Chapter 5 and 8 Continuation

Goals:

- ✓ To be able to draw 2-D representations of molecular compounds (Lewis structures).
- ✓ To be able to explain the 3-D shape (molecular geometry) of molecular compounds.
- ✓ To determine if a covalent bond is polar or nonpolar.
- ✓ To determine if a molecule is polar or nonpolar by considering it's Lewis structure, 3-D shape and the polarity of each individual bond.
- ✓ To determine the intermolecular forces of attraction present between molecules, and to know how this relates to melting points, boiling points and the overall states of matter.
- ✓ To interpret a heating curve.

Drawing Lewis Structures

1. Add up all of the valence electrons for the atoms involved in bonding

2. Write the symbols for the elements and show connectivity with single bonds (2 electrons shared).
   a. The central atom is typically the one there is only one of or the fewest of.
   b. If there is one of several atoms, they will usually be written in order.
   c. H is always terminal

3. Complete the octet for the atoms bonded to the central atom (NOT FOR HYDROGEN).

4. Place the leftover electrons on the central atom.

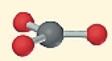
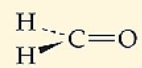
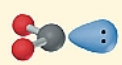
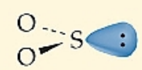
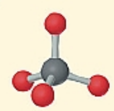
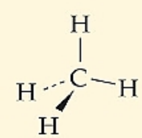
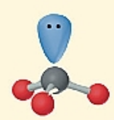
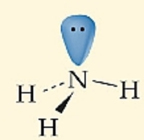
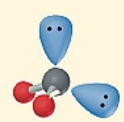
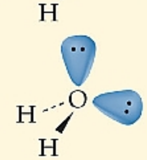
5. If octet is not satisfied on the central atom then form double or triple bonds as needed.

NOTE: We will only be concerned with molecules that follow the octet rule. We will not worry about exceptions to the rule. Some exceptions are discussed in your book in section 5.2.

Molecular Shape (Geometry)

VSEPR Theory: The repulsions between electrons will result in the placement of electron pairs (bonding or lone pairs) as far apart as possible in 3-D space. This causes molecules to take on very predictable shapes.

TABLE 5.1 Molecular Geometry Around Atoms with 2, 3, and 4 Charge Clouds

NUMBER OF BONDS	NUMBER OF LONE PAIRS	TOTAL NUMBER OF CHARGE CLOUDS	MOLECULAR GEOMETRY	EXAMPLE
2	0	2	 Linear	O=C=O
3	0	3	 Planar triangular	
2	1	3	 Bent	
4	0	4	 Tetrahedral	
3	1	4	 Pyramidal	
2	2	4	 Bent	

Draw Lewis Structures and Predict Molecular Shapes

1. NH_3

2. H_2O

3. $CHCl_3$

4. CO_2

5. HCN

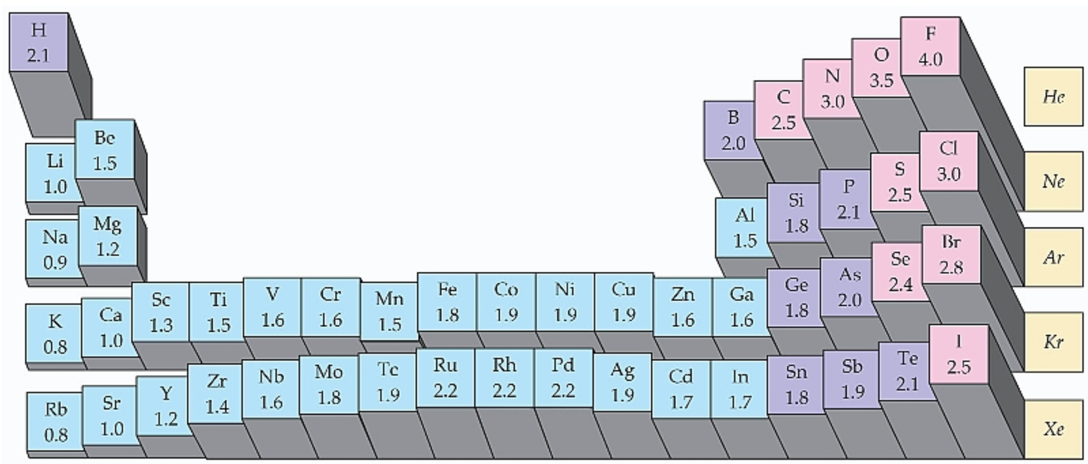
Polar Bonds

- Electronegativity refers to an atoms ability to pull electrons that are shared in a covalent bond to itself.

- Bonds are either nonpolar covalent, polar covalent or ionic.
  - Nonpolar covalent bonds occur when the two atoms sharing electrons share evenly. This occurs when the two atoms have similar electronegativity values. So long as the difference in electronegativity is less than 0.5 we will consider the bond to be nonpolar.

  - Polar covalent bonds occur when the two atoms sharing electrons share unevenly. This occurs when one atom has a much higher electronegativity than the other. We will consider electronegativity differences of 0.5-1.9 to be polar covalent.

  - Ionic bonds occur when electrons are transferred from one atom to another to form ions. This occurs when the electronegativity values of the two atoms are drastically different, as is usually the case when metals react with nonmetals. We will consider an electronegativity difference of 2.0 or greater to be ionic.



Polar Molecules

Just because a molecule contains polar bonds does not mean that the overall molecule is polar. To determine if the molecule is polar we must consider the shape/geometry of the molecule.

a. If a molecule contains no polar bonds than the molecule is nonpolar.
b. If a molecule contains polar bonds that are equal and opposite in direction, than those polar bonds cancel out and the molecule is nonpolar.
c. If a molecule contains polar bonds that are not equal and opposite in direction, than those polar bonds do not cancel out and the molecule is polar.

Examples:

1. CO_2

2. H_2O

3. $CHCl_3$

4. NH_3

5. CH_4

Intermolecular Forces of Attraction

Ideal gases have no attractive forces. Real gases will exhibit very weak attractive forces.

Liquids and solids have significant attractive forces for one another. Whether the attractions are strong or weak depends on the type of attraction and the size of the molecules involved.

Intermolecular forces of attraction refers to the forces of attraction that exist between molecules. Ionic compounds do not have intermolecular forces of attraction because they are not made up of molecules.

Ionic compounds have ionic bonds (electrostatic forces): Strong attractive forces between oppositely charged ions.

Molecular compounds have intermolecular forces of attraction:

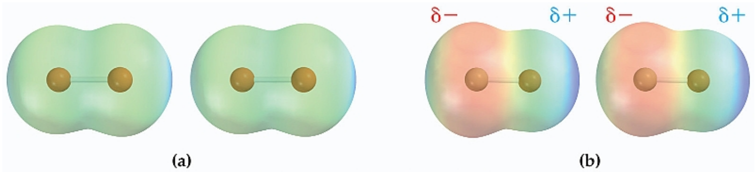
1) **London Dispersion Forces:** Weakest attractive force between the electrons of one molecule, ion or atom and the nuclei of another molecule, ion, or atom.

2) **Dipolar Forces (dipole-dipole):** Attractive forces between the partial positive charge of one dipole and the partial negative charge of another dipole.

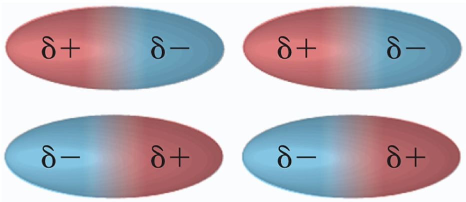
3) **Hydrogen bonding:** Special type of dipolar attractive force that exists between a hydrogen atom and two highly EN atoms (usually F, N or O). Hydrogen bonding is not a covalent bond!

IFAs

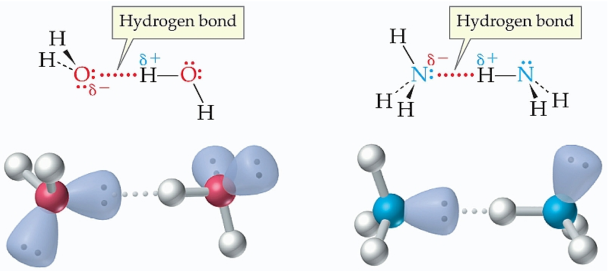
- **London Dispersion Forces:** Weakest attractive force that result from instantaneous dipoles forming in nonpolar molecules. The larger the molecules size, the more polarized it may become, thus increasing the strength of the LDF.



- **Dipolar Forces (ion-dipole, dipole-dipole):** Attractive forces between the partial positive charge of one dipole and the partial negative charge of another dipole.



- **H-bonding Forces:** Special type of dipolar attractive force that exists between a hydrogen atom and two highly EN atoms (usually F, N or O).



Predicting IFAs

Problems:

For the following, draw the Lewis structure, predict the molecular geometry, indicate partial positive and negative charge build-up (if any), and tell if the molecule is polar or nonpolar. Finally, predict the type of IFAs that would exist in a sample of each pure substance.

1. CF_4

2. F_2

3. $CH_3CH_2CH_2OH$

Arrange the three substances from highest to lowest boiling and melting point.

Change of State