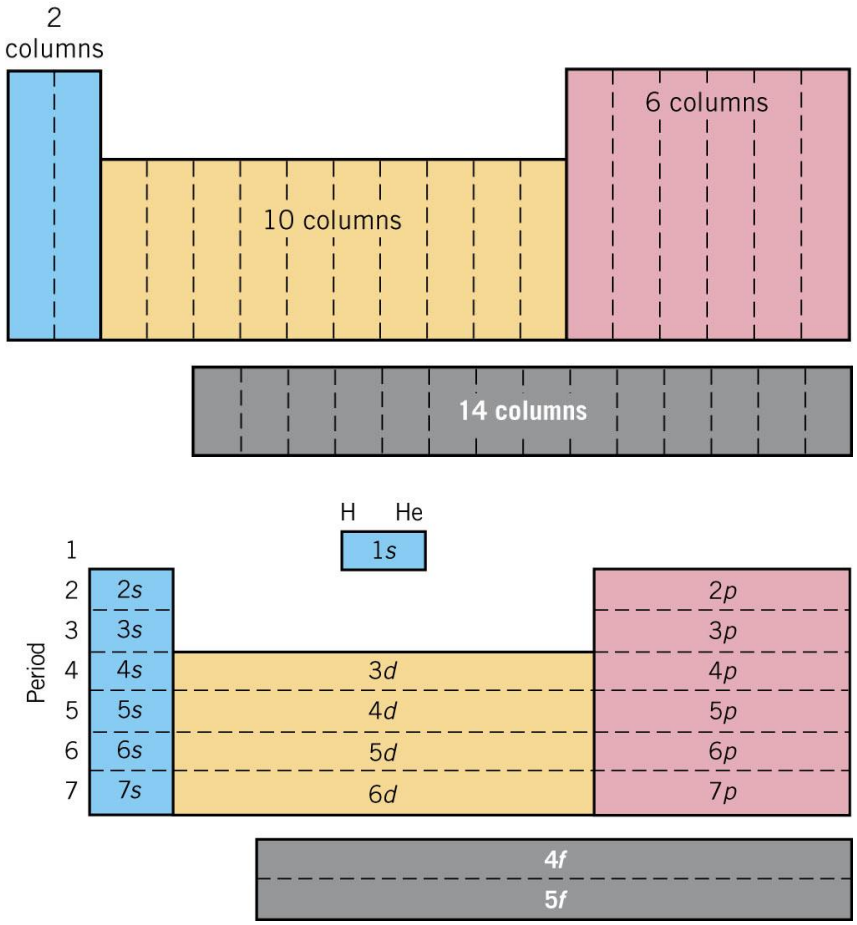
Periodic Trends

Atomic Radius, Ion Sizes,
Ionization Energies and
Electron Affinities

- Electron configurations explain the structure of the periodic table

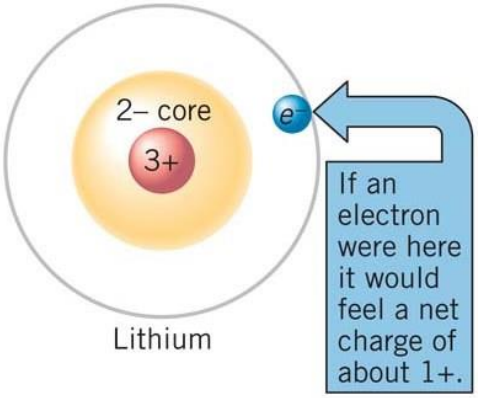


The periodic table is divided into regions of 2, 6, 10, and 14 columns which is the maximum number of electrons in *s*, *p*, *d*, and *f* sublevels.

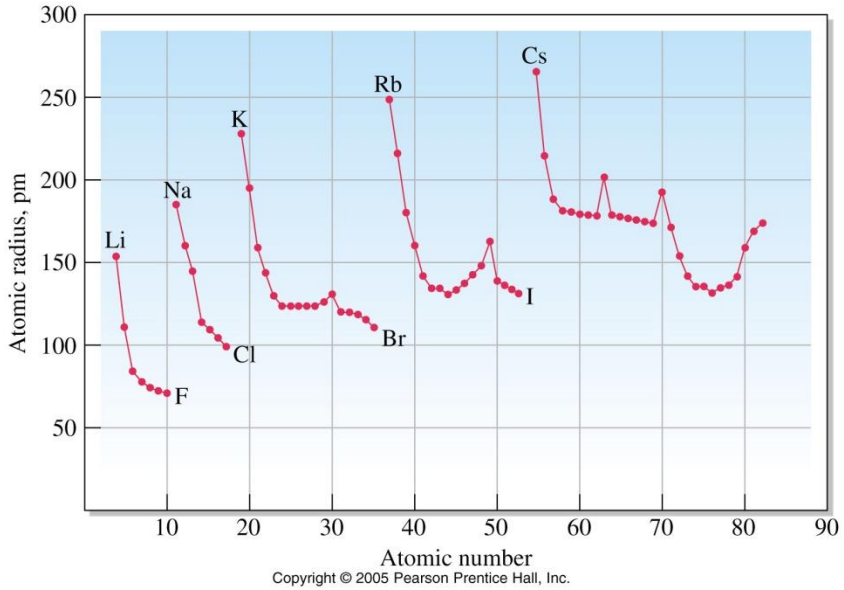
Subshells that fill across the periods.

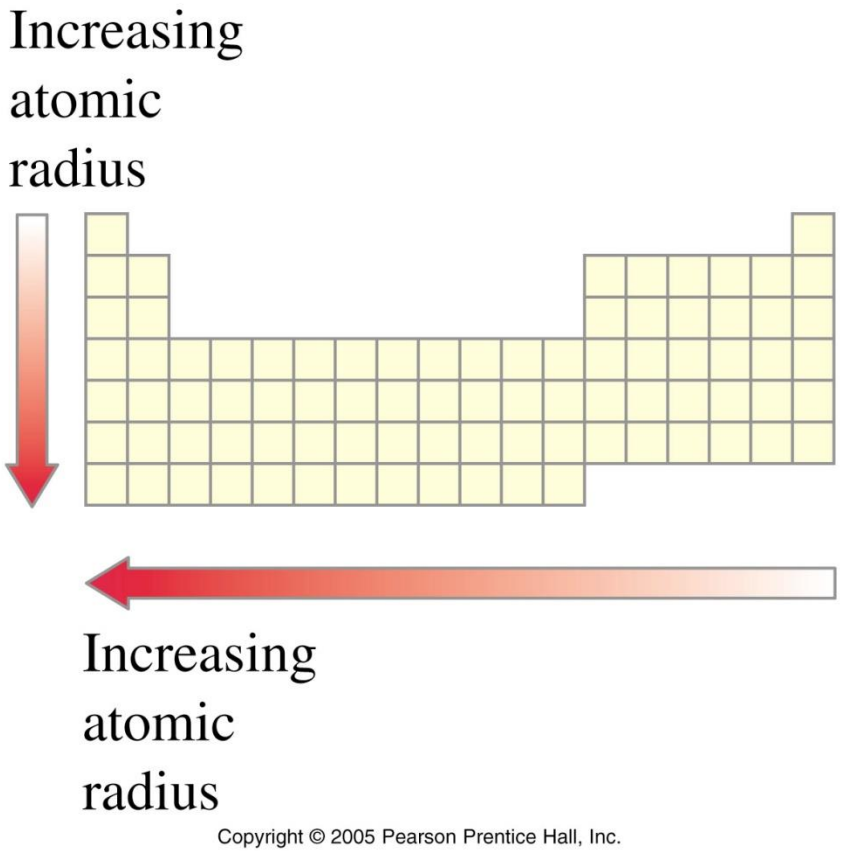
Shielding And Effective Nuclear Charge

- ***Shielding***: occurs when core electrons block the valence electrons from experiencing the full attraction of the nucleus
- ***Effective nuclear charge*** (Z^*_{eff}): the amount of positive charge "felt" by outer electrons in atoms other than hydrogen
  - Z^*_{eff}=Z-shielding electrons
  - is lower than the atomic number because of **shielding**



Atomic Radius (Size) = the distance from the nucleus to the outermost electron

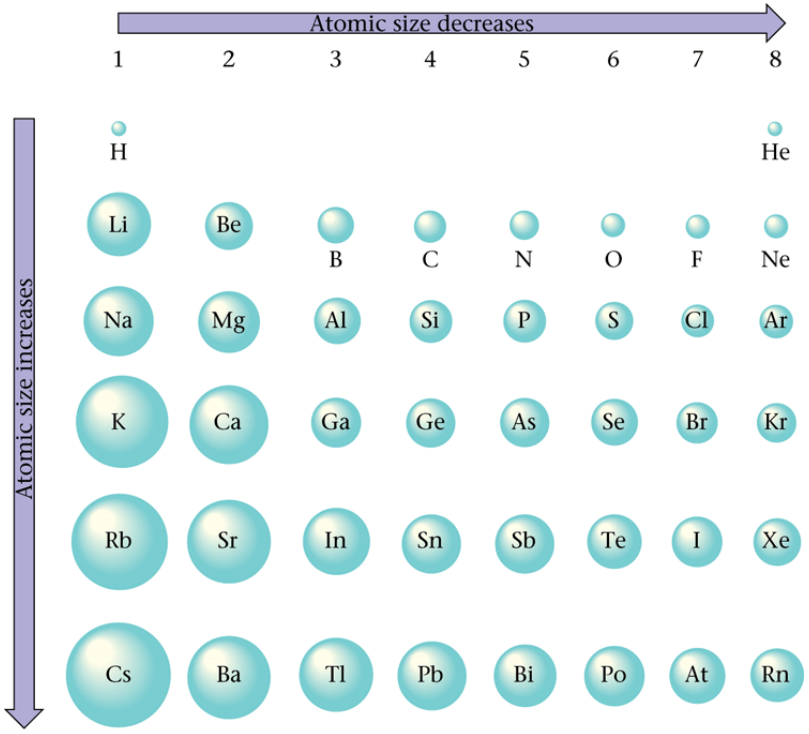




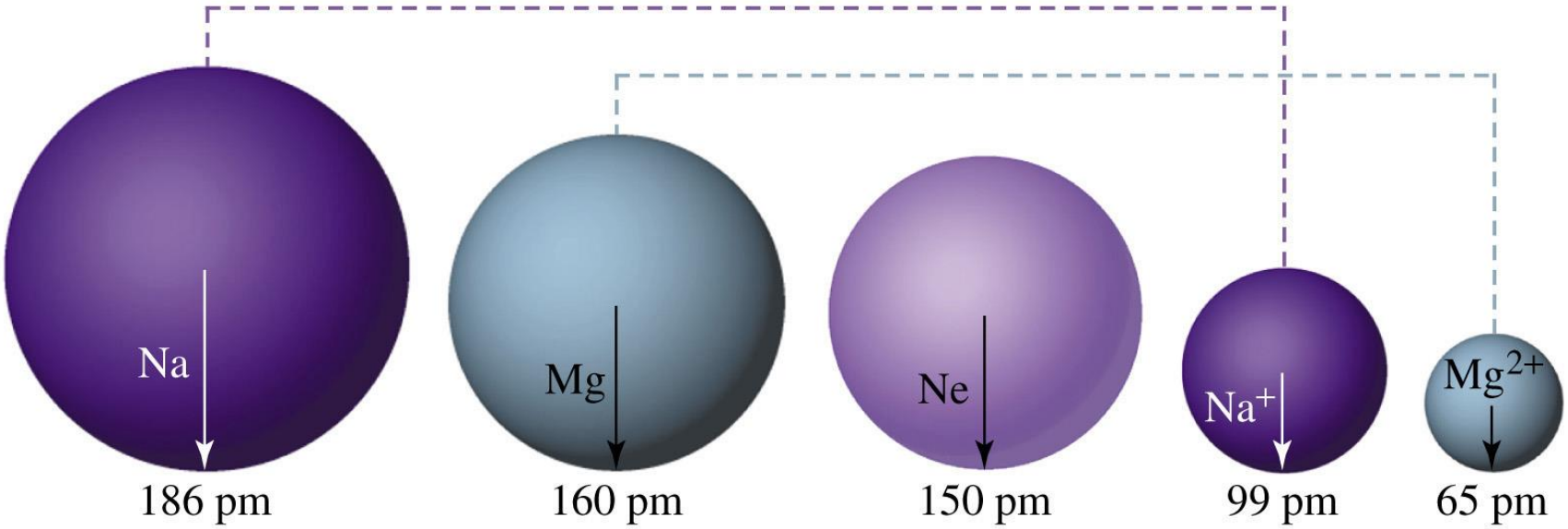
C. Atomic Properties and the Periodic Table

Atomic Size

- Size tends to increase down a column.
- Size tends to decrease across a row.



Atomic size across a period



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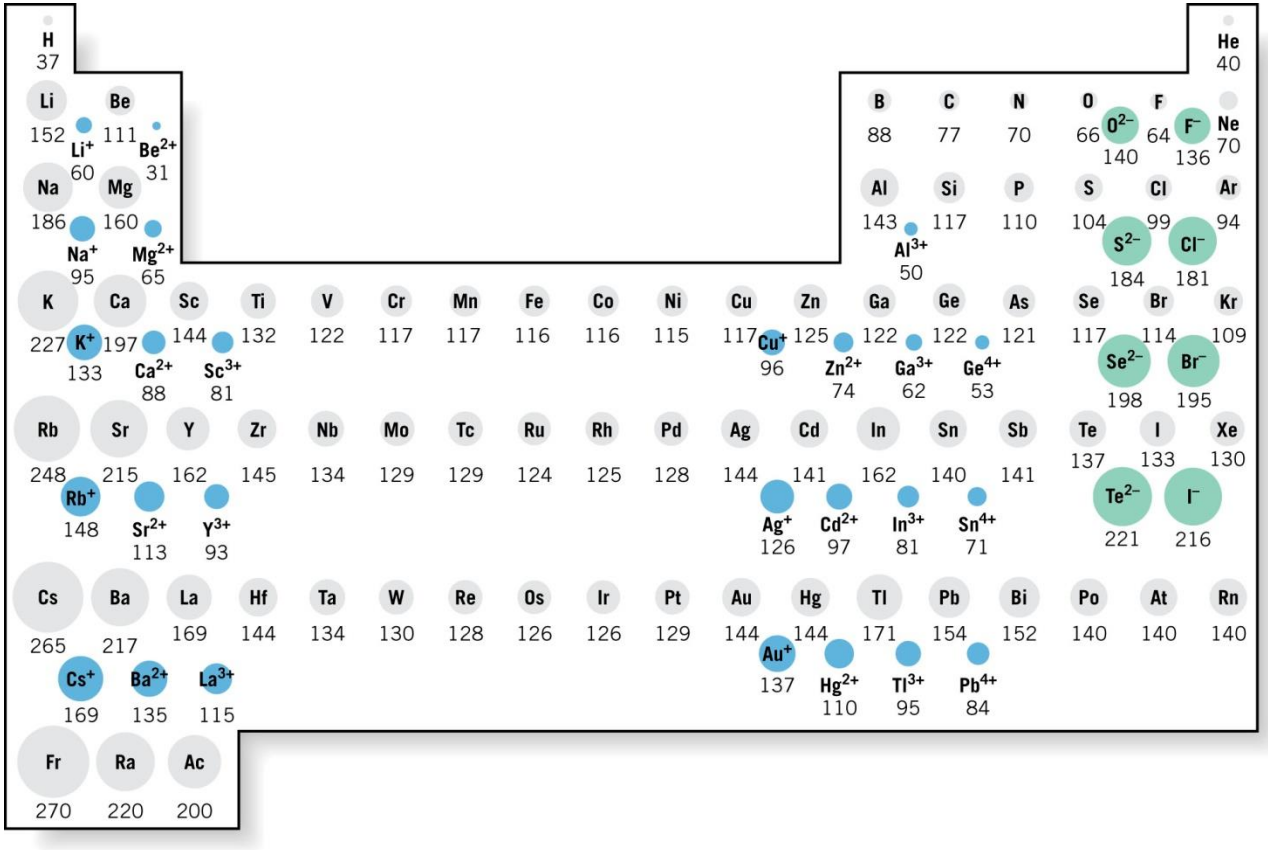
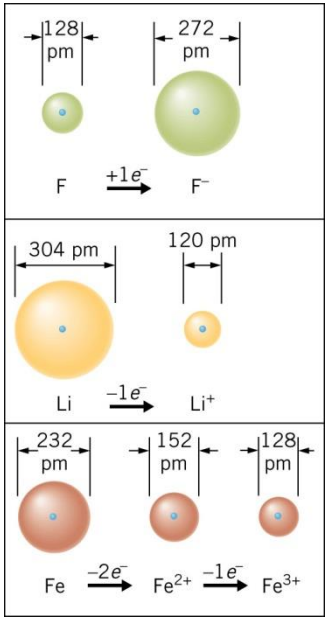


- Variation in atomic and ionic radii. Values in picometers (10^{-12} m)

- The size trends in ions can be summarized:
  - Positive ions are always smaller than the atoms they are formed
  - Negative ions always larger than the atoms from which they are formed



Adding electrons leads to an increase in size of a particle, as illustrated for fluorine. Removing electrons decreases the size of the particle, as shown for lithium and iron.

“s” Orbitals And Nodes

- Orbitals get larger as the principle quantum number *n* increases
- Nodes, or regions of zero electron density, appear beginning with the 2*s* orbital

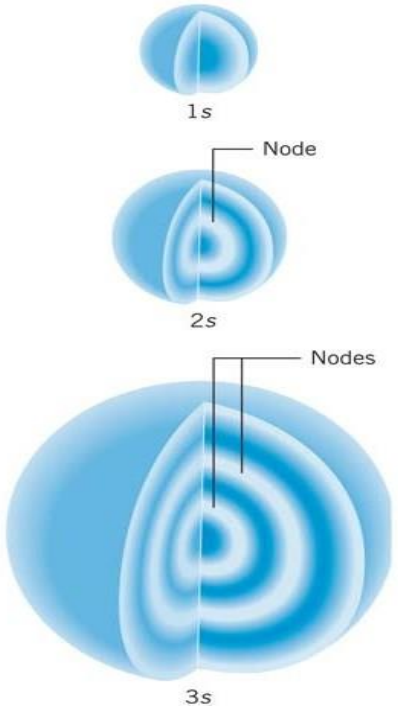


FIG. 7.23 Size variations among *s* orbitals. The orbitals become larger as the principal quantum number, *n*, becomes larger.

Table 8.4 Ionization Energies of Group 1A and Group 2A Elements, kJ/mol

	1A	2A
	Li	Be
I_1	520	900
I_2	7298	1757
	Na	Mg
I_1	496	738
I_2	4562	1451
	K	Ca
I_1	419	590
I_2	3051	1145
	Rb	Sr
I_1	403	550
I_2	2633	1064
	Cs	Ba
I_1	376	503
I_2	2230	965

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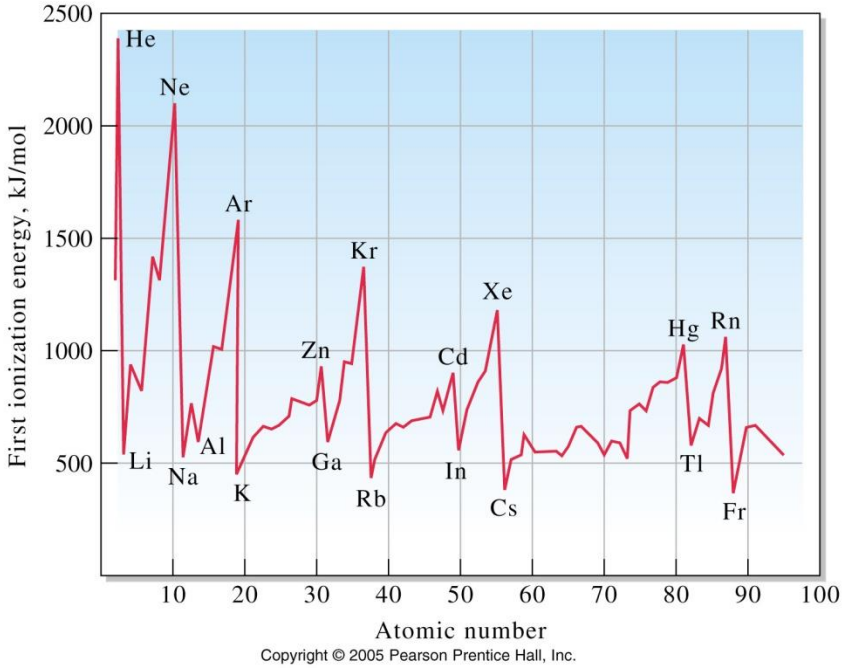
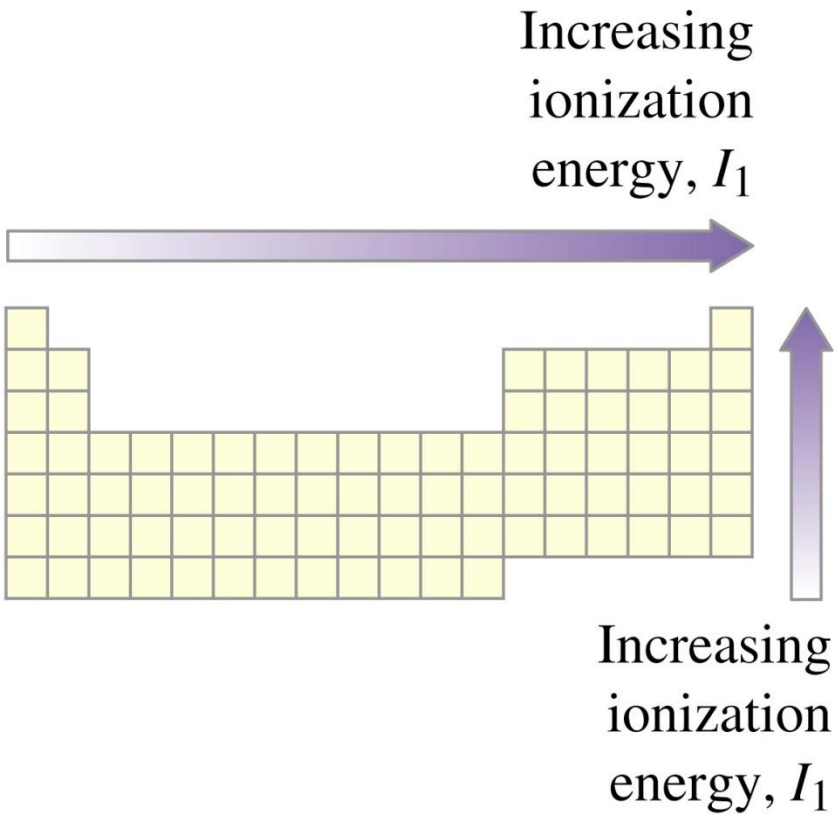
Ionization Energy (The energy required to remove an electron from an atom.)





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Electron Affinity (EA)

- Is the potential energy change associated with the addition of an electron to a gaseous atom or ion in its ground state

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

- Addition of one electron to a neutral atom is exothermic for nearly all atoms
- Addition of subsequent electrons always requires energy

Trends in Electron Affinity

In general, electron affinity:

- increases (as an exothermic value) from left to right in a period
- increases (as an exothermic value) bottom to top in a group

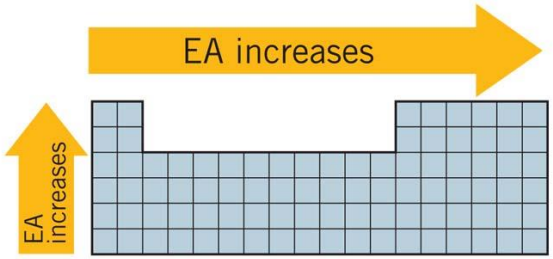

FIG. 7.33 Variation of electron affinity (as an exothermic quantity) within the periodic table.