Name:_______________________
Period:______________________

Periodic Table
Periodic Trends Notes

Objective:

3. define and apply the periodic law to the trends on the periodic table
   a. identify and explain the trends of the periodic table in terms of atomic radius and/or ion radii, ionization energy, and electron affinity

As we have discovered so far with the Periodic Table is that there are patterns or *trends* that occur throughout the table. We will be examining three of these: *Atomic Radius*, *Ionization Energy,* and *electronegativity*.

In order to have a better understanding of the trends, there are four properties that we should examine.

1. Nuclear Charge
2. Energy Level
3. Electron Shielding
4. Distance Electrons are from Nucleus

Nuclear Charge

The nuclear charge is quite frankly the charge of the nucleus. Since neutrons have no charge, only the protons are counted. Carbon, because it has 6 protons in the nucleus, has a nuclear charge of +6. Magnesium with 12 protons has a nuclear charge of +12. As we add more protons, we get a stronger pull on the electrons from the nucleus. A nucleus with 6 protons has less of a pull than one with 12 protons.

Across the Period: As we move across the period, the number of protons increases, therefore, so does the nuclear charge. As we learned in the previous paragraph by adding more protons, we get a stronger pull from the nucleus.

Down a Group/Family: As we move down a group, the number of protons increases. This is evident if we look at potassium, element 19. Rubidium has 37 protons, a much greater pull. Going down a group the nuclear charge increases.

Across: Increases Down: Increases

Energy Level

We will only concentrate on atoms that are filled with the s & p orbitals. Hydrogen has outer electrons in the first energy level, sodium has outer electrons in the third. Cesium is in the sixth energy level. Carbon is in the second energy level. Phosphorus would be in which energy level? That's right, it is the third energy level.

Across the Period: Moving across the second period, atoms are fill the second energy level. With lithium, the 2s sublevel fills, beryllium fills the second electron in the 2s sublevel. Carbon has two electrons in the 2p sublevel and has an electron configuration of $1s^2 2s^2 2p^2$. Moving across the period, atoms continue to fill in the second energy level. Therefore, as atoms move across there is no change in the energy level, however, there is an increase in electron charge.

Down a Group/Family: As we move down a group, magnesium is in the third energy level (3s) while calcium is in the fourth energy level. As we move down a group, the energy level increases. Francium is in the seventh energy level.

Across: Same Energy Level Down: Increases

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Electron Shielding

The best way to describe electron shielding is through the Campfire Analogy I found on a website: http://educ.queensu.ca/~science/main/concept/chem/c07/C07TPJI1.html.

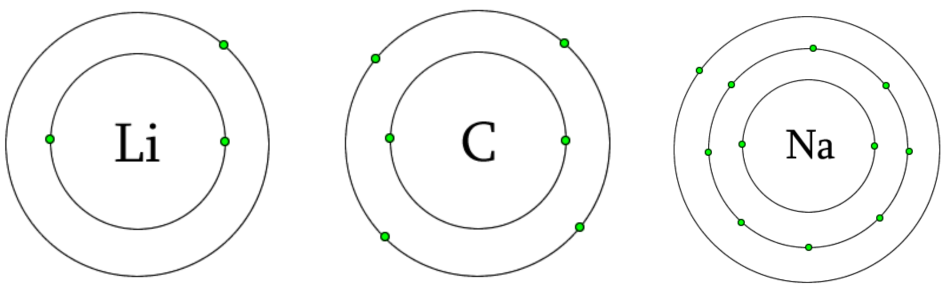
Campfire Analogy for Electron Shielding

Think of an atom as a campfire with the nucleus being the actual burning fire. Each person (an electron) who comes to the fire brings with them a log (a proton and a neutron or two) to throw on the fire, and then sits down. When the first ring is filled a second ring is started. The logs that these second row people bring are still thrown onto the fire, but, as they sit in the second row they do not feel the full heat of the fire because the first row is shielding them from some of the heat. Now as the second ring is filled up, and more logs are placed on the fire they will begin to feel more and more heat.

In the same way, as you move across a row in the periodic table, the electrons are all being placed in an orbital "ring" of equal distance from the nucleus. So, as the number of logs on the fire increases they will feel more of the nuclear pull "heat" This is why we see the trend of decreasing atomic radii as we go across a period.

When a new orbital is started every orbital of lower energy shields these electrons from feeling the full nuclear charge explaining why there is a dip in the first ionization energy at such a transition.

Look at the following elements…



Lithium is in the second energy level. There are only two electrons between the nucleus and the outermost electrons (only one right now). Carbon is also in the second energy level and even though it has more protons (and electrons), there are still only two electrons between the nucleus and the outermost electrons (four now).

Across the Period: As we add more protons and electrons to the atom going across the nucleus, there is no change in the number of electrons between the nucleus and the outermost electrons.

Down a Group: As we add another energy level, look at the difference between lithium and sodium. Lithium has only two electrons between the nucleus and the outermost electron BUT sodium has 10 electrons between the nucleus and the outermost electron!

Across: No change Down: Increases

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Distance Electrons are from Nucleus

So based on the other three topics, what happens with the distance the electrons are from the nucleus?

Across the Period: As we add more protons, the nuclear charge increases. The energy level remains the same, so there are no additional electrons added to the shielding effect. Because the increase in pull from the nucleus (because of the added protons), it causes the outer electrons to be pulled in towards the nucleus. The radius decreases.

Down a Group: As we add more protons, the nuclear charge increases. However, we add another energy level which has a greater effect than adding the protons, which means we have a greater amount of electron shielding. This causes the electrons not to be pulled in and the larger energy level causes the outer electrons to be further away from the nucleus.

Across: Decreases Down: Increases

Periodic Trend – Atomic Radius

Across the Period: The nuclear charge increases, which means there is a greater pull from the nucleus. There is no change in energy levels or electron shielding, so the electrons are pulled closer to the nucleus. Therefore, the trend decreases.

Down a Group: The nuclear charge increases, however, there is another energy level added (more important than nuclear charge) which means the electron shielding increases, the electrons are not pulled closer, so the outer electrons are farther from the nucleus and the atomic radius increases.

Across: Decreases Down: Increases

Periodic Trend – Ionization Energy

Ionization energy is the energy needed to remove an electron.

Across the Period: The nuclear charge increases, which means there is a greater pull from the nucleus. There is no change in energy levels or electron shielding, so the electrons are pulled closer to the nucleus. Because the electrons are held tighter, it takes more energy to remove those electrons. Thus, the ionization energy increases.

Down a Group: The nuclear charge increases, however there is another energy level added (more important than nuclear charge) which means the electron shielding increases, the electrons are not pulled closer. Because the electrons are not pulled closer or held tighter, it is easier to remove the electrons and the ionization energy decreases.

Across: Increases Down: Decreases

Periodic Trend – Electronegativity

Electronegativity is the ability or tendency of an atom to attract electrons to form a bond.

Across the Period: The nuclear charge increases, which means there is a greater pull from the nucleus. There is no change in energy levels or electron shielding, so the electrons are pulled closer to the nucleus. Because the electrons are closer to the nucleus, it is easier for an electron to be pulled in.

Down a Group: The nuclear charge increases, however there is another energy level added (more important than nuclear charge) which means the electron shielding increases, the electrons are not pulled closer. Because the electrons are not pulled closer or held tighter, it is harder to attract an electron, thus a lower electronegativity value.

Across: Increases Down: Decreases