Covalent and Ionic Bonds

BHS Chemistry
Chemical Bonds

- Chemical bonds form when the valence electrons of atoms join to make a complete octet.
  - Nobel gases are the only elements that satisfy the octet rule without forming compounds.

- As atoms bond, potential energy decreases and atoms form more stable arrangements.
Types of Bonds

- Ionic Bond: formed of metal & non-metal OR a metal & polyatomic ion
- Covalent Bond: formed of non-metal & non-metal.
  - Polar Covalent = unequal sharing of electrons between atoms
  - Non-Polar Covalent = equal sharing of electrons between atoms.
- Metallic Bond: formed of only metals
  - The “electron sea” model shows that in a metallic bond, mobile electrons are shared by all atoms.
Types of Bonds

- Covalent bond: Sharing of electrons between atoms, forming a molecule.
- Ionic bond: Transfer of electrons from one atom to another, creating positive and negative ions.

Positive ions from the metal

Electron cloud that doesn't belong to any one metal ion
What's a covalent compound?
I'm sure glad you asked!

- In a covalent compound the atoms that are bonded share electrons rather than transfer electrons from one to the other.
- Covalent compounds are formed when two nonmetals bond to each other.
"Why do elements share electrons?

- Nonmetals have to share electrons with each other due to **electronegativity**.

- Electronegativity is how strongly an element pulls electrons away from other elements.

- All nonmetals have roughly the same electronegativity.
Electronegativity Difference & Bond Type

- Electronegativity difference
  - 0 to 0.2 $\rightarrow$ nonpolar covalent
  - 0.3 to 1.7 $\rightarrow$ polar covalent
  - 1.8 & up $\rightarrow$ ionic
Using the table of EN difference, determine the type of bond between these atoms:

1) F and Na
   - $4.0 - 0.8 = 3.2$  IONIC

2) F and Cl
   - $4.0 - 3.0 = 1.0$  POLAR COVALENT

3) I and Cl
   - $3.0 - 2.8 = 0.2$  NON-POLAR COVALENT
Non-Polar Covalent:
Each of the atoms equally attracts the shared electrons.

Polar Covalent:
Atoms in a compound attract electrons unequally.
<table>
<thead>
<tr>
<th>Ionic</th>
<th>Covalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High melting point</td>
<td>Low melting point</td>
</tr>
<tr>
<td>High boiling point</td>
<td>Low boiling point</td>
</tr>
<tr>
<td>Electrically conductive</td>
<td>Electrically non-conductive</td>
</tr>
<tr>
<td>Form a formula unit</td>
<td>Form a molecule</td>
</tr>
<tr>
<td>Metal + nonmetal (or metal + polyatomic ion)</td>
<td>Nonmetal + nonmetal</td>
</tr>
<tr>
<td>Electrons are donated and accepted—not shared</td>
<td>Electrons are shared</td>
</tr>
<tr>
<td>Hard (crystalline solid)</td>
<td>Exist as solids, liquids, or gases</td>
</tr>
</tbody>
</table>
Naming Compounds

- All covalent compounds have two word names. The first word stays the same and the second has "-ide" is substituted for the end.

- If there is more than one atom of an element in a molecule, we need to add prefixes to these words to tell us how many are present.
Mono - 1
Di - 2
Tri - 3
Tetra - 4
Penta - 5
Hexa - 6
Hepta - 7
Octa - 8
Nona - 9
Deca - 10

- $\text{P}_2\text{O}_5$
  - diphosphorus pentoxide
- CO
  - carbon monoxide
- $\text{CF}_4$
  - carbon tetrafluoride
<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_3$</td>
<td>carbon tetraiodide</td>
</tr>
<tr>
<td>ICl$_3$</td>
<td>phosphorus trichloride</td>
</tr>
<tr>
<td>PBr$_5$</td>
<td>dinitrogen trioxide</td>
</tr>
<tr>
<td>P$<em>4$O$</em>{10}$</td>
<td>carbon dioxide</td>
</tr>
</tbody>
</table>
exceptions to this naming

- these names are so common that they're officially recognized

  \[ \text{H}_2\text{O} \text{ is } "\text{water}" \]
  \[ \text{NH}_3 \text{ is } "\text{ammonia}" \]
  \[ \text{CH}_4 \text{ is } "\text{methane}" \]
Most covalent compounds have small molecules. They are gases, liquids or solids, most with low melting & boiling points.

Chlorine Cl₂ - a gas

Iodine I₂ - a liquid

Carbon Dioxide CO₂ – a gas

Water H₂O – a polar molecule

http://www.youtube.com/watch?v=Kj3o0XvhVqQ
VSEPR—a theory that applies to nonmetals

VSEPR: *valence-shell electron-pair repulsion*

VSEPR theory states:
- “Repulsion between the sets of valence-electrons surrounding an atom causes these sets to be oriented as far apart as possible.”

VSEPR can help determine molecular shape or molecular geometry
<table>
<thead>
<tr>
<th>Geometry Name</th>
<th>shape</th>
<th>Atoms bonded to central atom</th>
<th>Lone Pairs of Electrons</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>linear</td>
<td><img src="image1.png" alt="Linear Shape" /></td>
<td>2</td>
<td>0</td>
<td>BeF₂</td>
</tr>
<tr>
<td>trigonal planar</td>
<td><img src="image2.png" alt="Trigonal Planar Shape" /></td>
<td>3</td>
<td>0</td>
<td>BF₃</td>
</tr>
<tr>
<td>tetrahedral</td>
<td><img src="image3.png" alt="Tetrahedral Shape" /></td>
<td>4</td>
<td>0</td>
<td>CH₄</td>
</tr>
<tr>
<td>Bent</td>
<td><img src="image4.png" alt="Bent Shape" /></td>
<td>2</td>
<td>2</td>
<td>H₂O</td>
</tr>
</tbody>
</table>