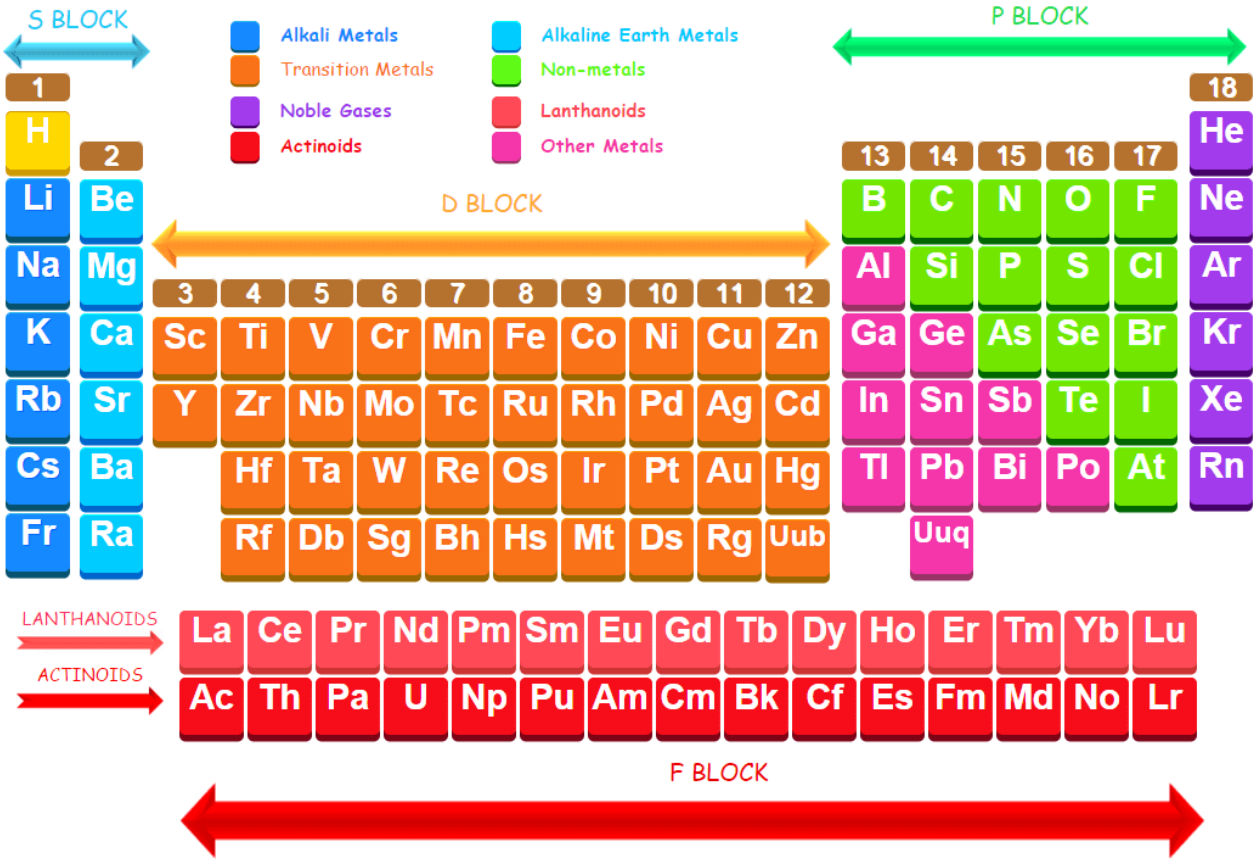
PERIODIC TRENDS

PERIODIC LAW

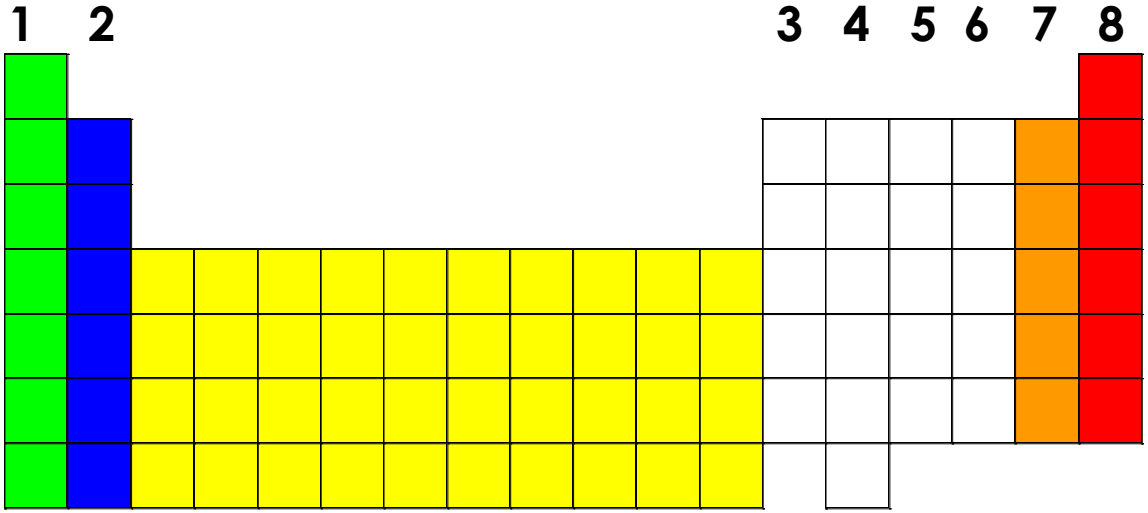
When elements are arranged in order of increasing atomic number, elements with similar properties appear at regular intervals



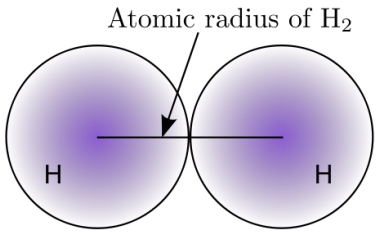
CHEMICAL REACTIVITY

Families

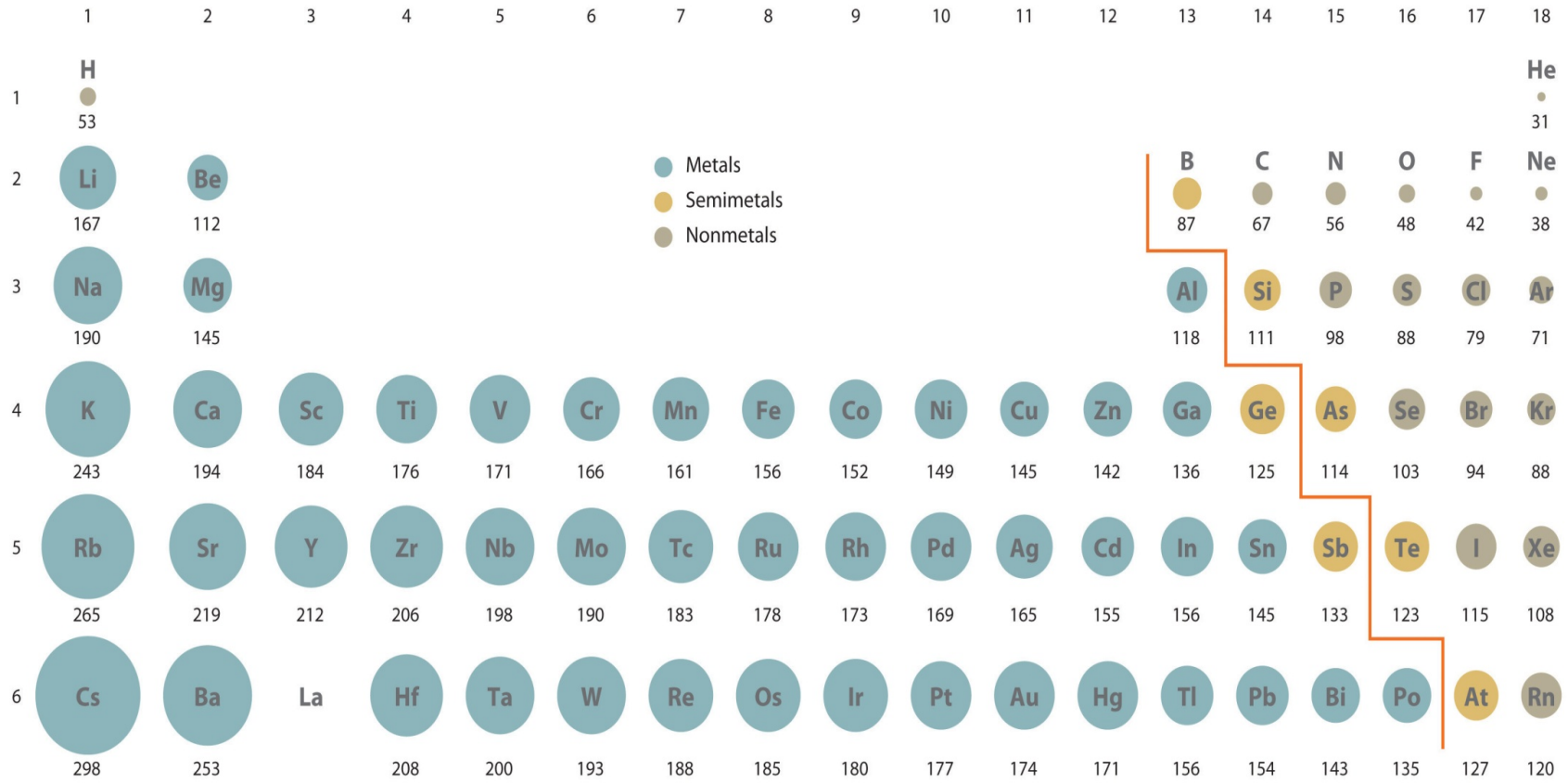
- Similar valence electrons within a group result in similar chemical properties
- **Valence electrons**: the electrons available to be lost, gained, or shared in the formation of chemical compounds

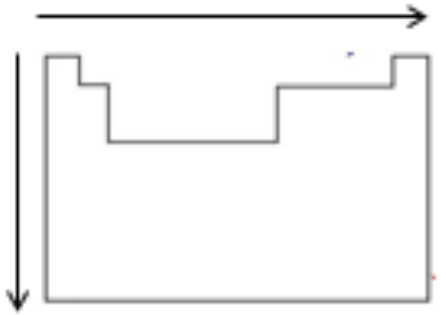
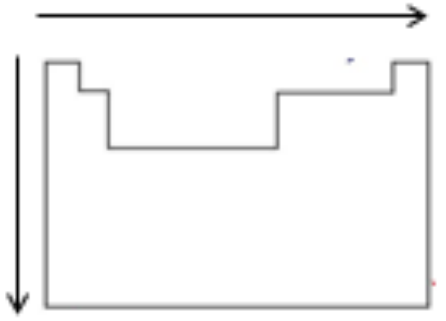


ATOMIC RADII

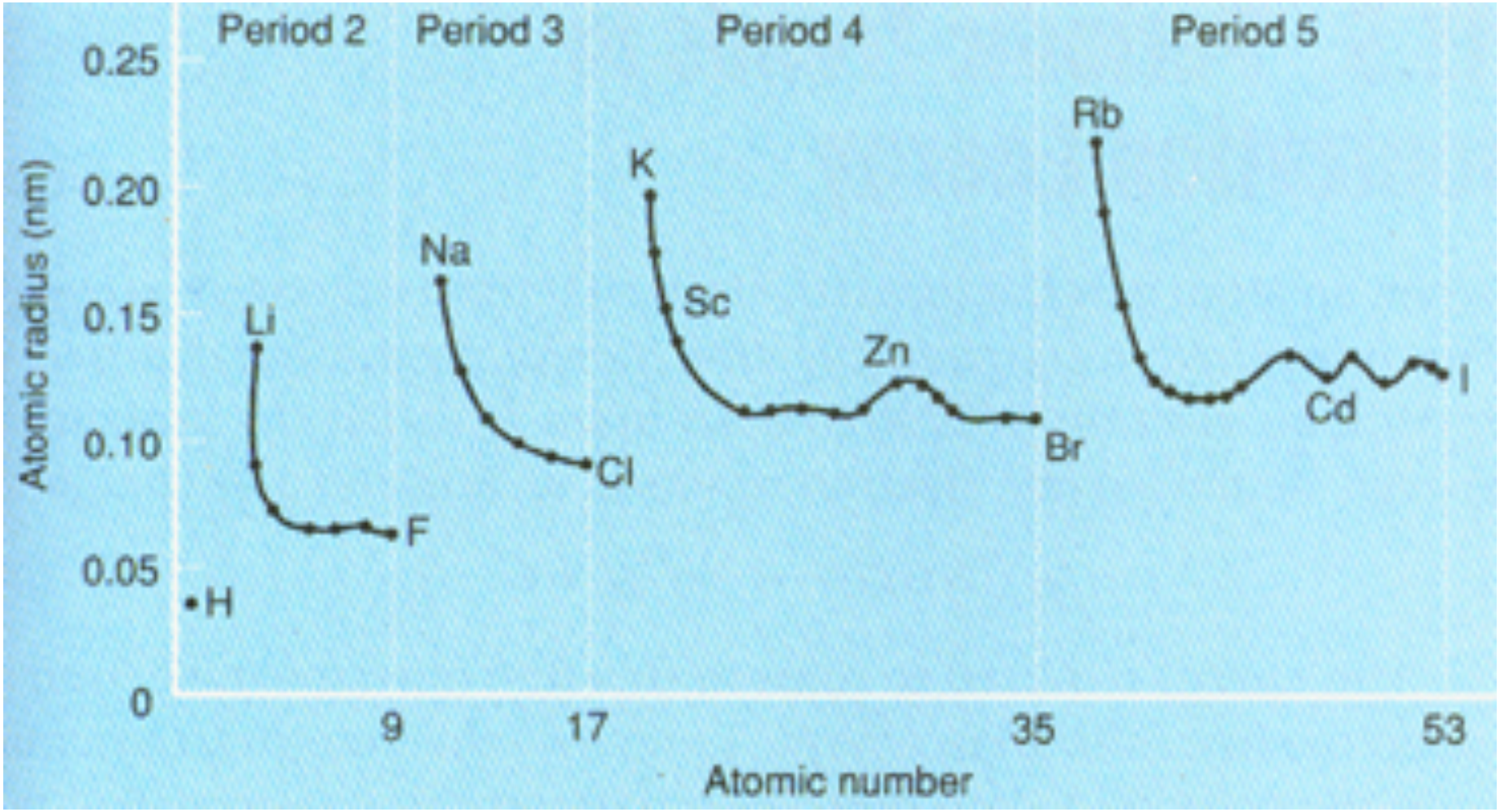


- **Atomic radius**: one-half the distance between the nuclei of identical atoms that are bonded together



Term	Definition	Trend on the Periodic Table	Why?
Atomic Radius	Atomic radius: one-half the distance between the nuclei of identical atoms that are bonded together		Period: Caused by increase in positive nuclear charge Group: Higher energy levels have larger orbitals
Ionization Energy			
Electronegativity			

Atomic Radius vs. Atomic Number



Plot of atomic radius versus atomic number shows period and group trends

SAMPLE PROBLEM

- **Of the elements magnesium, Mg, chlorine, Cl, sodium, Na, and phosphorus, P, which has the largest atomic radius? Explain your answer in terms of trends in the periodic table.**
  - 1. Find the elements listed in the periodic table.
  - 2. Put the elements in order and determine the trend.
    - Sodium, Na.
    - Because atomic radii decreases across a period.
- **Of the elements calcium, Ca, beryllium, Be, barium, Ba, and strontium, Sr, which has the largest atomic radius? Explain your answer in terms of trends in the periodic table.**
  - 1. Find the elements listed in the periodic table.
  - 2. Put the elements in order and determine the trend.
    - Barium, Ba.
    - Because atomic radii increases down a group.

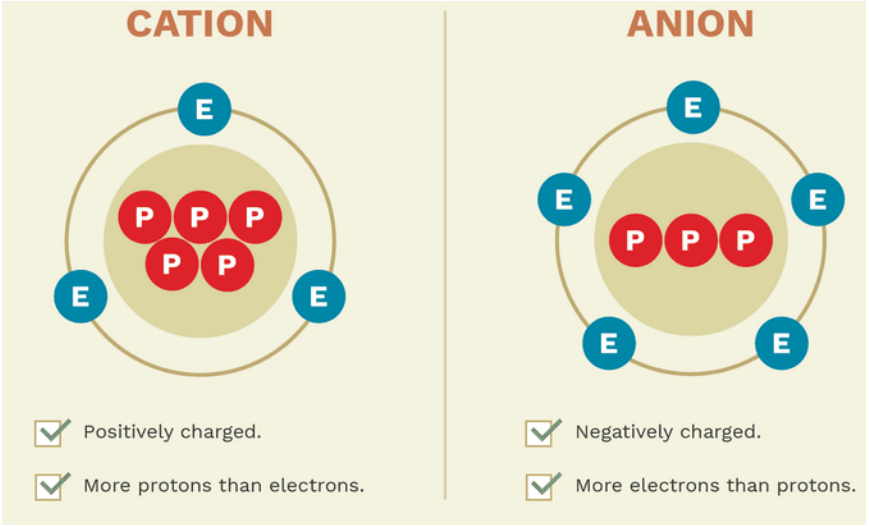
YOU TRY!

- **Of the elements Li, O, C, and F, identify the one with the largest atomic radius and the one with the smallest atomic radius.**
  - Largest: Li
  - Smallest: F

- **Of the elements Br, At, F, I, and Cl, identify the one with the smallest atomic radius and the one with the largest atomic radius.**
  - Smallest: F
  - Largest: At

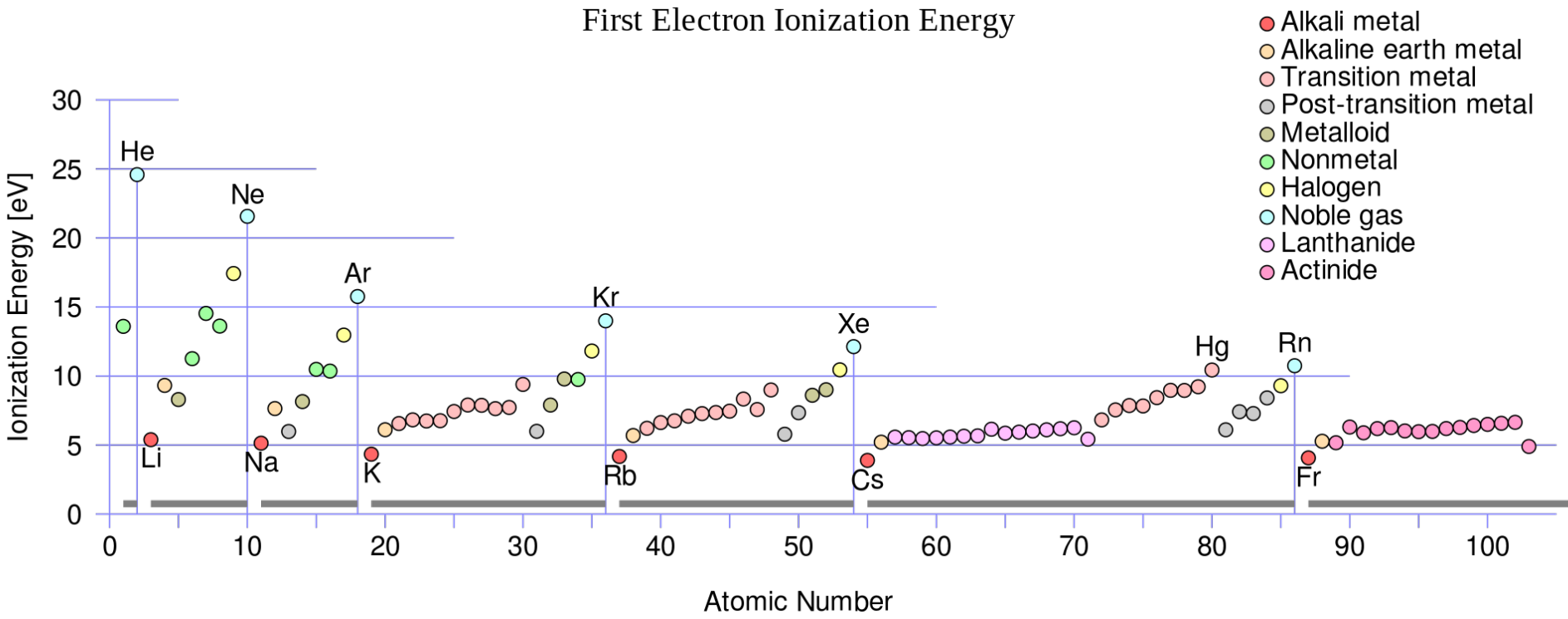
IONIZATION ENERGY

- **Ion:** an atom or group of bonded atoms that has a positive or negative charge
  - Positive ion = removal of electron
  - Negative ion = addition of electron



- **Ionization**: any process that results in the formation of an ion

- **Ionization energy (IE)** : the energy required to remove one electron from a neutral atom of an element
  - *Indicates how strongly an atom's nucleus holds onto its electrons*


First Electron Ionization Energy
Alkali metal
Alkaline earth metal
Transition metal
Post-transition metal
Metalloid
Nonmetal
Halogen
Noble gas
Lanthanide
Actinide
Ionization Energy [eV]
Atomic Number
He
Ne
Ar
Kr
Xe
Hg
Rn
Li
Na
K
Rb
Cs
Fr
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
90
100

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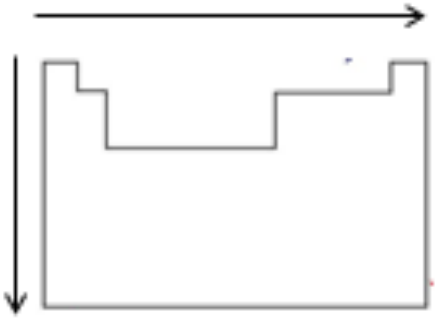
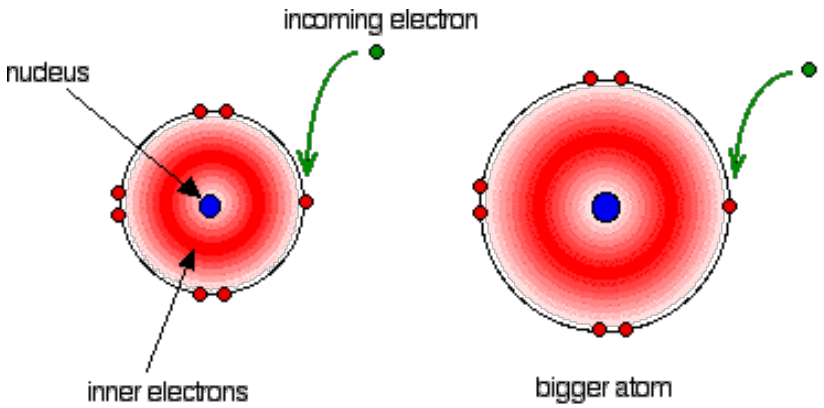
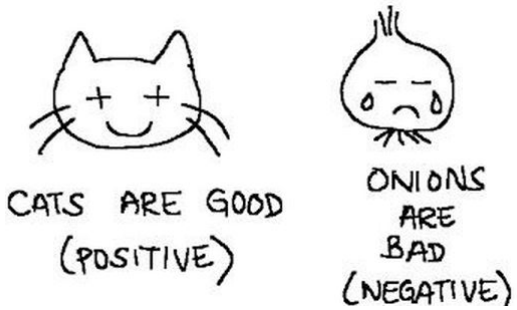
Electronegativity			

ELECTRON AFFINITY

- **Electron affinity**: the energy change that occurs when an electron is acquired by a neutral atom
- Most atoms release energy when they acquire an electron
- Some atoms must be "forced" to gain an electron by the addition of energy
  - Ion produced this way will be unstable and will lose the added electron easily



IONIC RADII



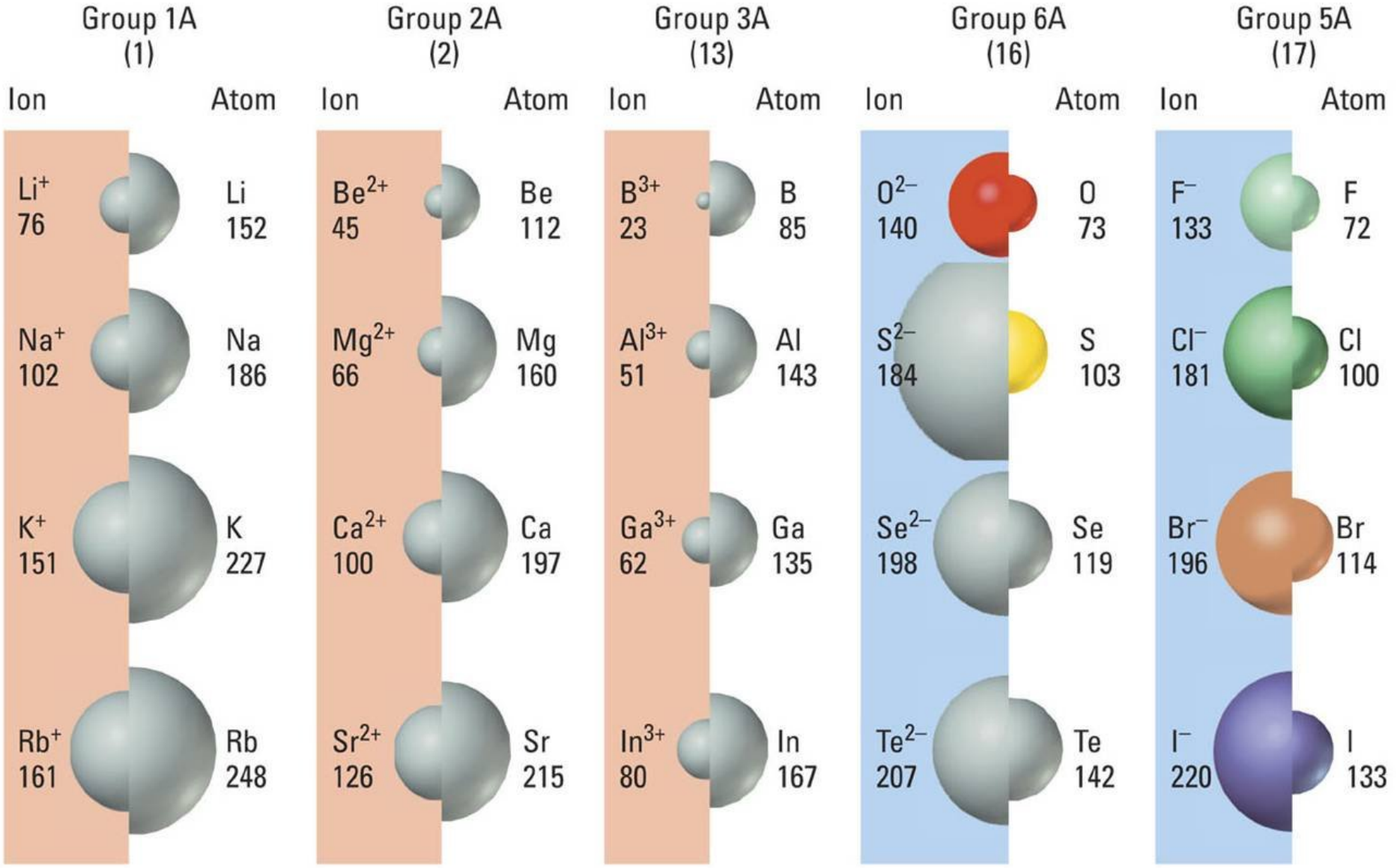
Cation (+)

- **Cation**: positive ion
- Formation by the loss of one or more electrons
- Smaller than the atoms from which they are formed
- Remaining electrons are drawn closer to the nucleus by its unbalances positive charge

Anions (-)

- **Anion**: negative ion
- Formation by the addition of one or more electrons
- Leads to an increase in atomic radius
- Electron cloud spreads out due to greater repulsion between the increased number of electrons

- *Metals to the left tend to form cations*
- *Nonmetals at the upper right tend to form anions*


Group 1A
(1)
Ion
Atom
Li^+ 76
Li 152
Na^+ 102
Na 186
K^+ 151
K 227
Rb^+ 161
Rb 248
Group 2A
(2)
Ion
Atom
Be^{2+} 45
Be 112
Mg^{2+} 66
Mg 160
Ca^{2+} 100
Ca 197
Sr^{2+} 126
Sr 215
Group 3A
(13)
Ion
Atom
B^{3+} 23
B 85
Al^{3+} 51
Al 143
Ga^{3+} 62
Ga 135
In^{3+} 80
In 167
Group 6A
(16)
Ion
Atom
O^{2-} 140
O 73
S^{2-} 184
S 103
Se^{2-} 198
Se 119
Te^{2-} 207
Te 142
Group 5A
(17)
Ion
Atom
F^- 133
F 72
Cl^- 181
Cl 100
Br^- 196
Br 114
I^- 220
I 133

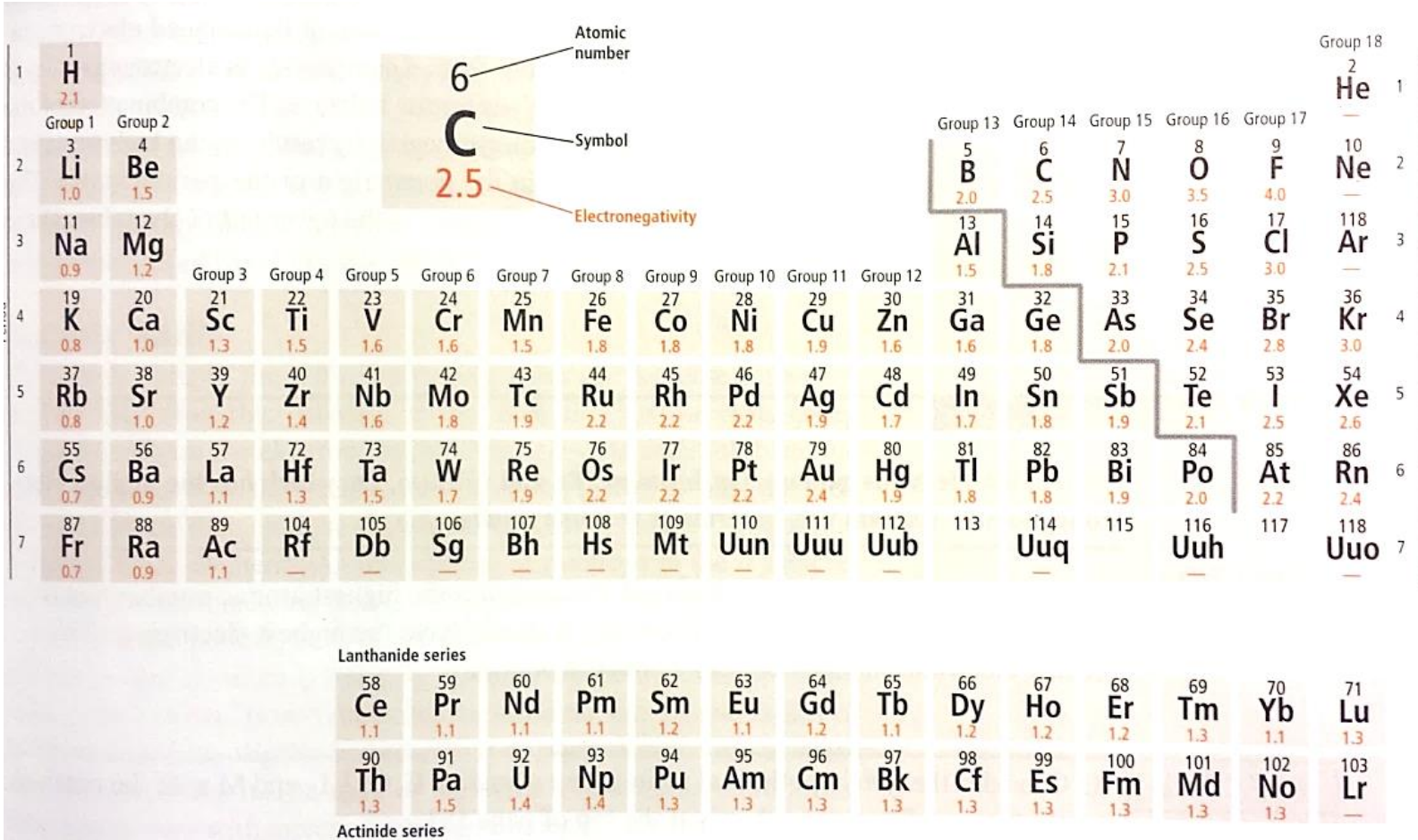
Ex: Which particle has the larger radius?

- S or S^{2-}
  - **S^{2-}**

- Al or Al^{3+}
  - **Al**

ELECTRONEGATIVITY

- **Electronegativity**: measure of the ability of an atom in a chemical compound to attract electrons



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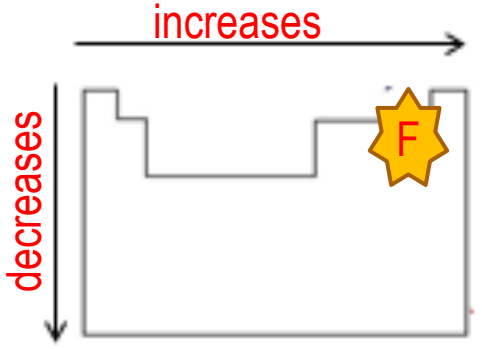
Electronegativity	Electronegativity: measure of an ability of an atom in a chemical compound to attract electrons		Period: Shared electrons are closer to the nucleus in small atoms Group: Shared electrons are farther from the nucleus in large atoms

PERIODIC PROPERTIES OF THE *D*- AND *F*-BLOCK

- Properties of the *d*-block element vary less and with less regularity than those of the main-group elements
  - Difference is due to the presence of electrons in incompletely filled d sublevels in the atoms of the *d*-block elements