

Teacher's Tools[®] Chemistry

Periodic Trends Worksheet

1. (A) Answer: $\text{Kr} < \text{Br}$.

Both Kr and Br are in the same period, which means they have the same number of energy levels (or: their valence electrons are in the same energy level.) Since there are more protons in the nucleus of Kr (or a greater *effective nuclear charge* in Kr), the attraction between the outer electrons and the nucleus is greater in Kr and electrons are pulled in more tightly. This results in a smaller atom.

(B) Answer: $\text{Rb} > \text{Br}$.

The larger size of Rb is due to the fact that its valence electron is in the 5th energy level, while the valence electrons for Br are in the 4th energy level. Electrons in the 5th energy level are farther from the nucleus, resulting in a larger atom.

(C) Answer: $\text{F}^- > \text{Na}^+$

Both ions have the same electron configuration (*you could write it*). However, there are nine protons in the F^- nucleus while there are 11 protons in the Na^+ nucleus. The electrons in F^- experience a smaller nuclear charge and are less attracted to the nucleus, resulting in a larger ion.

2. (A) Answer F

Both F and O are in the same period, which means they have the same number of energy levels (optional: their valence electrons experience similar shielding effects.) Since there are more protons in the nucleus of F (or a greater *effective nuclear charge* in F), the attraction between the outer electrons and the nucleus is greater in F and electrons are more difficult to remove, resulting in higher ionization energy.

(B) Answer Mg

The electron configuration for Mg is $1s^2s^22p^63s^2$, whereas the electron configuration for Al is $1s^2s^22p^63s^23p^1$. The first electron removed from aluminum is in a $3p$ subshell, which is higher in energy than the $3s$ subshell, from which the first electron is removed in magnesium. The higher in energy the subshell containing the electron to be removed (ionized), the lower the ionization energy

(C) Answer Kr

The valence electrons for Kr are in the 4th energy level, while those for Xe are in the 5th energy level. Electrons in the 4th energy level are closer and more strongly attracted to the nucleus. This means they are more difficult to remove than electrons in the 5th energy level, resulting in a higher ionization energy.

3. (A) The smaller size of Na is due to the fact that its valence electron is in the 3rd energy level, while the valence electron for K is in the 4th energy level. Electrons in the 3rd energy level are closer to the nucleus, resulting in a smaller atom.

(B) Both bromine and iodine have the same valence shell configuration ns^2np^5 . Similar valence configurations give elements similar chemical properties. (*They form the same charged ion, they react in similar ways with other elements, they form compounds with similar formulas, etc.*)

(C) Draw an orbital diagram to show that there are unpaired electrons in the $3p$ sublevel.

4. (A) Within a family such as the halogens, each successive atom has electrons in a higher energy level. Higher energy levels are further from the nucleus, resulting in larger ions. (*Even though the statement mentioned ions and the trends are for neutral atoms, you can give the same argument.*)

(B) A neutral chlorine atom has 17 electrons, while Cl^- has 18 electrons. "The extra electron in the anion adds to the repulsion between outer electrons, making the negative ion larger than the neutral atom." (p. 154)

(C) The electron configuration for Be is $1s^22s^2$, whereas the electron configuration for B is $1s^22s^22p^1$. The first electron removed in boron is in a $2p$ subshell, which is higher in energy than the $2s$ subshell, from which the first electron is removed in beryllium. The higher in energy the subshell containing the electron to be removed, the lower the ionization energy

(D) In calcium, the first two electrons are removed from the $4s$ sublevel, while the 3rd electron would be removed from the $3p$ sublevel. Electrons in the 3rd level are much closer to and more strongly attracted to the nucleus, so they are much more difficult to remove,