

PERIODIC TRENDS

As we have learned the periodic table has a distinct organization pattern based on increasing atomic number; there are additional patterns or trends that can be found in the periodic table. These trends include energy levels and sublevels, atomic radii, ionic radii, ionization energy, electronegativity and electron affinity.

Energy levels and sublevels are important trends that can be easily identified on the periodic table. The number of **energy levels** present is represented by the period that the element exists in. For example, potassium is found in the fourth period and it has four energy levels. The trend for sublevels is a little more complicated. First we have to identify the sublevels – s, p, d, f. These **sublevels** indicate the divisions of the principle energy level (the placement of the electrons within an energy level):

Energy Level	Sublevels
1	1s
2	2s 2p
3	3s 3p 3d
4	4s 4p 4d 4f

The remaining energy levels have the same configuration as energy level 4.

Groups IA and IIA are filling the *s* sublevels, Groups IIIA through VIIIA are filling the *p* sublevels, the Transition elements are filling the *d* sublevels. The Lanthanoid and Actinoid series are filling the *f* sublevels.

- For example: Which sublevel is potassium filling?
It is in Group IA, so it is filling the *s* sublevel.
- Which sublevel is copper filling?
It is a Transition element so it is filling the *d* sublevel.

Practice: For the following elements determine which sublevel is being filled.

1. Calcium _____
2. Iron _____
3. Chlorine _____
4. Lead _____

Atomic Radius is the distance between the center of the nucleus and the outer most electron. There are two trends that can be followed:

1. Atoms get larger as you go down a group.
 2. Atoms get smaller as you go from left to right. This results from the increase in the number of protons, their positive charge pulls the electrons in closer, thus shrinking the orbitals.
- For example: Which atom has the larger atomic radius, lithium or potassium?
Potassium has the larger atomic radius.
 - Which atom has a larger atomic radius, carbon or fluorine?
Carbon has the larger atomic radius.

Practice: Determine which of the following pairs of atoms has the larger radius.

1. Ca or Ni _____
2. Ga or B _____
3. O or C _____
4. Cl or Br _____

Ionic Radius is the atomic radii of an atom that has lost or gained electrons.

There are two types of ions, **anion** (a negative ion) and **cation** (a positive ion). There are two rules to remembering the trend for ionic radii:

1. When cations lose electrons the protons are able to draw the remaining electrons closer to the nucleus thus making the ionic radii smaller.
 2. When anions gain electrons the repulsion from the nucleus increases thus increasing the ionic radii.
- For example: Which of the following has a smaller ionic radius, a calcium ion or a fluorine ion?
A calcium ion has a smaller ionic radius. (It has lost 2 electrons)
 - Which of the following has a larger ionic radius, a nitrogen ion or a fluorine ion?
A nitrogen ion has a larger ionic radius. (It has gained 3 electrons)

Practice: Determine for the following pairs which has a smaller ionic radius.

1. K¹⁺ or O²⁻ _____
2. Ba²⁺ or I⁻ _____
3. Al³⁺ or P³⁻ _____
4. K¹⁺ or Cs¹⁺ _____

Ionization energy is the energy required to remove the most loosely held electrons. $X(g) + \text{energy} \rightarrow X^+(g) + e^-$

- For example: Which of the following atoms has a higher ionization energy, sodium or oxygen?
Oxygen has the higher ionization energy, it wants to gain electrons, not lose them.
- Which of the following has the higher ionization energy, potassium or francium?
Potassium has the higher ionization energy, its electrons are closer to the nucleus and held more tightly than francium's outer electron which is in the 7th energy level.

Practice: Determine for the following pairs of atoms which has the higher ionization energy.

1. Be or Ba _____
2. Ar or F _____
3. Cu or Ra _____
4. I or Ne _____

Electronegativity is the relative attraction of an atom for the electrons in a covalent bond. Electronegativity is not an amount of energy and can not be measured directly. The trend for electronegativity follows the same trend as ionization energy, Francium having the lowest and Chlorine having the highest.

- For example: Which of the following has a higher electronegativity, rubidium or oxygen?
Oxygen has the higher electronegativity.
- Which has the higher electronegativity, carbon or oxygen?
Again, oxygen has the higher electronegativity.

Practice: Determine which of the following atoms has the higher electronegativity.

1. Cs or Ga _____
2. Fr or Be _____
3. Cl or Hg _____
4. Ba or N _____

Electron Affinity is a measure of the energy involved when an electron is added to a gaseous atom to form a negative ion. This is measured as the change in energy when an atom gains an extra electron. This trend seems to be fairly irregular, except to say that the non-metals have higher electron affinities than metals. The exception is the noble gases that have positive electron affinities.

- For example: Which of the following has a stronger electron affinity, bromine or magnesium?
Bromine, a non-metal, has a higher electron affinity.
- Which of the following has less of an electron affinity, calcium or phosphorus?
Calcium, a metal, has less of an electron affinity.

Practice: Determine which of the following has the higher electron affinity.

1. Li or F _____
2. S or Cs _____
3. P or Pb _____
4. Co or O _____



Name: _____ Period: _____ Date: _____

Homework: Periodic Trends

Choose the best answer for the following multiple choice questions. Indicate your answer on the line provided.

- ____ 1. As the number of energy levels increases, the size of the electron cloud _____.
a. increases b. decreases c. remains the same d. changes at random
- ____ 2. As you look across a period from left to right on the periodic table, the size of the atoms.
a. increases b. decreases c. remains the same d. changes at random
- ____ 3. Which of the following atoms has a smaller radius?
a. Nickel b. Potassium c. Chlorine d. Cesium
- ____ 4. What charge do the ions of Group IIIA form?
a. 1+ b. 3+ c. 3- d. 1-
- ____ 5. The amount of energy required to remove the most loosely held electrons from an atom is referred to as:
a. ionization energy c. bonding energy
b. energy of formation d. activation energy
- ____ 6. Which of the following atoms has an ionization energy that is less than phosphorus?
a. F b. Ga c. N d. Cl
- ____ 7. As you move through a period from metals to non-metals, the ionization energy:
a. increases b. decreases c. remains the same d. changes at random
- ____ 8. A measure of the attraction of an atom for additional electrons is referred to as:
a. ionization energy c. electron affinity
b. electronegativity d. combining capacity
- ____ 9. In which of the following pairs does the second particle have the larger radius?
a. Rb, Y b. Br, F c. S^{2-} , S d. Ga^{3+} , As^{3-}
- ____ 10. Elements from the same group or family have what in common?
a. same number of energy levels
b. same number of isotopes
c. same atomic radii
d. same number of valence electrons

For the following pairs determine the atom with the larger atomic radius.

11. Li or Ba _____ 13. K or Be _____
12. Cl or Ti _____ 14. N or Bi _____

For the following pairs determine the ion with the larger radius.

15. K or As _____ 17. F or Cl _____
16. Cs or B _____ 18. Na or P _____

For the following pairs determine the atom with the higher ionization energy.

19. I or Ne _____ 21. Ca or Fr _____
20. K or V _____ 22. W or Se _____

For the following pairs determine the atom with the higher electronegativity.

23. Te or O _____ 25. Cl or O _____
24. Ra or Li _____ 26. C or Si _____

For the following atoms indicate the sublevel being filled.

27. Silver _____ 29. Erbium _____
28. Nitrogen _____ 30. Cesium _____