Name _____ Period ____ Date __/__/__

Ch. 5 : Periodic Properties & Trends

Classifying the Elements:

The elements can be classified in two ways:
1. Metals, non-metals, and metalloids
2. Chemical families (groups)

Metals are good conductors of heat and electricity. They are lusterous which means they are shiny. They are malleable which means they can be pounded into thin sheets. They are ductile which means they can be drawn into wires. Metals have low ionization energy (trend) which means that they do not hold onto their valence electrons tightly. They tend to lose (gain/lose) electrons when forming compounds therefore they form ions with + (+/-) charge.

Nonmetals are poor conductors of heat and electricity. Unlike metals, as solids they are brittle when hit with a hammer. All of the diatomic elements are nonmetals. Note that hydrogen is a nonmetal even though it is located with the metals on the periodic table. Nonmetals have high ionization energies (trend) and tightly hold onto their valence electrons. In their compounds the nonmetals form ions with − (+/-) charge because they gain (gain/lose) electron(s).

Metalloids have properties that are between metals and nonmetals. They are important in the semiconductor and computer industries. The metalloids are: B Si Ge As Sb Te Po.

Properties of the Families:

Alkali Metals (Group 1): Li Na K Rb Cs Fr

- Alkali metals have one valence/outer electron. Their chemistry involves losing (gaining/losing) one electron. In their compounds they always form + (+/-) ions.
- They are soft and can be cut with a knife.
- They are never found uncombined in nature because they are so reactive.
- They are stored in oil.

Alkaline Earth Metals (Group 2): Be Mg Ca Sr Ba Ra

- Alkaline Earth metals have 2 valence electrons. Their chemistry involves losing (gaining/losing) two electrons. In their compounds they always form + (+/-) ions.
- Calcium is a component of bones and teeth.

Halogens (Group 17): F Cl Br I (At)

- They have 7 valence electrons.
- They react with metals to form salts which gives them their name of "salt formers." *Example:* 2 Na + Cl_2 → NaCl
- Their chemistry involves gaining (gaining/losing) one electron. In their compounds they always form − (+/-) ions.
- All of the members of this family are diatomic. (We assume At_2 ***would*** exist if there ***were*** any.)
- Halogens are very electronegative (trend). The element on the table with the greatest attraction for electrons is Fluorine.

Noble Gases (Group 18): He Ne Ar Kr Xe Rn

- These elements do not easily combine/react with other elements. They are odorless, colorless and therefore were difficult to discover.
- About 1% of air is composed of the noble gas Argon.
- One noble gas was discovered on the Sun. It's spectrum was identified first. It is Helium.
- One noble gas is radioactive and seeps up through basement floors and walls. It is the element Radon.
- One noble gas is best known for its orange color in gas discharge tubes. It is used for signs that bear its name. The element is Neon.

Hydrogen, H

- Hydrogen is its own family because it has properties like two families: alkali metals and halogens.
- Hydrogen has 1 valence electron. It can combine with halogens. *Example:* $H_2 + Cl_2 \rightarrow 2\ HCl$
- In this case, H loses (gains/loses) one electron. It usually forms + (+/-) ions.
- It has one less electron than the noble gas, Helium.
- It can combine with alkali and other metals. *Example:* $2Li + H_2 \rightarrow 2\ LiH$
- In this case, H gains (gains/loses) one electron and has a negative charge.
- It is diatomic like the halogen family.

Trends in the Periodic Table:

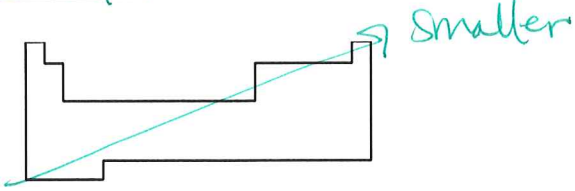
Size of the Atoms

The attraction between the nucleus and the electrons in the outer energy level determines the size of the atom. If the attraction is strong the atom is small; if the attraction is weak, the atom spreads out and is larger. Because the nucleus is positively charged, it exerts an attractive force on the electrons. The size of the atom is due to the size of the electron cloud. The two forces at play are repulsion between the electrons and other electrons and attraction between the electrons and protons in the nucleus.

Going **down** any group or family, the atoms get larger because there are more and more shells/layers of electrons. Each level of electrons is further from the nucleus. The attraction/pull of the nucleus to the valence electrons gets partially cancelled or weakened by the electrons in the inner/middle energy levels. This is referred to as shielding.

Left to right **across** the table, the atoms get smaller because there are more and more protons in the nucleus pulling on the valence electrons. In any period, the valence electrons are in the same energy level. This causes the electrons to be pulled in closer which makes the atom smaller.

Draw an arrow to indicate the trend in size.



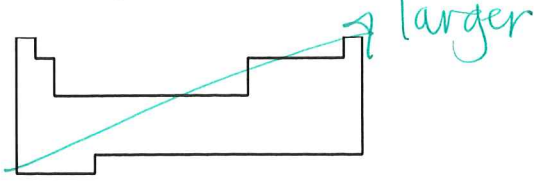
Ionization Energy (IE)

Ionization energy is the energy required to remove one electron from an atom's outer energy level. It is easier to remove an electron from a larger atom. This is because the electron is further from the nucleus and feels less attraction.

Ionization energy decreases as you go **down** a group. The shielding effect makes it easier to remove the outer most electrons from those atoms that have many layers of electrons. These valence electrons are further from the nucleus and are not held as tightly which makes them easier to remove.

Ionization energy increases as you go from left to right **across** a period. Elements on the right have more protons which creates a greater attraction for the outermost electrons which are in the same shell. Because noble gases have 8 electrons in their outermost energy level, they are very unreactive/stable and therefore it takes a very large amount of energy to remove an electron from a noble gas.

Draw an arrow to indicate the trend in ionization energy.



The second ionization energy is the energy needed to remove a Second electron from the energy level. The second ionization energy is always greater than the first ionization energy. Each successive electron removed has a larger ionization energy. After all the valence electrons are removed, the next electron is much closer to the nucleus and is more difficult to remove. Consequently, there is a big jump in ionization energy.

Sizes of Ions

Ions are atoms that lose or gain electrons. Metals tend to lose electrons while non-metals tend to gain electrons.

Atoms that lose electrons become positively charged because they have less electrons than protons. These ions are called cations. Each time an electron is removed, the atom/ion becomes smaller (smaller/larger) because there is less (more/less) repulsion between electrons.

Atoms that gain electrons become negatively charged because they have more electrons than protons. These ions are called anions. Each time an electron is added, the atom/ion becomes larger (smaller/larger) because there is more (more/less) repulsion between electrons.

Electronegativity (EN)

Electronegativity measures an atom's ability to attract an electron to itself. Electronegativity is measured on a scale from 0 to 4.2.

As you move **down** a group within the periodic table, electronegativity decreases. This is because as more shells/layers of electrons are added, the attraction of the nucleus for the valence electrons gets weaker. Electrons in inner energy levels shield the positive charge/pull of the nucleus from outer electrons making it harder to attract electrons to itself.

As you move from left to right **across** a period, electronegativity increases. This is because as more protons are added to the nucleus, the attraction of the nucleus for the valence electrons gets stronger. Elements on the right side of the period table only need a few electrons to fill/complete their outer shell, so they have strong desire to take another atom's electrons. Atoms that become negative ions have a much higher electronegativity than atoms that become positive ions.

Noble gases have a full/complete valence shell of electrons. Therefore we cannot calculate their electronegativity values. This means that Fluorine is the most electronegative element on the periodic table.

Draw an arrow to indicate the trend in electronegativity.