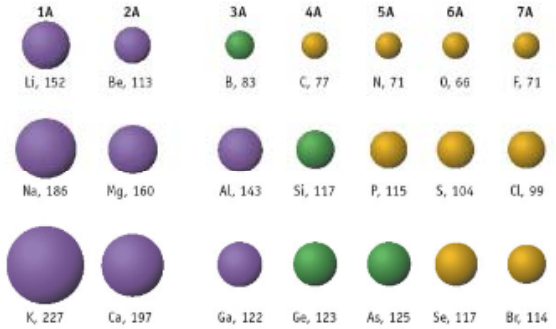
2.5 Electron Affinity



Periodic Trends

4.2 Uniqueness Principle

- Small size



Periodic Trends

4.3 Uniqueness Principle

- Tendency to form π-bonds

Periodic Trends

4.4 Uniqueness Principle

- Absence of d orbitals of appropriate energy

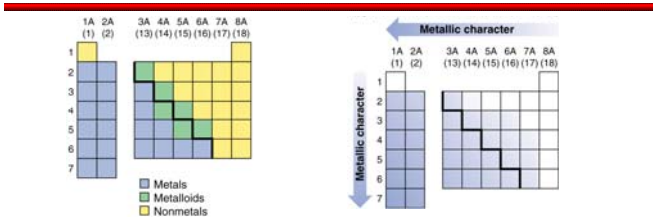
5.1 Diagonal Effect

- Diagonal relationship (similar chemical properties) between first member of a group and the second member of the next group
- Li and Mg
- Be and Al
- B and Si

5.2 Diagonal Effect

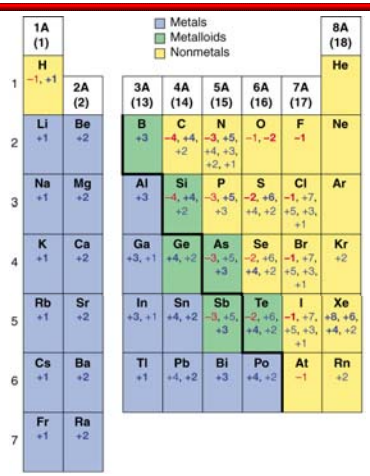
- Why does this diagonal relationship exist?

6.1 Metals, Non-metals, Metalloids



	Metals	Nonmetals
Atomic Properties	Have fewer valence electrons (in period) Have larger atomic size Have lower ionization energies Have lower electronegativities	Have more valence electrons (in period) Have smaller atomic size Have higher ionization energies Have higher electronegativities
Physical Properties	Occur as solids at room temperature Conduct electricity and heat well Are malleable and ductile	Occur in all three physical states Conduct electricity and heat poorly Are not malleable or ductile
Chemical Properties	Lose electron(s) to become cations React with nonmetals to form ionic compounds Mix with other metals to form solid solutions (alloys)	Gain electron(s) to become anions React with metals to form ionic compounds React with other nonmetals to form covalent compounds

6.2 Oxidation State and Reactivity



Periodic Trends

6.3 Oxidation State and Reactivity