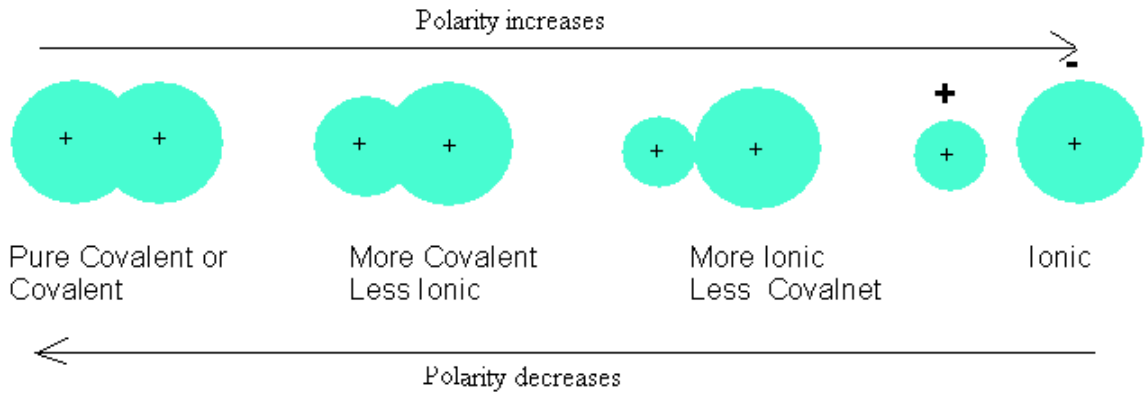
Electronegativity

Electronegativity is a measure of electron affinity or liking for electrons. It is the *ability of an atom to attract the electrons*. It is the power of attraction in covalent bond; through which, the amount of partial ionic character of the bond may be determined. Atoms with higher electronegativities have greater attraction for electrons than those with lower electronegativities. Electronegativity is a qualitative phenomenon as such it becomes not so useful in explaining the chemical bonding. Hence, it needs to be quantified to use it in a meaningful and easily understandable way.

There are number of electronegativity scales available, but the one developed by Linus Pauling is very popular. According to this scale, fluorine is assigned the maximum electoronegativity value of 4.0 and other atoms are assigned based on this number. You can consult any general chemistry text for the entire scale. Therefore, electronegativity scale is a relative scale. When the separation on the scale (difference in electronegativity) is 1.7 the bond has about 50% ionic character. In reality, there is no clear distinction between polar covalent bond and an ionic bond. But we can adopt the following guidelines to classify the bonds based on their electronegativity difference (ΔE).

- If $\Delta E = 0$, then it is classified as a **covalent or pure covalent bond**
- If $0 < \Delta E < 1.7$, then it is classified as a **polar covalent bond**
- If $\Delta E \geq 1.7$, then it is classified as **ionic bond**

These situations are exemplified in the following diagram.



Example. Classify the following bonds as ionic, polar covalent or covalent : (a) the bond in NaCl, (b) the CO bond in CO_2, (c) CH bond in CH_2, (d) NN bond in H_2NNH_2, and (e) HCl bond in HCl.

Answer:

(a) The ΔE between Na and Cl is 2.1. Therefore, the bond between Na and Cl is ionic.
(b) The ΔE between C and O is 1.0. Therefore, the bond between C and O is polar covalent.
(c) The ΔE between C and H is 0.4. Therefore, the bond between C and H is polar covalent.
(d) The ΔE between N and N is 0. Therefore, the bond between N and N is covalent or pure covalent.
(e) The ΔE between H and Cl is 0.9. Therefore, the bond between H and Cl is polar covalent.

Example. Arrange the following bonds in order of increasing polarity: (a) H – Cl, (b) C-O, (c) N-F, (d) Si- I, and (e) O – O.

Answer.

First calculate the electronegativity difference (ΔE) between atoms in each bond. Then arrange the bonds from smallest ΔE value to greatest _E value.

(a) H- Cl bond, ΔE = 2.1 – 3.0 =0.9
(b) C- O bond, ΔE = 2.5 – 3.5 = 1.0
(c) N –F bond, ΔE = 3.0 – 4.0 = 1.0
(d) Si – I bond, ΔE = 1.8 – 2.5 = 0.7
(e) O – O bond, ΔE = 3.5 – 3.5 = 0.0

Therefore, the increasing polarity order is

O-O < Si-I < H-Cl < N-F = C-O

Bond Polarity

In a polar bond, there is a shift of electron density from one atom to another atom depending upon the magnitude of electronegativity. It simply means that there is an asymmetric distribution of electrons around nuclei that manifests in polarity. For example, in H-Cl bond, Cl is higher electronegativity compared H. Due to that the electrons are pulled more closer to Cl nucleus from H atom. This shift in electrons density is denoted by placing a crossed arrow (⟷) to indicate the direction of shift. For example,


H - Cl