

## Molecules and Bonding

As we investigate structures going from the simple to the complex, we find that the individual **atoms** combine with one another to form **molecules**. The atoms in these molecules are held together by **chemical bonds**. In order to understand the properties of molecules, it is important to understand the forces which hold them together. Chemists divide chemical bonds into two limiting cases: **ionic bonds** and **covalent bonds**.

**Ionic bonding** - Electron Donation  
**covalent bonding** - Electron Sharing

**Ionic Bonds**

**Covalent bonds**

<sup>3</sup> Li 6.941	<sup>4</sup> Be 9.021	<sup>5</sup> B 10.81	<sup>6</sup> C 12.01	<sup>7</sup> N 14.01	<sup>8</sup> O 15.99	<sup>9</sup> F 18.99	<sup>10</sup> Ne 20.18
<sup>11</sup> Na 22.99	<sup>12</sup> Mg 24.31	<sup>13</sup> Al 26.98	<sup>14</sup> Si 28.09	<sup>15</sup> P 30.97	<sup>16</sup> S 32.06	<sup>17</sup> Cl 35.45	<sup>18</sup> Ar 39.95
<sup>19</sup> K 40.00	<sup>20</sup> Ca 40.08	<sup>31</sup> Ga 69.72	<sup>32</sup> Ge 72.59	<sup>33</sup> As 74.92	<sup>34</sup> Se 78.96	<sup>35</sup> Br 79.90	<sup>36</sup> Kr 83.80

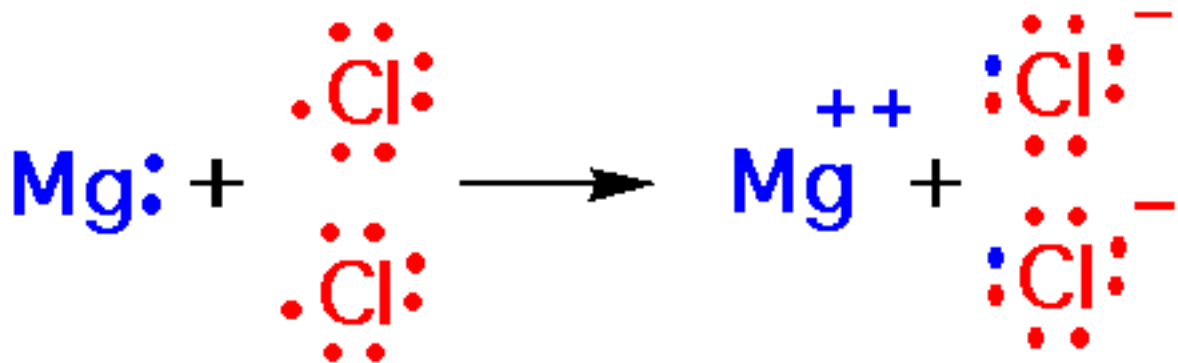
The glue that holds atoms together in molecules is the electrons

Ionic bonds - Donation of Electrons





NaCl Sodium Chloride



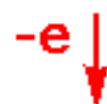
MgCl<sub>2</sub> Magnesium Chloride

To form bonds, atoms want to **gain**, **lose**, or **share** electrons in order to have filled shells

**Valence electrons** - electrons in the outer most shell of an atom

**A completed octet in the outer shell is desirable**

A completed **octet** in the outer shell is desirable:





## Covalent bonds

Sharing of electrons forms covalent bonds

The hydrogen molecule is formed by

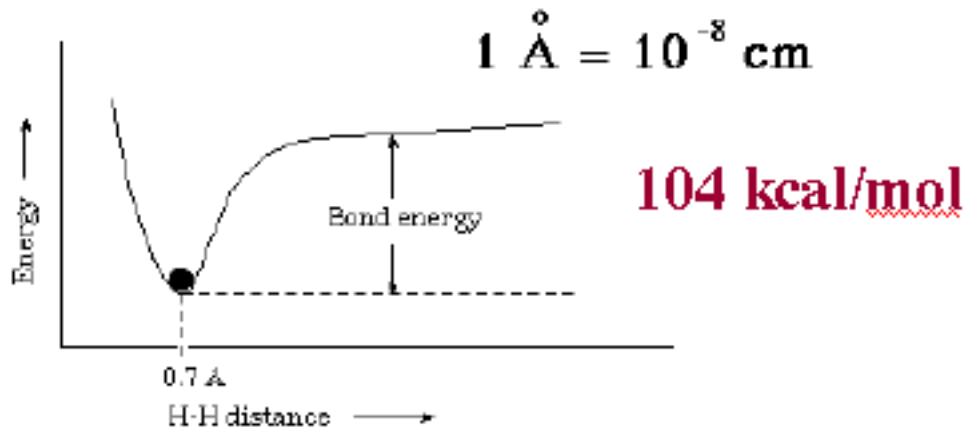


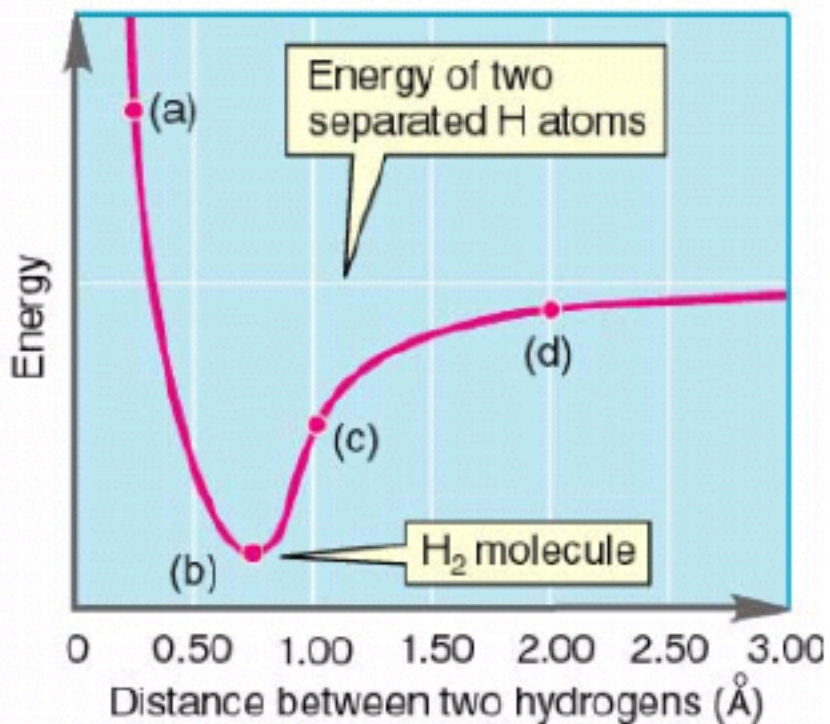
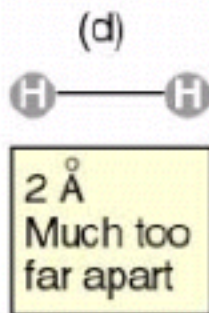
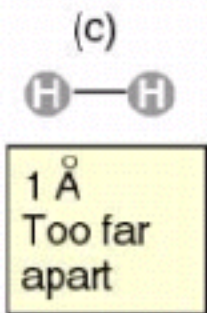
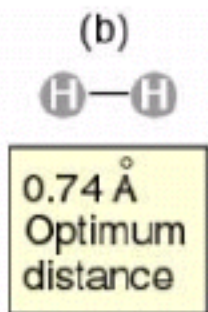
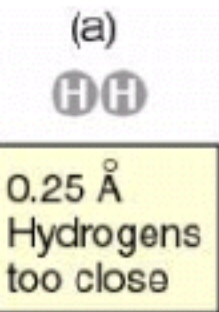
Electron sharing



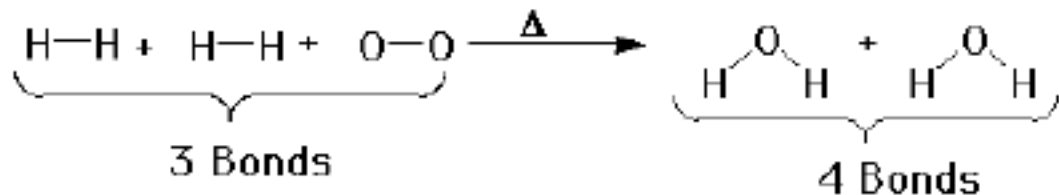
**Bond formation is an energy releasing process**

**Bond energy is the energy released when a bond is formed and the energy required to break the bond. The bond distance is the distance between the atoms when the bond is formed.**

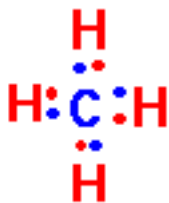




When hydrogen and oxygen combine to form water, energy is released:



# Carbon forms 4 bonds



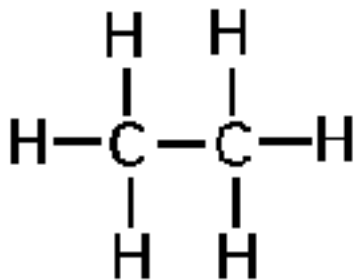
**TABLE 3.5** Bonding Requirements for Octet Formation of Some Nonmetals\*

Group			
IV	V	VI	VII
$\begin{array}{c}   \\ -\text{C}- \\   \end{array}$	$\begin{array}{c}   \\ -\text{N}- \end{array}$	$-\text{O}-$	$\text{F}-$
	$\begin{array}{c}   \\ -\text{P}- \end{array}$	$-\text{S}-$	$\text{Cl}-$
			$\text{Br}-$
			$\text{I}-$

\* The lines indicate the number of bonds needed for octet formation.

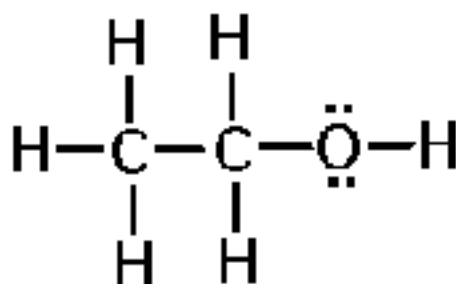
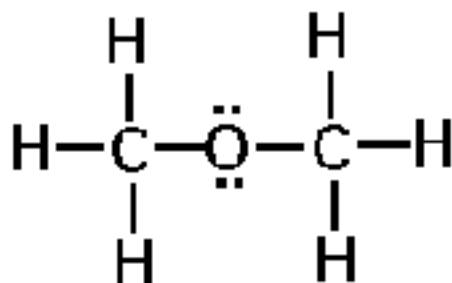
**Draw the Lewis structure of C<sub>2</sub>H<sub>6</sub>**

Lewis structures



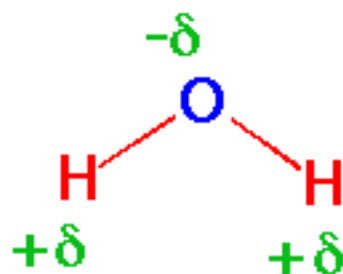
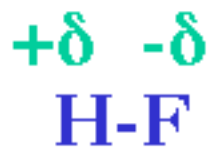
# Draw the Lewis structure of C<sub>2</sub>H<sub>6</sub>O

## Lewis structures



# Polar Covalent Bonds

Covalent Bonds between atoms of different Electronegativity are often polar with a partial negative charge on the atom of highest electronegativity.

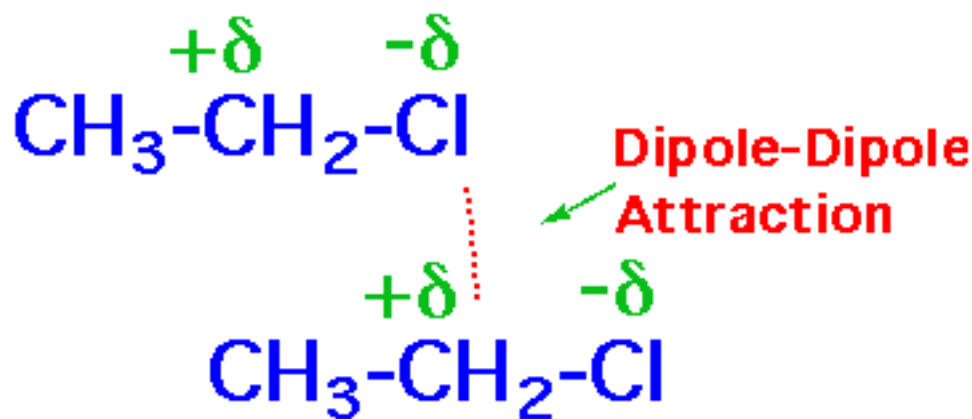


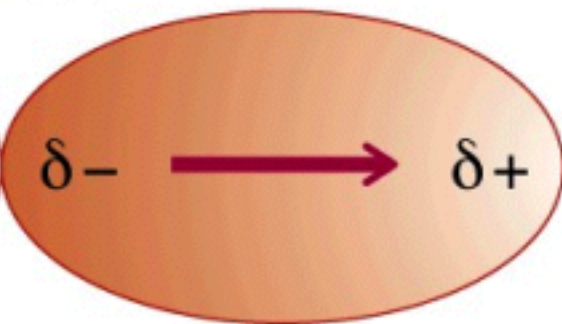
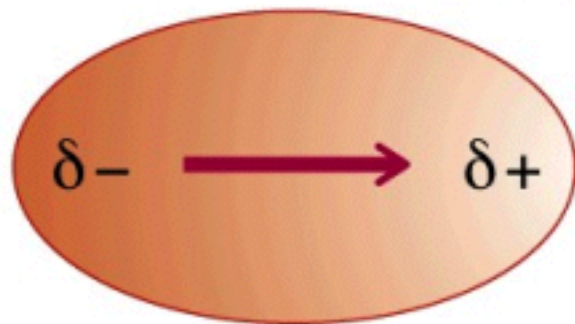
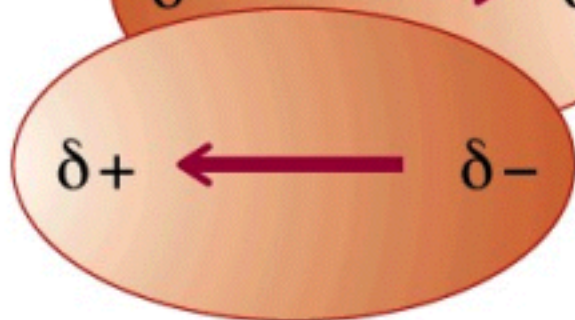
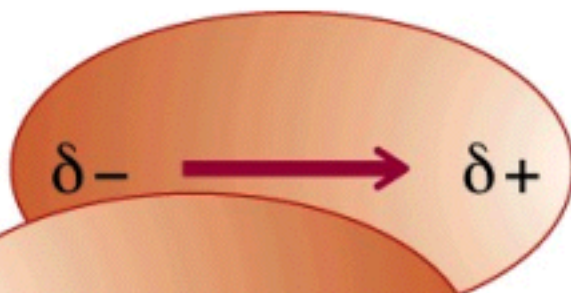
Water



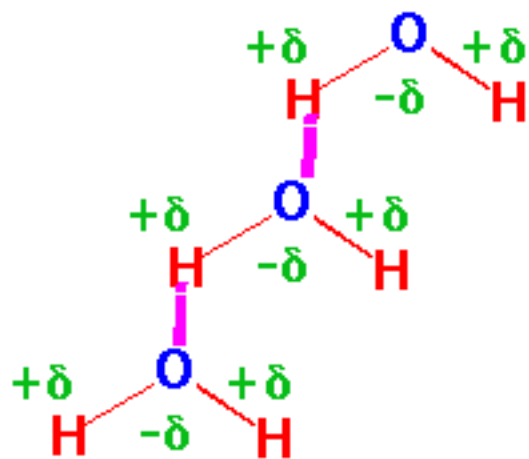
# Chlorine is more electronegative than carbon:

A dipole

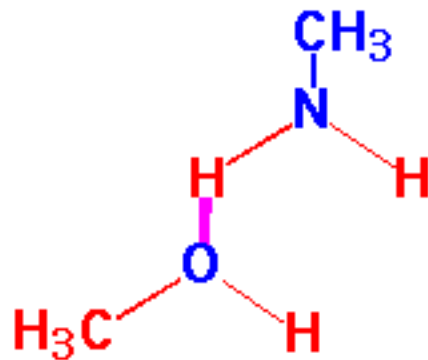
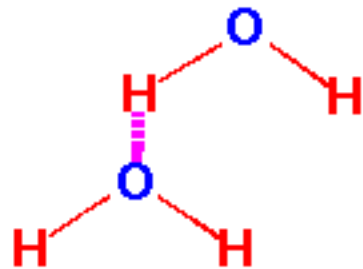




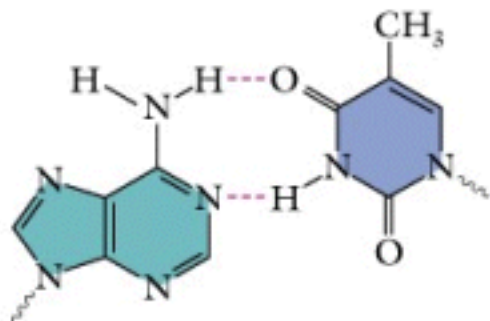
# One consequence of polar covalent bonding is Hydrogen Bonding



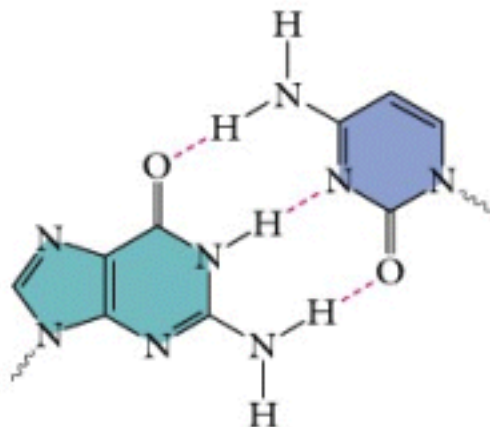
Hydrogen Bonds form between a hydrogen attached to a more electronegative atom and another electronegative atom:



# Hydrogen Bonds hold the double helix of DNA together:



Adenine-thymine base pair



Guanine-cytosine base pair