4.4 Polar Molecules

Rules for Polar and Non-polar Molecules

- The following rules can be used to predict, from the molecular formula, whether a molecule is polar or non-polar.

Polar Molecules

Type	Examples	
AB	$HCI_{(g)}$,$CO_{(g)}$	diatomic with different molecules
N_xA_y	$NH_{3(g)}$,$NF_{3(g)}$	containing N and other atoms
O_xA_y	$H_2O_{(1)}$,$OCl_{2(g)}$	containing O and other atoms
$C_xA_yB_z$	$CHCl_{3(l)}$,$C_2H_5OH_{(l)}$	containing C and 2 other kinds of atoms

Non-polar Molecules

Type	Examples	
A_x	$Cl_{2(g)}$, $N_{2(g)}$	elements
C_xA_y	$CO_{2(g)}$,$CH_{4(g)}$	containing C and only 1 other kind of atom

Electronegativity

- Pauling invented electronegativity to explain polarity in molecules.
- He arbitrarily assigned values. F the most electronegative element was given a value of 4.
- Electronegativity increases as you move up and to the right on the periodic table.
- Based on the difference of electronegativities between the bonding pair, 3 bond types could form.
  a) Covalent bond: a non-polar bond with equal sharing of bonding electrons.
  b) Ionic bond: a bond in which the bonding pair of electrons are mostly with one atom/ion
  c) Polar Covalent bond: a bond in which electrons are shared somewhat unequally.
- See figure 4 on page 252

Polar Molecules

- Just because the bond is polar it does not mean the molecule is polar.

- Arrows are used to show the bond dipole. These arrows are vectors and can be added.
- Bond Dipole: the electronegativity difference of 2 bonded atoms represented by an arrow pointing from the lower (δ^+) to the higher (δ^-) electronegativity.
- E.g. Non-polar

CO_2	δ^-		δ^+		δ^-
	O	=	C	=	O
Electronegativity	3.5		2.5		3.5

- E.g. Polar: H_2O

- Both the shape of the molecule and the polarity of the bonds are necessary to determine if a molecule is polar or non-polar.
- All symmetrical molecules, the sum of the bond dipoles are zero and the molecule is non-polar.
- **Tip:** Use vector analysis to determine if it is polar or non-polar. If there is a resultant you will know the direction of the dipole (polar). If you get a null resultant then it is non-polar.

Homework

- Practice 1,2,3,6,7,8,9,10
- Questions 1,2,4