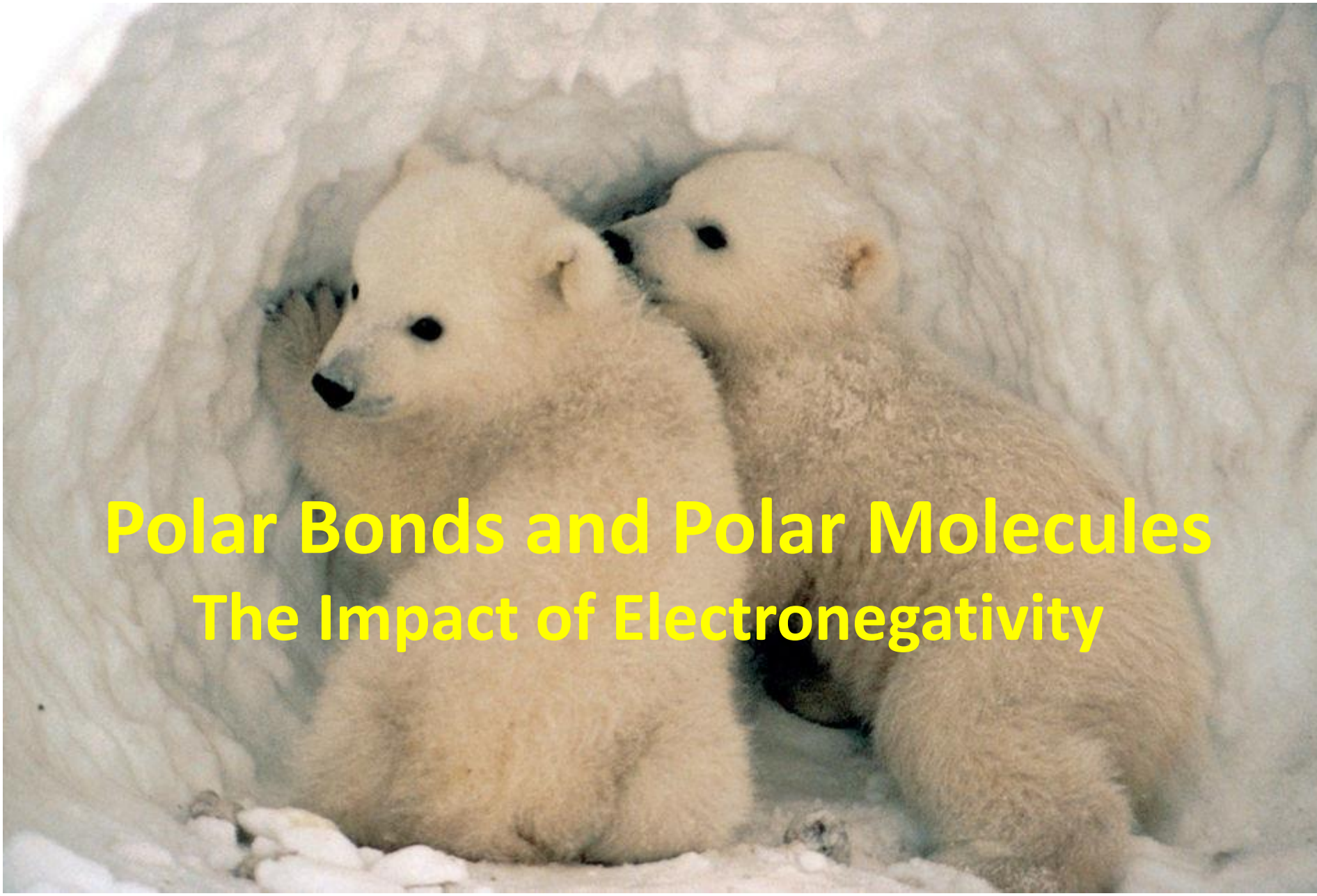
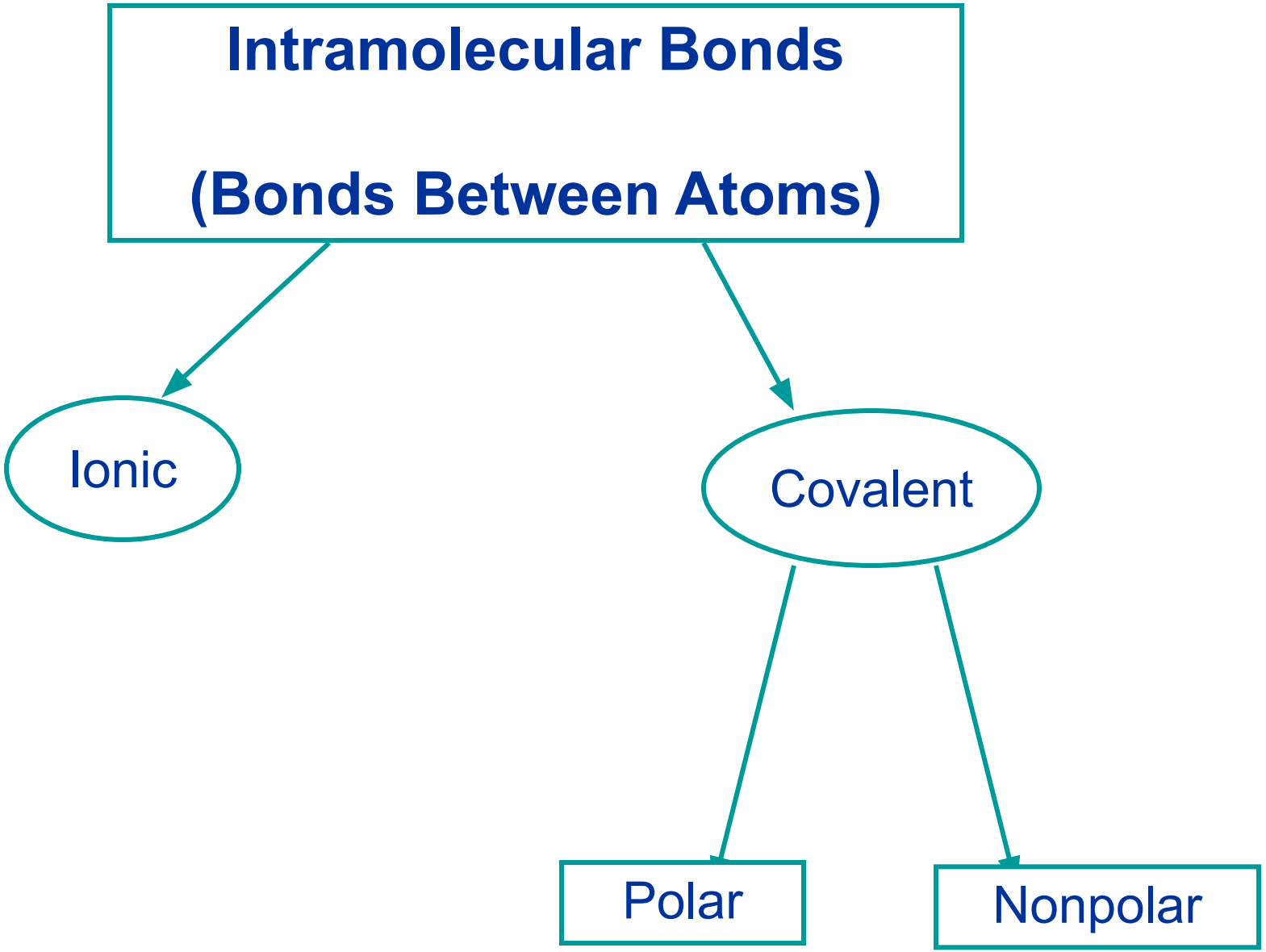


Polar Bonds and Polar Molecules

The Impact of Electronegativity


Intramolecular Bonds
(Bonds Between Atoms)
Ionic
Covalent
Polar
Nonpolar

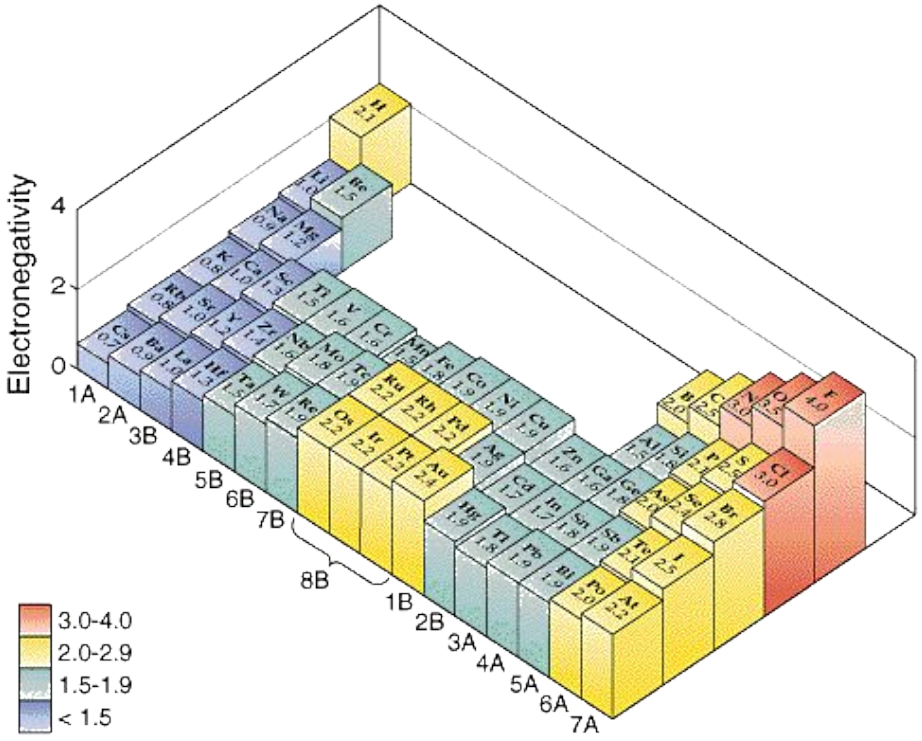
Learning Goals

- ❑ I will be able to explain the difference between polar bonds and polar molecules

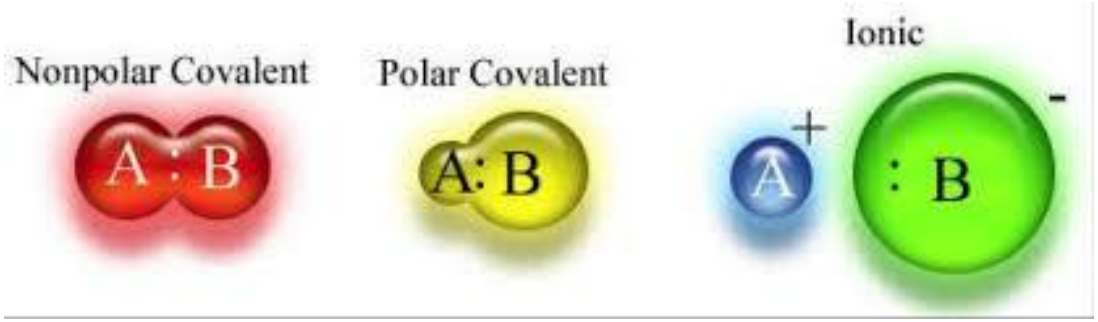
- ❑ I will be able to explain how polarity impacts the behavior of a substance.

Bond Polarity and Electronegativity

- **Electronegativity:** The ability of one atoms *in a molecule* to attract electrons to itself.
- Pauling set electronegativities on a scale from 0.7 (**Cs**) to **4.0** (**F**).
- Electronegativity increases
  - across a period and
  - up a group.

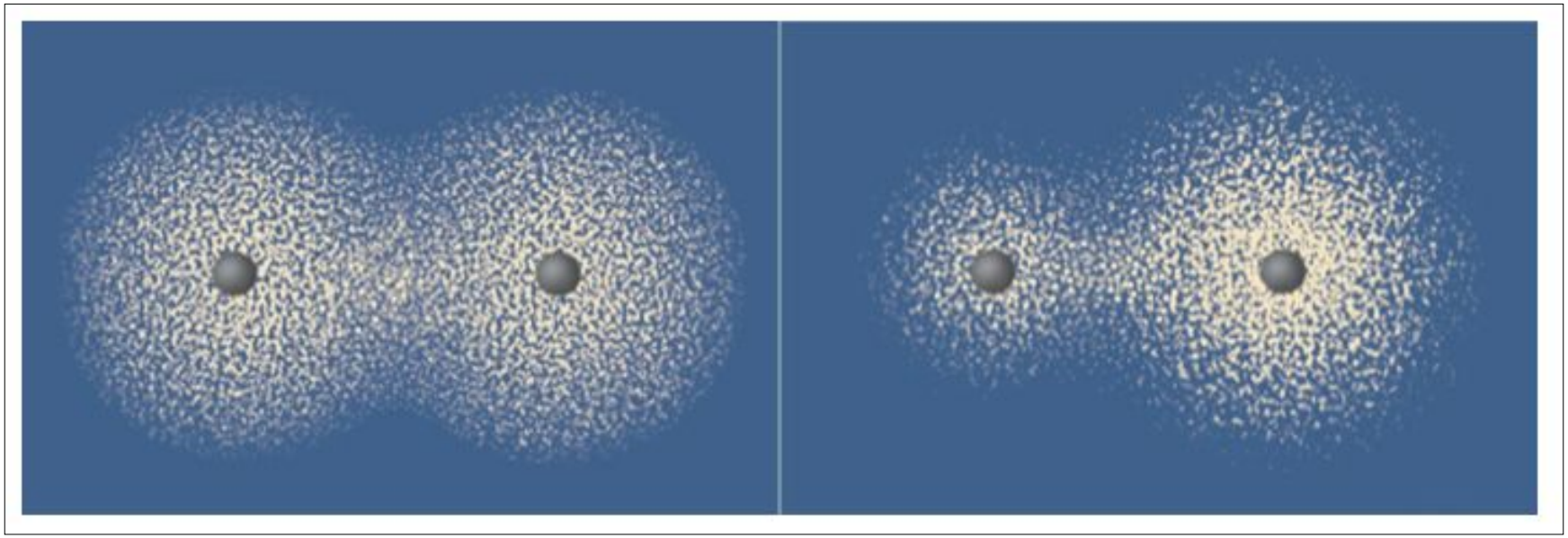


Electronegativity



- A non-polar bond or molecule has an equal sharing of the electrons.
- A polar bond or molecule has an unequal sharing of the electrons.

The electron clouds of a non-polar and polar covalent molecule (only two atoms, therefore only one bond shown).

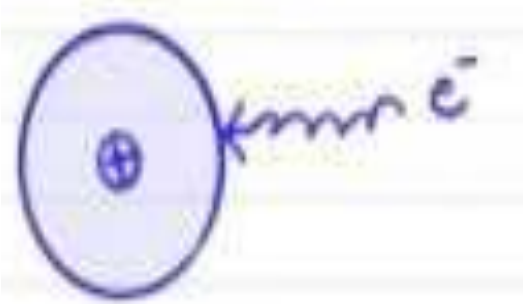


http://hfs.ncvps.org/Curriculum/APChemistry/ModuleFive/BondingLesson/APChem_Bonding_ToGo4.html

DO NOT GET THESE CONFUSED

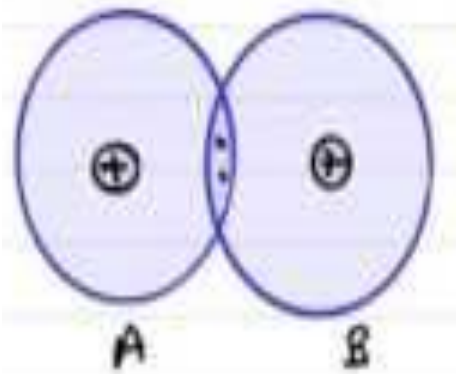
Electron Affinity

- Electron affinity is the amount of energy released when a neutral atom or molecule gains an electron.
- Quantitative Property
- Measured in units like kJ/mol
- Defined in isolated and gaseous state.



Electronegativity

- Electronegativity is the ability of an atom to attract electrons from outside.
- Qualitative Property
- Measured on a scale (no real units).
- Defined in shared or bonded state.



Determining the polarity of a bond

- Look up the electronegativities of each element
- Subtract the smaller number from the bigger number
- If the difference in electronegativities is between:
  - 1.7 to 4.0: Ionic
  - 0.41 to 1.7: Polar Covalent
  - 0.0 to 0.4: Non-Polar Covalent

Example: NaCl
Na = 0.9, Cl = 3.0
Difference is 2.1, so this is an ionic bond!

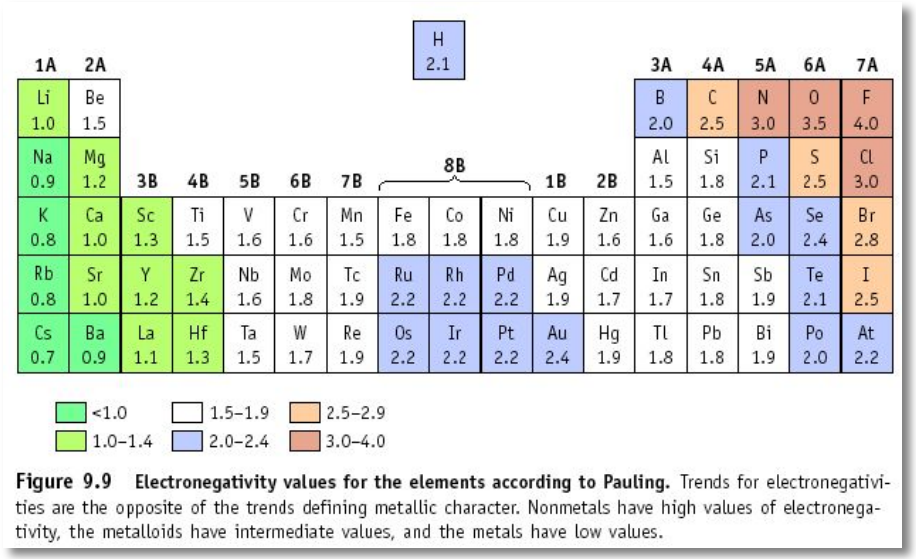
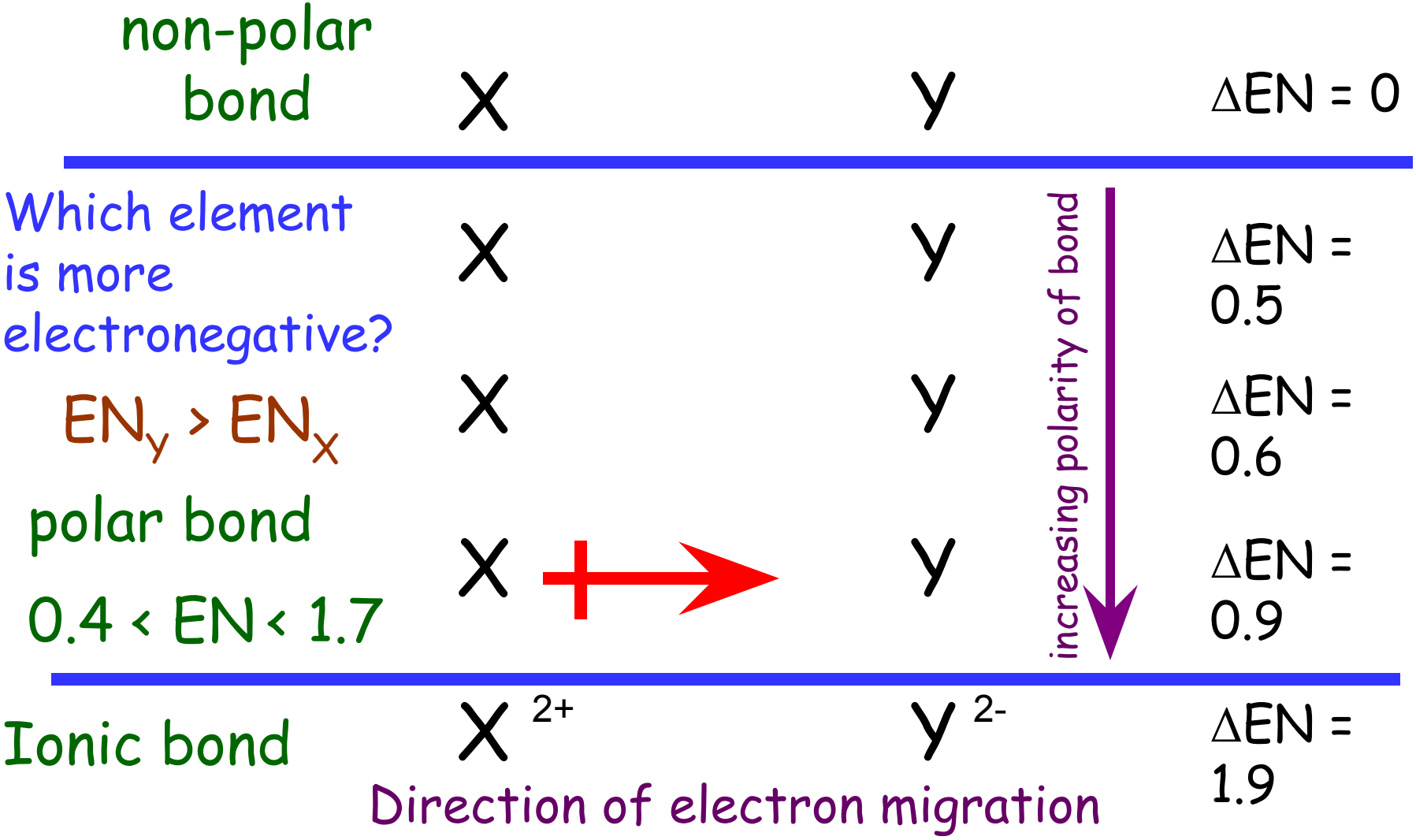


Figure 9.9 Electronegativity values for the elements according to Pauling. Trends for electronegativities are the opposite of the trends defining metallic character. Nonmetals have high values of electronegativity, the metalloids have intermediate values, and the metals have low values.

Is the sharing of electrons in molecules always equal?



Non-Polar Covalent Bonds

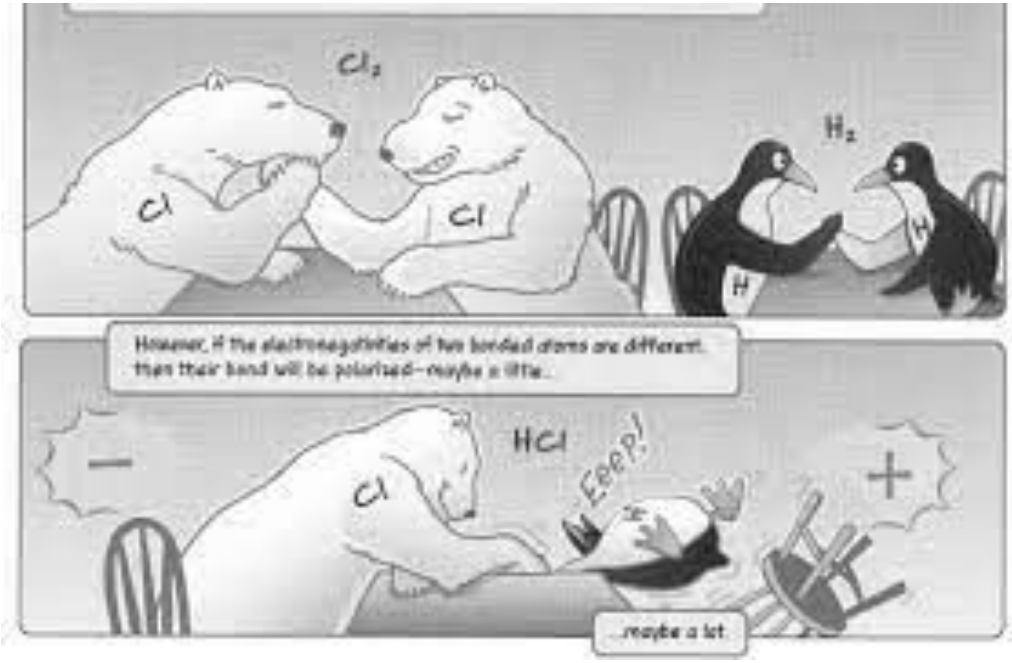
What is non-polar covalent?

-Non polar covalent is a covalent bond that has an even distribution of charge due to an equal sharing of bonding electrons.

Examples:

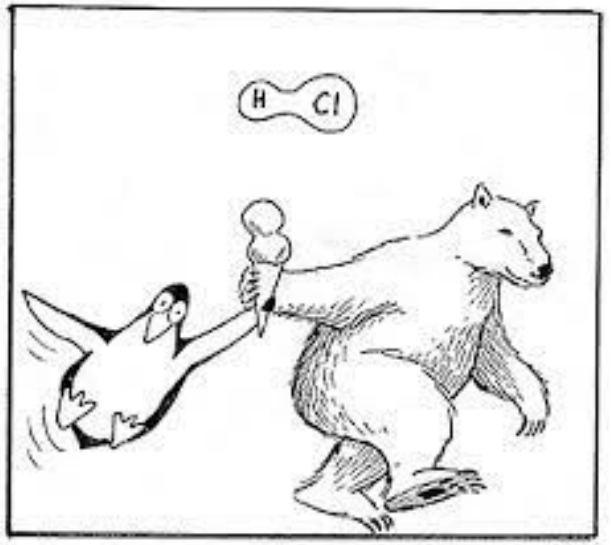
All diatomic molecules

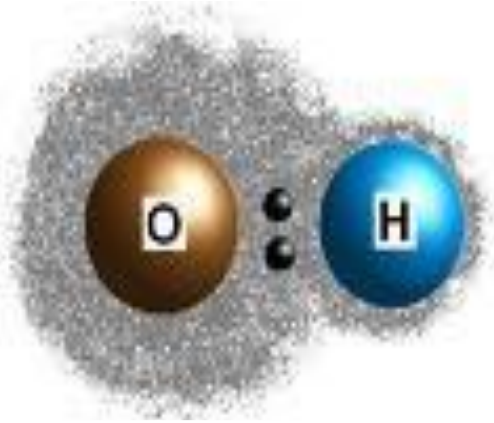
(ie: Cl_2, H_2)



Polar Covalent Bonds

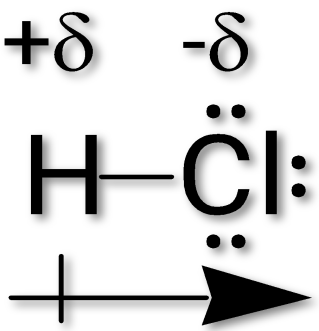
What is polar covalent?
-Polar covalent is a description of a bond that has an uneven distribution of charge due to an unequal sharing of bonding electrons.





Polar Covalent Bonding

Example: HCl
H = 2.1, Cl = 3.0
Difference is 0.9, so
this is an polar covalent bond!



Cl has a greater electronegativity than H, and therefore, pulls the electrons in the shared bond towards itself.

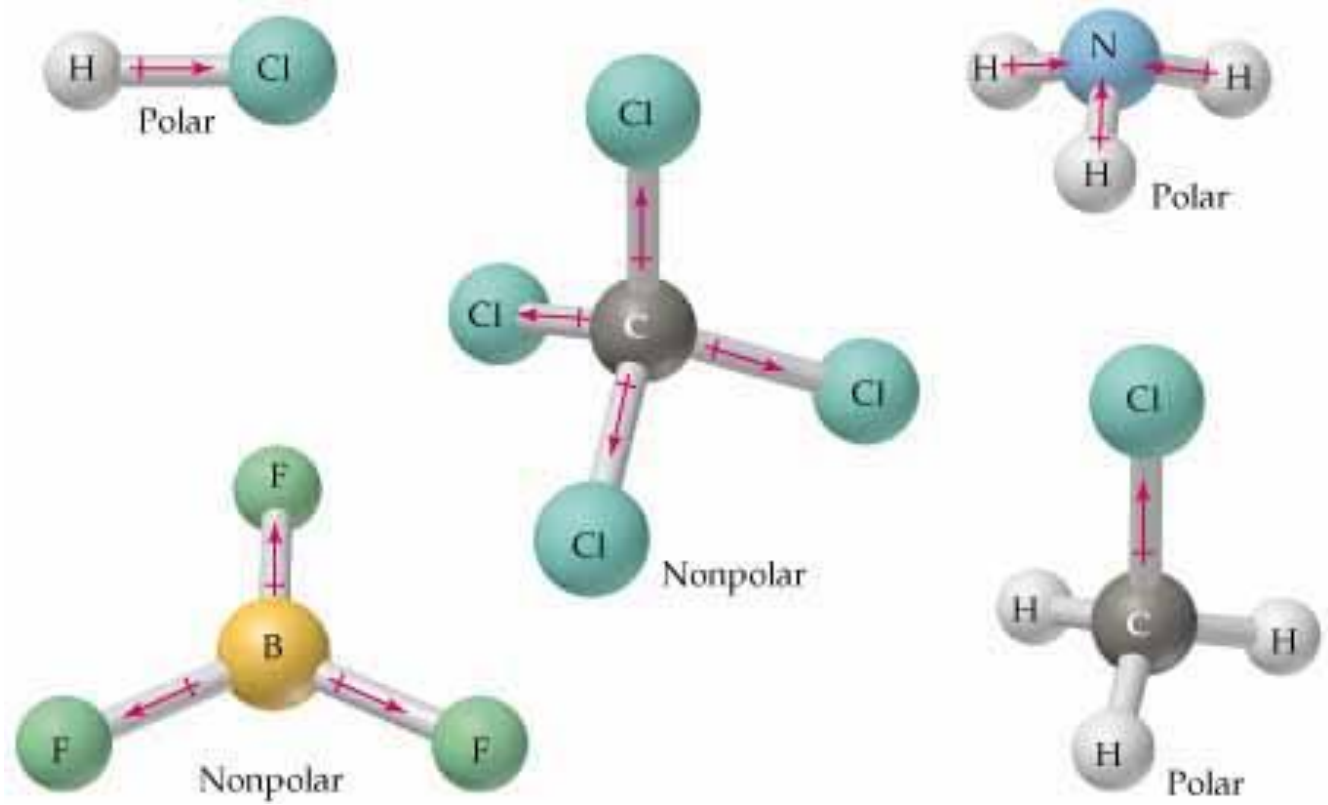
Cl has slight negative charge (-δ) and H has slight positive charge (+ δ)

Polar Molecules…

- Draw the Lewis diagram of the molecule
- In order to be a polar molecule, it MUST CONTAIN POLAR BONDS!!!!
- And it must be an asymmetrical molecule. Which means it has a positive end and a negative end

Polar Molecules

- **Note:** Not all molecules with polar bonds are polar molecules



Significance of Molecular Polarity

- Why is polarity of the whole molecule so important?

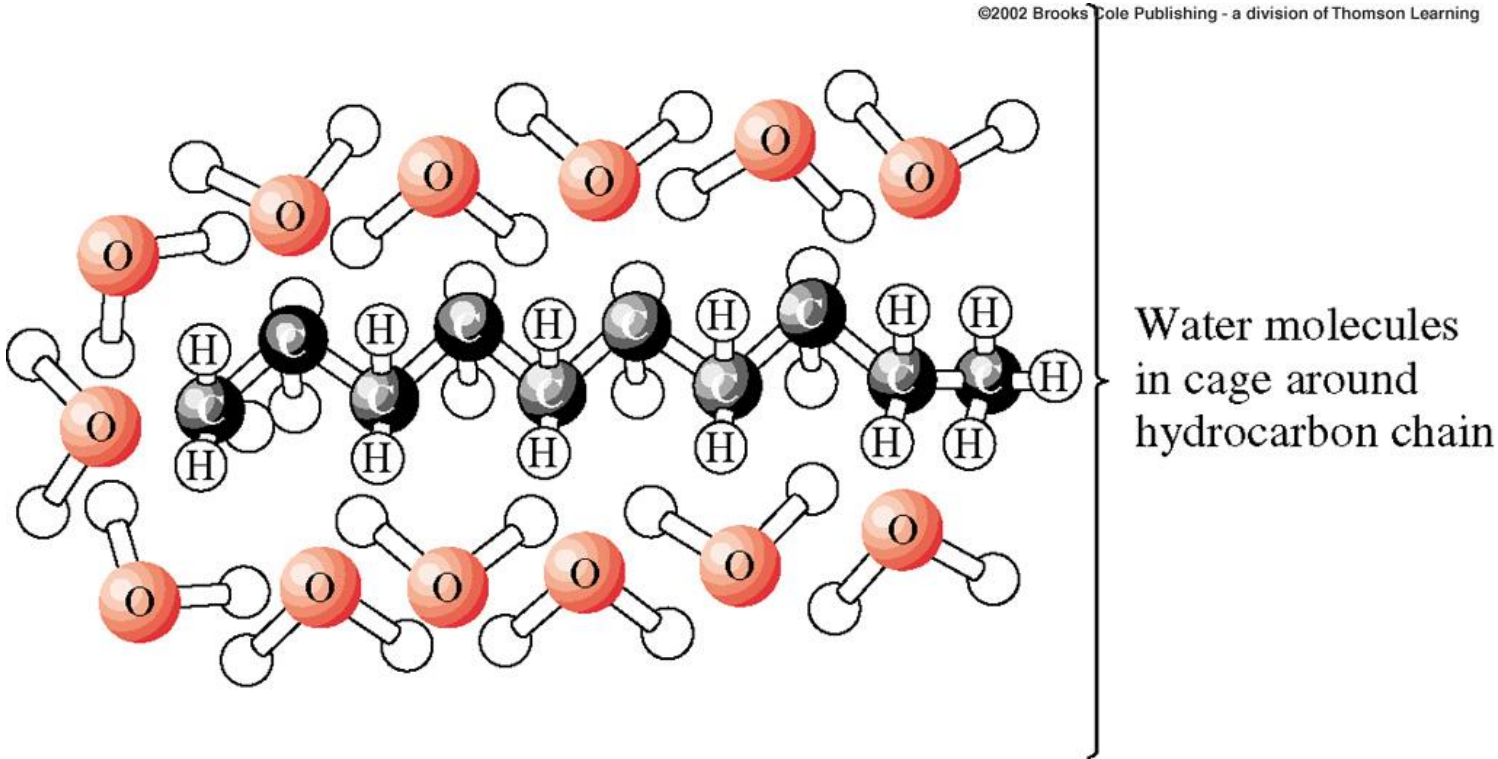
- Many physical properties of substances (ie: state at SATP, melting and boiling points, solubility) are affected by the polarity of their molecules, not just their intramolecular bonds

Why do we care?

- A polar substance will only mix with another polar substance.
- A non-polar substance will only mix with another non-polar substance.
- Polarity also affects properties such as melting point.

Bond Polarity

- This is why oil and water will not mix! Oil is nonpolar, and water is polar.
- The two will repel each other, and so you can not dissolve one in the other



LET'S TRY

Try These bonds, their EN difference & bond type. Compare with a partner.

1.Li and Cl

(1.0 & 3.0)

2. N & N (# bonds formed? Doesn't change EN why?)

For N & N, a triple bond is formed but you do NOT multiply electronegativity because its a measure of the nucleus' attraction for electrons and therefore the number of bonds between two atoms isn't relevant to the electronegativity difference and type of bond formed.

Try these:

Be & N

(1.5& 3.0)

P & F (what kind of bond would you expect, 2 non-metals)

(2.1& 4.0)

P & F -> you would expect a covalent bond

(2.1& 4.0) but the electronegativity difference indicates its ionic.

In this case, in the context of a whole molecule (more than one fluorine etc) the bond would just be highly polar rather than ionic, because it is TWO NON-METALS still. For assessments, you would indicate the electronegativity difference falls in the ionic range but you should be able to explain why the molecule has polar properties (difference is just a GUIDELINE).