**Chemical Bonds**

**Noble Gases** (Group VIII)
- inert - no (almost) reactions
- electronic configuration - filled outer shell
- high ionization energy - E needed to remove an electron

He - only material that does not freeze at normal pressure
- superfluid at T < 1 K
- flows without friction
- macroscopic quantum mechanical properties
- like superconductors

**Ionic Bond** - typically "salts"
- valence electrons - those in incomplete highest energy orbitals
- ion - atom that has gained or lost an electron
  - usually to complete a shell
  - charged!
- typically between
  - Group I - alkali metals
    - have an extra electron
  - Group VII - halogens
    - need one more electron

transfer of electron(s)
- completes (fills) orbitals
- in donor and recipient
- creates oppositely charged ions
- attractive electrical force
- hold ions together

**Covalent Bond** - holds molecules together

**Molecule** - smallest unit of a substance that can have a stable independent existence.

**Gilbert N. Lewis** (1875-1946)
- chemist
- 1st to isolate heavy water
  - H replaced by deuterium
- sharing electrons can achieve
  - Noble Gas structure
  - filled shells
introduced Lewis Diagram
electron dot symbols

number of dots (valence electrons) = column number except for He position atoms and draw dots so that electrons can be shared

H–H

1s 1s

Table 14–8 LEWIS STRUCTURES OF HYDROGEN THROUGH ARGON

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>He:</td>
</tr>
<tr>
<td>Li</td>
<td>·</td>
<td>Be ·</td>
<td>·</td>
<td>C ·</td>
<td>·</td>
<td>O ·</td>
<td>F ·</td>
<td>Ne:</td>
</tr>
<tr>
<td>Na</td>
<td>·</td>
<td>Mg ·</td>
<td>·</td>
<td>Al ·</td>
<td>·</td>
<td>Si ·</td>
<td>P ·</td>
<td>S ·</td>
</tr>
</tbody>
</table>

dash notation also indicates single, double, or triple bonds

Goal: get 8 (or 2) dots near each atom

Table 14–9 LEWIS STRUCTURES OF SOME COVALENT MOLECULES

<table>
<thead>
<tr>
<th>Substance</th>
<th>Lewis Structure</th>
<th>Dash Formula</th>
<th>Substance</th>
<th>Lewis Structure</th>
<th>Dash Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromine</td>
<td>Br : Br : Br</td>
<td>Br—Br</td>
<td>Carbon dioxide</td>
<td>O : C : O : O</td>
<td>O—C—O</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl : Cl : Cl</td>
<td>Cl—Cl</td>
<td>Ammonia</td>
<td>H : N : H : H</td>
<td>H — N — H</td>
</tr>
<tr>
<td>Iodine</td>
<td>I : I : I</td>
<td>I—I</td>
<td>Hydrogen</td>
<td>H : H</td>
<td>H — H</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O : O</td>
<td>O—O</td>
<td>Nitrogen</td>
<td>N : N</td>
<td>N = N</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N : N : N</td>
<td>N = N</td>
<td>Carbon tetrachloride</td>
<td>Cl : Cl : Cl : Cl</td>
<td>Cl—Cl—Cl</td>
</tr>
</tbody>
</table>

POLAR MOLECULES
unequally shared electrons in covalent bond has + and - "poles"
important example: $\text{H}_2\text{O}$
oxygen holds electrons
tighter than hydrogen
hydrogen bond

Ability of an atom to attract an electron gives:

Electronegativities of the Elements

What type of bond is $\text{H-O}$?  $\text{Cl-Cl}$?  $\text{K-F}$?

METALLIC BOND
outer electrons
conduction electrons
shared among all atoms
positive charge remains
around each nucleus
opposite of Thomson’s Plum Pudding atom model
conduction electrons hold metal together
they are free to move and give
high electrical and thermal conductivity
non-directional bond
atoms can move relative to each other
malleable - can be rolled or hammered into shape
ductile - can be drawn into wires