

## Periodic Trends Practice

1. Which of the following has the largest atomic radius? Why? Mg Ca Sr

Sr has the most number of energy levels compared to Ca and Mg therefore its valence electrons are farthest from the nucleus. Because Sr has the most energy levels, it has the most innermost electrons that shield the outermost valence electrons from the positive charge of the nucleus leading to less proton (or nuclear) pull. As a result, Sr has the largest atomic radius.

2. Which of the following is the smallest atom? Why? Al Si P

P has the smallest atomic radius compared to Al and Si because P has the most number of protons and the most number of electrons. The higher number of protons create a stronger nuclear charge. Also the higher number of electrons in the same energy level allow for stronger nuclear pull between the positive nucleus and the negative electrons. The stronger nuclear attraction to the electrons pull these electrons closer to the nucleus therefore P has the smallest atomic radius.

3. Which of the two atoms is greater in radius? Why? Mg Mg<sup>2+</sup>

Mg neutral atom is bigger in radius compared to Mg<sup>2+</sup> because Mg loses 2 electrons from its outermost shell and the same number of protons (12) that were pulling 12 electrons in the neutral atom are now pulling on 10 electrons in the ionic form. The size of protons is much larger than the size of electrons therefore these 10 electrons are now pulled even closer to the nucleus. As a result, Mg neutral atom is bigger in radius compared to its ion Mg<sup>2+</sup>.

4. Which of the following atoms is smaller in radius? Why? Br Br<sup>-</sup>

Br neutral atom is smaller in radius compared to its ion Br<sup>-</sup>. When Br gains an electron, there are now more electrons to be pulled by the positive nucleus. In the Br neutral atom, 35 protons are pulling on 35 electrons. In the ionic form, the same 35 protons are now pulling on 36 electrons therefore the nuclear or proton pull gets smaller. Also, as an electron is added to Br's outmost shell the repulsion amongst the electrons increases. As a result, Br neutral atom is smaller in radius compared to its ion Br<sup>-</sup>.

5. Which of the following has the highest 1<sup>st</sup> ionization energy? Why? Be Mg Ca

Highest Ionization Energy means hardest to remove an electron from the outer energy level. Be has the highest 1<sup>st</sup> ionization energy because it has the least number of energy levels compared to Mg and Ca. It has the least number of electrons shielding the electrons in its outermost shell from the positive nucleus, causing it to have the smallest radius compared to Mg and Ca. Because its radius is the smallest, its valence electrons are closest to the nucleus therefore it would require great amount of energy to pull an electron away from Be. As a result, Be has the highest 1<sup>st</sup> ionization energy.

6. Which of the following has the highest 1<sup>st</sup> ionization energy? Why?      K    Ca    Br

Br would have the highest 1<sup>st</sup> ionization energy because it would be very hard to pull away 1 electron from Br's outermost shell compared to K and Ca. Br has more electrons in its valence shell and more protons compared to K and Ca therefore there is greater nuclear or proton pull for its valence electrons to the nucleus making the atom smaller. Due to a smaller radius, the valence electrons are closest to the nucleus and it is very hard to pull an electron away from Br. Therefore, Br has the greatest 1<sup>st</sup> ionization energy.

7. Which of the following is the most electronegative? Why?      F    Cl    I

F would have the highest electronegativity compared to Cl and I because F has the smallest atomic radius. The Cl and I have more energy levels and their outer electrons are shielded by the inner electrons. Due to a small radius, the valence electrons of F are closest to the nucleus compared to Cl and I. This means that the positive nucleus of F can attract electrons with greater strength compared to Cl and I. As a result, F has the greatest ability to attract electrons and therefore it the most electronegative.

8. Which of the following is the most electronegative? Why?      Na    Mg    Al

Aluminum is the most electronegative because it has the greatest proton or nuclear pull therefore the smallest radius compared to Na and Mg. Due to greater proton or nuclear pull by the nucleus, Al is able to attract electrons with greater strength compared to Na and Mg. As a result, Al has the greatest ability to attract electrons and therefore is the most electronegative.

9. Using only their location on the periodic table, rank the atoms in each set by decreasing atomic size.

a. Br, Rb, Kr: Rb>Br>Kr

b. Se, Br, Cl: Se>Br>Cl

c. Te, Se, Sr: Sr>Te>Se

10. Rank the elements in each set by increasing 1<sup>st</sup> ionization energy. Explain.

a. Xe, He, Ar: Xe<Ar<He Although they all have stable octets helium has the smallest radius therefore its electrons are very close to its nucleus. It would require a lot of energy to pull 1 electron away from the outermost shell of helium compared to xenon and argon.

b. Sn, In, Sb: In<Sn<Sb Antimony has the smallest radius compared to indium and tin therefore it would require a lot of energy to pull 1 electron away from the valence shell of antimony.

c. Sr, Ca, Ba: Ba<Sr<Ca Calcium would require the most energy to pull 1 electron away from its valence shell because it has the smallest atomic radius compared to barium and strontium.

- d. Kr, Br, K:  $K < Br < Kr$  Krypton would require the most energy to pull 1 electron away from its outermost shell because it has a stable octet and a smaller radius compared to bromine and potassium due to greater proton on nuclear pull.
- e. K, Ca, Rb:  $Rb < K < Ca$  Calcium would require the most energy to pull 1 electron away from its outermost shell because it has the smallest atomic radius compared to rubidium and potassium. Due to a smaller radius, calcium has greater attraction between the positive nucleus and its valence electrons. As a result, a lot more energy will be required to pull 1 electron away from Calcium.
- f. Kr, Br, Rb:  $Rb < Br < Kr$  Krypton would require the most energy to pull 1 electron away from its outermost shell because it has a stable octet and a smaller radius compared to bromine and rubidium. Due to a smaller radius, there is greater attraction between the positive nucleus and electrons. As a result, krypton requires a lot of energy to remove 1 electron.
11. Identify the atom in each pair with the lowest 1<sup>st</sup> ionization energy. Explain.
- a. B, O: Boron has the lowest 1<sup>st</sup> ionization energy because boron is bigger in atomic size than oxygen and has less nuclear or proton pull per electron. Due to less nuclear attraction in boron, it is easier to remove an electron from its valence shell.
- b. B, In: Indium has the lowest 1<sup>st</sup> ionization energy because indium is a bigger in atomic size than boron due to greater nuclear or proton pull and has a greater shielding effect. Being further away from the nucleus, it is easier to pull an electron away from indium than boron.
- c. I, F: Iodine has the lowest 1<sup>st</sup> ionization energy because it is bigger in atomic size than fluorine due to greater nuclear or proton pull and greater shielding effect. Being further away from the nucleus, it is easier to remove an electron from iodine than fluorine.
- d. F, N: Nitrogen has the lowest 1<sup>st</sup> ionization energy because it is bigger in atomic size than fluorine due to less attraction between the positive nucleus and the electrons. Due to less nuclear attraction, it is easier to remove 1 electron from nitrogen than fluorine.
- e. Ca, K: Potassium has the lowest 1<sup>st</sup> ionization energy because it is bigger in atomic size than calcium due to less attraction between the positive nucleus and the electrons. Because there is less nuclear attraction, it is easier to remove 1 electron from potassium than calcium.
12. Which element will have lower electron affinity? Explain.
- a. K or Ca: Potassium would have lower electron affinity because potassium because it has a bigger radius than calcium therefore it would not want to pay as much energy to buy an electron because it will not be able to hold on to it as strongly as calcium.
- b. O or Li: Lithium would have lower electron affinity because it has a bigger radius than oxygen. If lithium was to purchase an additional electron, its nucleus will not be able to attract is as well as oxygen would. Oxygen would pay a very high price to get another electron so it can get closer to neon's stable electron configuration.

- c. Cs or F: Cesium would have lower electron affinity because it has a larger radius than fluorine. Due to a larger radius, Cs has less nuclear attraction for electrons and when we add an electron to Cs it will not be able to hold on to it as strongly as fluorine. Fluorine is a smaller atom and would pay any price to get 1 more electron to reach neon's stable electron configuration.
- d. S or Se: Selenium has lower electron affinity because it has a bigger radius than sulfur. Due to a larger radius, it will not be able to attract an additional electron as well as sulfur because that new electron will be further from the nucleus. As a result, selenium would not want 'pay' as much energy to 'buy' an electron.

