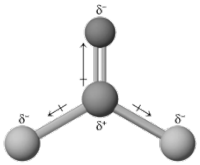
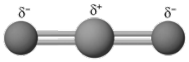


Molecular Polarity

Chapter 10



Ionic and Covalent Bonds

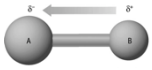
- An ***ionic bond*** is a bond in which a cation and an anion have an electrostatic attraction for one another.
- A ***covalent bond*** is a bond in which two atoms share electrons. It is the mutual attraction of two nuclei for the same electrons that keeps the atoms together.

Bond Polarity

- In reality, few bonds are completely ionic or completely covalent.
- The ***electronegativity difference*** **(ΔEN)** between two atoms will allow us determine whether two atoms in a bond will display more ionic properties or more covalent properties.

Bond Polarity

- If the electrons are ***shared evenly***, the bond is ***non-polar***.
- If the electrons are ***shared unevenly***, the bond is considered ***polar*** – it has a positive side and a negative side.



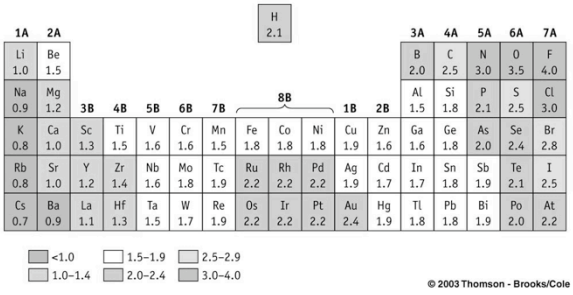
- If one atom has an attraction so much stronger than the other atom that it ***pulls the electrons away***, then we consider the bond to be ***ionic***.

Bond Polarity

There is a continuum from non-polar to ionic, with no clear breaks. However, we will define some arbitrary cut-off points:

ΔEN ≤ 0.4	Nonpolar Covalent Bonds (electrons unevenly shared)
0.5 ≤ ΔEN ≤ 1.6	Polar Covalent Bonds (electrons unevenly shared)
ΔEN ≥ 1.7	Ionic Bonds (full charges)

Chart of Electronegativities

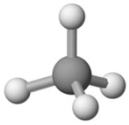


Molecular Polarity

- Bonds are considered polar or non-polar based on electronegativity differences.
- A molecule will only be a dipole (polar) when 2 criteria are met:
  1. There is a polar bond in the molecule.
  2. There is asymmetry with respect to charge.

Methane (CH_4)

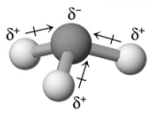
- *Are the bonds polar?*
  ΔEN = 2.5 - 2.1 = 0.4 → NO

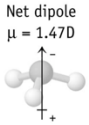


- Therefore, methane is a NON-POLAR Molecule.
- We do NOT need to ask the second question:
  Is there any charge asymmetry in the molecule?

Ammonia (NH_3)

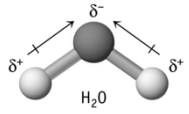
- *Are the bonds polar?*
  ΔEN = 3.0 - 2.1 = 0.9 → YES, polar bonds:
  δ^- **N–H** δ^+
- *Is there any charge asymmetry?*
  Consider the shape: **Trigonal pyramidal** → YES
- Therefore, Ammonia is a POLAR Molecule.

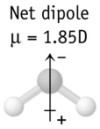




Water (H_2O)

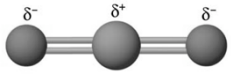
- *Are the bonds polar?*
  ΔEN = 3.5 - 2.1 = 1.4 → YES, polar bonds:
  δ^- **O–H** δ^+
- *Is there any charge asymmetry?*
  Consider the shape: **Bent (~105°)** → YES
- Therefore, Water is a POLAR Molecule.





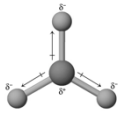
Carbon Dioxide (CO_2)

- *Are the bonds polar?*
  ΔEN = 3.5 - 2.5 = 1.0 → YES, polar bonds:
  δ^+ **C–O** δ^-
- *Is there any charge asymmetry?*
  Consider the shape: **Linear** → NO
- Therefore, carbon dioxide is a NON-POLAR Molecule.



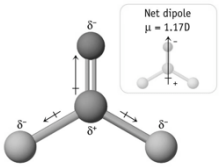
Boron Trifluoride (BF_3)

- *Are the bonds polar?*
  ΔEN = 4.0 - 2.0 = 2.0 → YES, polar bonds:
  (despite large ΔEN, bonds have covalent character)
  δ^+ **B–F** δ^-
- *Is there any charge asymmetry?*
  Consider the shape: **Trigonal Planar** → NO
- Therefore, BF_3 is a NON-POLAR Molecule.

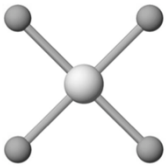


Other molecules

- $COCl_2$ is a POLAR molecule

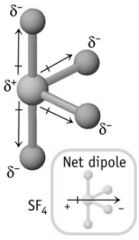


- XeF_4 is a NON-POLAR molecule.

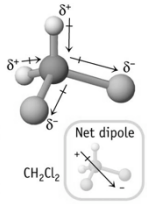


Other molecules

- SF_2 is a POLAR molecule

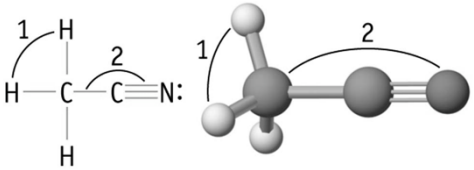


- CH_2Cl_2 is a NON-POLAR molecule.



Other molecules

- CH_3CN is a POLAR molecule:



Other molecules

- $CH_3CH(OH)CH_3$ is a POLAR molecule.