

## Periodic Trends Practice

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

Mg Ca Sr

Sr has the largest atomic radius. This is because it has more energy levels than the other elements. Even though it has a greater number of protons than the other elements as well, the energy levels have a greater number of electrons which create a greater shielding effect, allowing the electrons to repel each other and not have such a big impact when the protons are pulling in the electrons. Its valence electrons are farthest from the nucleus and the innermost electrons shield the valence electrons from receiving the pull of the protons and also repel them. Therefore Sr has the largest radius.

2. Which of the following is the smallest atom? Why?

Al Si P

Phosphorus is the smallest out of the 3 elements. Due to them being in the same period, the amount of valence electrons are the same, which means that the energy levels are the same and we can ignore the shielding. The number of protons however increases as we go left to right, and phosphorus has more protons than Si and Al. The higher number of protons create a stronger nuclear charge. Also the higher number of electrons in the same energy level allows for stronger nuclear pull between the positive nucleus and the negative electrons.

3. Which of the two atoms is greater in radius? Why?

Mg Mg<sup>2+</sup>

Mg is greater in radius. Mg<sup>2+</sup> is a cation which loses 2 electrons. This makes the attraction between the protons and electrons stronger in the ion because Mg<sup>2+</sup>'s nucleus will now hold onto its electrons even stronger - and the shielding effect is reduced. Because protons are larger than electrons, and there are even less electrons than protons, the pull is even greater, and is why Mg<sup>2+</sup> is bigger than Mg.

4. Which of the following atoms is smaller in radius? Why?

Br Br<sup>-</sup>

Br is smaller in radius because the anion Br<sup>-</sup> gains an electron which makes the repulsion force greater. There are now more protons than electrons. Also, because an electron is added to the outer shell, there is now "more to repel" which makes the ion larger than its neutral counterpart.

5. Which of the following has the highest 1st ionization energy? Why?

Be Mg Ca

Highest ionization energy means how hard is it to remove an electron from the outer energy level of an element. Beryllium has the least amount of energy levels present therefore the least amount of shielding. This is why it's very hard to ionize Beryllium because it would take a huge amount of energy to rip the electron apart. The electrons are closer to the nucleus which makes the attraction force stronger, making the ionization energy higher.

6. Which of the following has the highest 1st ionization energy? Why?

K Ca Br

Br would have the highest first ionization energy because although all the elements listed are in the same period and the energy levels they have are the same number - Bromine has more electrons and more protons than the other elements, but because it has more protons than the other elements, the attraction force is greater, and because shielding depends on the energy levels, They are more tightly bound to the energy levels and the atoms more than K or Ca. Due to the smaller radius, the valence electrons are much closer to the nucleus of the Bromine atom, therefore the ionization energy would

have to be really high for it to be able to pull an electron apart.

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 is the most electronegative.

8. Which of the following is the most electronegative? Why?

Na Mg Al

Aluminum because it has the smallest radius out of all the elements given. It has a greater nuclear or proton pull because the electrons are closer to the nucleus. Also, Al is able to attract electrons and is more electronegative because it really wants to gain an electron.

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

a. Rank the elements in each set by increasing 1st 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 protons 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.

- b. Identify the atom in each pair with the lowest 1st ionization energy. Explain.
- a. B, O: Boron has the lowest 1st 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 1st ionization energy because indium is 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 1st 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 1st 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 1st 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 than 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 it 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 have 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 to 'pay' as much energy to 'buy' an electron.