

Notes: Ionic vs Covalent Bonds and Electronegativity

1. Recall: Ionic bonds form when there is a transfer of electrons from a metal to a non-metal. The metal becomes a positive metal ion and the non-metal becomes a negative non-metal ion. The goal for each is to have 8 outermost valence electrons. The resulting positive and negative ions are attracted to each other and form a crystal.

Ex: $\text{Na} + \text{Cl}$

2. Covalent bonds, on the other hand, form when two non-metals share one or more of their valence electrons. Again, the goal is for each to have 8 outermost valence electrons. But non-metals will not give away electrons. No way. Sharing is the most you can expect from them.

Ex: $\text{Cl} + \text{Cl}$

a. How evenly shared are these shared electrons?

i. If the atoms sharing the electrons are of the same element, the shared electrons are totally evenly shared, and will be found right between the two atoms.

Ex: $\text{H} + \text{H}$

ii. But if the atoms sharing the electrons are of different elements, then we have uneven sharing. Some atoms have more power over the shared electrons than others.

Ex: $\text{N} + \text{O}$ O has a greater attraction, or affinity for the electrons.

b. In the 1930's a really nice guy named Linus Pauling tested a zillion different bonds and rated the atoms according to how much power they had when involved in bonds. He came up with the following scale, which he called The Electronegativity Scale. He gave it no units (weird!).

Defn: Electronegativity = the ability of an atom in a bond to attract the electrons involved in that bond.

The Electronegativities of the Elements

H 2.1																	
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	
K 0.8	Ca 1.0		Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0		Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	*	Lu 1.3	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2
Fr 0.7	Ra 0.9	**	Lr -----	Rf -----	Db -----	Sg -----	Bh -----	Hs -----	Mt -----	Ds -----	Rg -----	Uub -----	UUt -----	Uuq -----	Uup -----	Uuh -----	Uus -----

*	La 1.1	Ce 1.1	Pr 1.1	Nd 1.1	Pm 1.1	Sm 1.2	Eu 1.1	Gd 1.2	Tb 1.1	Dy 1.2	Ho 1.2	Er 1.2	Tm 1.3	Yb 1.1
**	Ac 1.1	Th 1.3	Pa 1.5	U 1.4	Np 1.4	Pu 1.3	Am 1.3	Cm 1.3	Bk 1.3	Cf 1.3	Es 1.3	Fm 1.3	Md 1.3	No 1.3

3) Using the Electronegativity Scale to determine bond types:

First, find the electronegativities of the two atoms that are forming a bond.
Subtract the two numbers. If the difference between the numbers is:

- a. 1.8 or higher, then it's an ionic bond (this is almost always what happens when you consider a metal and a non-metal)

Ex: Na and Cl

Ex: Sr and Br

- b. .4 to 1.7, the electrons are considered unevenly shared. This kind of bond is called "polar covalent", because the bond has a positive side and a negative side but is still considered sharing. (The electrons are unevenly shared.) The atom with the greater electronegativity is the more negative atom. The other is the more positive atom.

Ex: O and S

Ex: P and Cl

We call these "polar bonds"

- c. 0 to .3, the electrons are considered evenly shared. No dipole. These are called "non-polar covalent" bonds.

Notice on the table of electronegativities that electronegativity increases as you go across from left to right and decreases as you go down the chart.