

# Salt Lake Community College, Chemistry Department

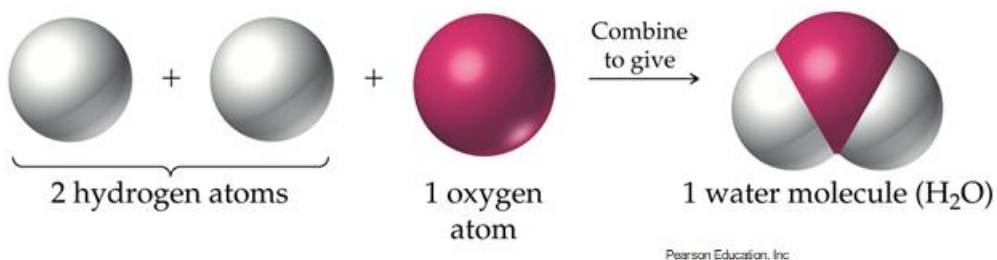
## Chem 1110 Workshop 5

### Topic: Covalent Compounds

#### Objective:

- Molecular Compounds and Covalent Bonds
- Covalent bonds and the periodic table
- Drawing Lewis Structures and the Shapes of Molecules
- Polar and Non-polar Covalent Bonds and Electronegativity
- Polar and Non-polar Molecules
- Naming Binary Molecular Compounds

**Molecular compounds:** usually combinations of nonmetals,  $\text{H}_2\text{O}$



**Molecule:** A group of atoms held together by covalent bonds

#### Covalent bonds and the Periodic Table:

Number of valence electrons

Usual number of covalent bonds

H

1 bond

Group 1A

1 e<sup>-</sup>

Group 8A

8 e<sup>-</sup>

Group 3A

3 e<sup>-</sup>

Group 4A

4 e<sup>-</sup>

Group 5A

5 e<sup>-</sup>

Group 6A

6 e<sup>-</sup>

Group 7A

7 e<sup>-</sup>

					He 0 bonds
B 3 bonds	C 4 bonds	N 3 bonds	O 2 bonds	F 1 bond	Ne 0 bonds
	Si 4 bonds	P 3 bonds (5)	S 2 bonds (4, 6)	Cl 1 bond (3, 5)	Ar 0 bonds
				Br 1 bond (3, 5)	Kr 0 bonds
				I 1 bond (3, 5, 7)	Xe 0 bonds (2, 4, 6)

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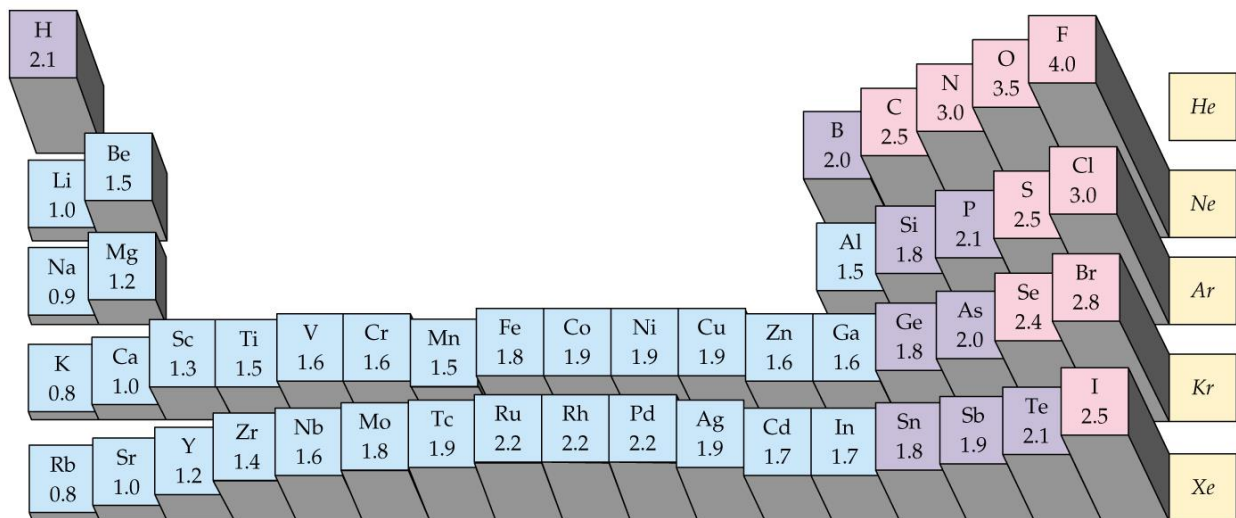
Numbers of covalent bonds are typically formed by main group elements to achieve octet configurations.

### Drawing Lewis Structures and the Shapes of Molecules

- A. Lewis structures: show bonds between atoms and the presence of unpaired electrons
- B. Drawing Lewis structures of molecules Rules:
1. Sum the valence electrons from all the atoms in the molecule (\*\*do not forget to add or subtract electrons based on the overall charge).
  2. Determine the central atom (This will usually be the largest number of bonds/ or the first named atom in the molecular formula \*\*except H atom)
  3. Place the central atom (using its chemical symbol) and attach each of the peripheral atoms to it using a bonding pair of electrons written as a line.
  4. Give each peripheral atom an octet of electrons (8 electrons) written as pairs of dots (except H – it follows the duet rule).
  5. Any remaining electrons go on the central atom, even if doing this gives the central atom more than an octet of electrons.
- C. **Valence shell electron-pair repulsion Model:** It is a method predicting molecular shape by noting how many electrons charge clouds surround atoms and assuming that the clouds orient as far away from one another as possible. The mutual repulsion of pairs of electrons cause them to arrange themselves as far apart spatially as possible

total pairs	bonding pairs	nonbonding pairs	geometry	example
2	2	0	linear	BeH <sub>2</sub>
3	3	0	trigonal planar	BF <sub>3</sub>
	2	1	bent	NO <sub>2</sub>
4	4	0	tetrahedral	CH <sub>4</sub>
	3	1	pyramidal	NH <sub>3</sub>
	2	2	bent	H <sub>2</sub> O

## Polar and non-polar covalent bonds:

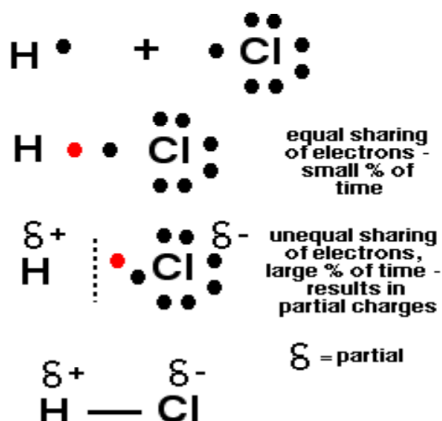


1. Electronegativity: Electronegativity is the tendency of an atom to attract electrons to itself (0-4).
2. F is the most electronegative atom in the periodic table (Electronegative value= 4.0)
3. Cs the least electronegative atom (Electronegative value = 0.7)
4. To determine the type of **bond between two atoms**, you can use the electronegativity difference:

<0.5	nonpolar covalent
0.5 – 1.9	polar covalent
>2.0	ionic

- A. Polar covalent bonds - bonding electrons are not shared equally due to differences in electronegativity between the bonding atoms

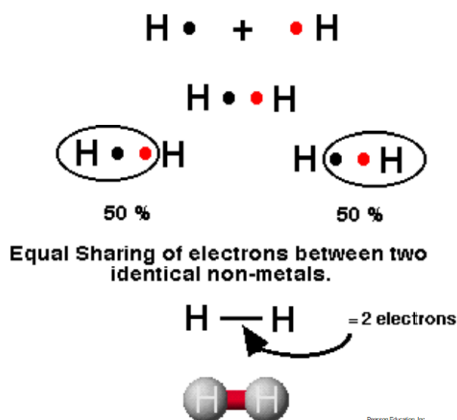
### Polar Covalent Hydrogen Chloride, HCl



### Nonpolar covalent bonds:

1. If the bonding atoms are the same (for example,  $H_2$ ,  $N_2$ ,  $O_2$ ,  $F_2$ , etc.) the bonding atoms are shared equally (50%/50%)

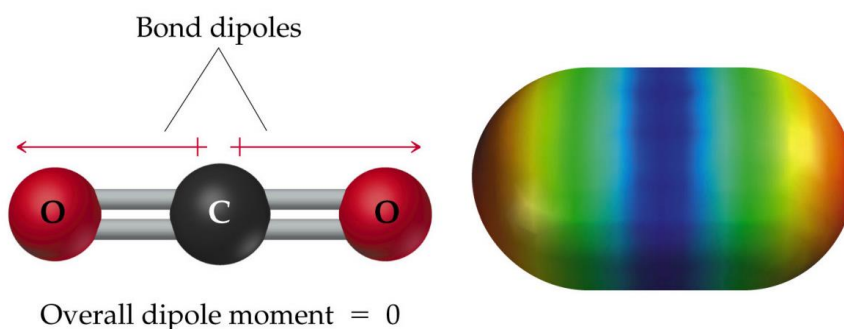
### Non-polar Covalent Bonding - Hydrogen Molecule, $H_2$



### Polar and Nonpolar Molecules

1. When there is a difference in electronegativity between two atoms, then the bond between them is polar.
2. It is possible for a molecule to contain polar bonds, but not be polar. For example, the bond dipoles in  $CO_2$  cancel each other because  $CO_2$  is linear.

3. Exceptions: highly symmetric molecules with polar bonds may be nonpolar.



### Naming Binary Molecular Compounds:

prefixes (mono-, di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, nona-, deca-) are used to indicate the number of atoms of each element (mono- is never used with the first element).

### Practice Problems:

1. Classify each of these following compounds as an ionic or covalent compound

(a)  $\text{N}_2\text{O}$

(b)  $\text{CaCl}_2$

2. For each of the following molecules, give the total number of valence electrons, draw the Lewis structure, give the molecular shape, calculate the electronegativity difference, and identify the type of bond.

Chemical Formula	Total Number of valence electrons	Lewis Structure	Molecular Shape	Electronegativity difference	Type of bond (Polar or non-polar)
HBr					
$\text{CO}_2$					
CO					
$\text{CH}_2\text{O}$					
$\text{NH}_4^+$					

HCN					
CH <sub>3</sub> CH <sub>2</sub> OH					

3. Name the following binary molecular compounds:

Binary Molecular Compound	Name
CO	
P <sub>4</sub> O <sub>10</sub>	
Cl <sub>2</sub> O	
N <sub>2</sub> O <sub>4</sub>	
SO <sub>3</sub>	
SO <sub>2</sub>	

4. Classify each of these following compounds as polar or nonpolar molecules

(a) NH<sub>3</sub>

(b) CH<sub>4</sub>

(c) CH<sub>3</sub>Cl