Electron configuration, shielding and periodic properties

The BIG picture: properties such as atomic size (or radius), ionization energy, electronegativity, metallic character, etc. repeat regularly throughout the table because the electron configurations repeat regularly

The LAST words on Shielding: inner spherical orbitals (s-orbitals) "shield" electrons on <u>higher</u> levels from the pull of the nucleus partially since they completely surround it. This is most readily observed in the great difference between the ionization energies of the noble gases (high) and the alkali metals (low) that immediately follow them

s-orbitals shield p and d orbital electrons on the <u>same</u> energy level to a much smaller extent. This effect is only really obvious when the ionization energy of an element like Mg is compared to that of Al. The poorer shielding as electrons are added on the same energy level and more protons are added in the nucleus accounts for the decrease in size across a period since the electrons feel the pull of the nucleus more.

<u>MORAL</u>: periodic properties are best understood in terms of shielding

Some of the major properties to know:

1. **size** (or radius): decreases from left to right (poor shielding)
   increases from top to bottom (good shielding)

   atoms shrink as you advance across a period because added protons in the nucleus pull the added electrons more tightly in the absence of effective shielding

   atoms in the same column increase in size as you go down the family since electrons are being added on successively higher energy levels and are well-shielded by the previous completed electron energy levels

2. **ionization energy**: exact opposite of size

   the outer-most electron becomes increasingly more difficult to remove as you advance across a period since shielding is very poor and the added protons continue to exert a stronger attraction

   the outer-most electron is easier to remove as you move down a column since each time you are one energy level farther from the nucleus, benefiting from that much more shielding

3. **electronegativity/electron affinity**: same trend as ionization energy

   the ability to attract additional electrons increases as you advance across a period since shielding is largely ineffective and the pull of the increased protons in the nucleus is sufficient to influence electrons which approach the outer limits of the atom from other sources

   any attractive force of the nucleus is so diminished by effective shielding of electrons in lower levels that additional electrons become more difficult to hold onto as you move down a column

4. **metallic character**: same trend as size

metallic properties are related to the freedom of the outer electrons to move in a macroscopic sample and thus these properties are most pronounced at the left side of the table where shielding is at a maximum

this means that metallic properties will also increase as you move down a family since shielding improves

Interpreting other facts using these principles: examples

1. The most reactive metal would be Fr. The most reactive non-metal would be F.

In reacting, metals typically form + ions. For this to happen, electrons must be lost. This will be favored by excellent shielding.

In reacting, non-metals typically form - ions. For this to happen, electrons must be gained and held. This will be favored by poor shielding.

2. The noble gases are very unreactive.

Although it might seem that the noble gases should be very electronegative, recall that they are at the end of their energy levels. Any attracted electrons would have to go into the next energy level, too far away to feel any permanent pull from the nucleus.

3. The common charges or oxidation states MAKE SENSE!

Alkali metals: +1
lone, well-shielded outer electron is removed
and the remaining electrons are tightly held
Alkaline earth metals: +2
(as for alkali metals above)
Group IIIA: +3
(as above) [why is +1 observed in some Group IIIA elements?]
Group VIA: -2
electrons are too tightly held to remove, but
shielding is so poor that high electronegativity
is able to attract enough electrons to fill level (2 more)
Group VIIA: -1
similar to Group VIA