Periodic Trends

Activity 1: Charge, Distance, Forces, and Periodic Trends

Predicting the properties of elements requires an understanding of the atom, its sub-structure (protons, electrons, and neutrons), and the interaction between the nucleus and the surrounding electron shells. This interaction is electrical in nature and sometimes worded as *oppositely-charged objects attract*. The force of attraction between the positively-charged protons of the nucleus and a negatively-charged electron in the outermost shell of an atom depends upon …

1) the distance between the charges, and
2) the amount of positive charge in the nucleus.

Both of these factors are associated with the location of an element on the Periodic Table. And so we notice trends or patterns in how properties change as one moves from element to element down a column or across a row of the Periodic Table.

In this activity, you will identify trends associated with charge, distance, force, and the location of an element on the Periodic Table.

Activity 2: Atomic Radius Trends

An atom is not like a baseball or soccer ball that has a well-defined edge. The nucleus of the atom is surrounded by electrons that are perceived to occupy spherical regions known as <B>electron shells</B>. There are several electron shells centered on the nucleus and having varying sizes. Each shell has a capacity to hold a certain number of electrons. For instance, the first electron shell (the smallest shell) can hold only two electrons; the second smallest electron shell can hold up to 8 electrons; the third smallest electron shell can hold up to 18 electrons; and so forth. Each shell becomes larger than the ones before it and can hold more electrons. The electrons are located somewhere inside the shell; they do not orbit the nucleus at a fixed distance from the shell. The radius of an atom is defined as the distance from center of the nucleus to the outermost edge of the shell.

This radius is a **periodic property** of an element. Like any periodic property, we notice trends or patterns in how radius changes as one moves from element to element down a column or across a row of the Periodic Table. In this activity, you will use the trend to the identify the element that has the greatest radius from among three given elements. You will also provide an explanation of the underlying reason for why this is the case.

Activity 3: Metallic Character Trends

Metallic character refers to the readiness of an element to undergo a reaction. Metal reactivity is generally greatest for elements that are most willing to give up an electron. Elements with a high metallic character generally have low ionization energies and low electronegativity values. Metallic character is a **periodic trend**. As such the relative tendency of an element to act as a metal can be predicted by its location in the periodic table.

In this activity, you will be given three elements (and their location in the periodic table). You must identify the element that most easily loses electrons. Finally, you will have to identify the underlying reason for your choice.

Activity 4: Electronegativity Trends and Type of Bonding

The **electronegativity** of an element refers to the tendency of that element to attract the electrons involved in the bond between atoms. Elements with a high electronegativity have a strong attraction for the electrons in a bond and tend to be more nonmetallic. These elements can be thought of as *electron-hungry*. On the other hand, metallic elements have a relatively lower electronegativity value and are more willing to *give up an electron*. Electronegativity is a **periodic trend**.

Bonds between atoms can be ionic or covalent. Ionic bonds result when a metal with a low electronegativity transfers an electron to a nonmetal with a considerably higher electronegativity. Being willing to *give up an electron*, the metal becomes a positive ion. The nonmetal acquires the electron and becomes a negative ion. The oppositely charged ions attract, forming an **ionic bond**.

Two nonmetals will more likely form a **covalent bond**. The covalent bond results when the two atoms share their electrons with each other in order to obtain a stable octet. The shared electrons in the bond can be distributed equally among the two atoms or unequally between the two atoms. The bigger the difference in electronegativity between the two elements, the greater the difference in the level of attraction each atom has for the shared electrons, and the more unequal the sharing will be. Covalent bonds that involve unequal sharing are referred to as **polar covalent bonds**. And covalent bonds between elements with similar electronegativity values will involve equal sharing of electrons and be classified as **nonpolar covalent bonds**.

Whether a bond between two elements is ionic, polar covalent, or nonpolar covalent depends on the relative attraction the elements have for electrons, and thus upon their relative electronegativity values. It is possible to make rules for relating electronegativity differences between elements to the type of bonds that results between them. But doing so too often misses the big idea that these classifications of ionic, polar covalent, and nonpolar covalent are part of a *continuum*. Ionic bonds (due to large differences in electronegativity) and nonpolar covalent bonds (resulting when there are small differences in electronegativity values) are on opposite ends of this continuum. Polar covalent bonds occupy the wide expanse across the middle of this continuum.

In this activity, you will use electronegativity values to classify the bond that results between three elements and carbon, fluorine, hydrogen, or nitrogen. Since electronegativity is a periodic trend, you can use the relative location of the three elements in determining the type of bond it forms with carbon, fluorine, hydrogen, or nitrogen.

Activity 5: Covalent Bonds, Formulae, and Periodic Trends

Main group elements undergo bonding in order to acquire a stable electron configuration that resembles that of the nearest noble gas. We often say that an element wants to acquire a **stable octet** of outer shell (valence shell) electrons. This is known as the **octet rule**. In the case of hydrogen, it acquires the electron configuration of helium and is said to follow the **duet rule**.

Lewis electron dot diagrams are often used to represent the number of valence electrons in an atom. Each dot in the diagram represents the number of valence electrons in the atom. Since main group elements in the same group of the periodic table have the same number of valence electrons, they will also have identical Lewis electron dot diagrams.

Nonmetals fall short of an octet of valence electrons by 1, 2, 3, and even 4 electrons. When bonding with other nonmetals, they share their valence electrons with enough atoms in order to acquire an octet of valence shell electrons. The number of bonds that such nonmetals form is generally dependent upon the number of additional valence electrons that are needed to satisfy the octet rule.

In this activity, you will be given the molecular formula of a compound formed between two nonmetals. One of the nonmetals will have an unknown identity – "X". The formula will indicate the number the number of bonds that are formed with X in the molecular compound. You will use this information to predict the Lewis electron dot diagram of element X. You will also predict the Group number of unknown element X.