I. Introduction to Bonding

Ch. 7 & 8 - Chemical Bonding

IV

Lewis (Electron) Dot Structures

- **Lewis Structure**: atoms represented using the element symbol and dots for valence electrons
  - Two shared e- equals one bond
  - e^- not used to form a bond are called “lone pairs” or “nonbonding pairs”
- **Cations** (positive ions) have Lewis structures without valence electrons
- **Anions** (negative ions) have Lewis structures with 8 valence electrons

A. Types of Bonds

	IONIC	COVALENT
Bond Formation	e^- are transferred from metal to nonmetal	
Type of Structure	crystal lattice	
Physical State	solid	
Melting Point	high	
Solubility in Water	yes	
Electrical Conductivity	yes (solution or liquid)	
Other Properties		

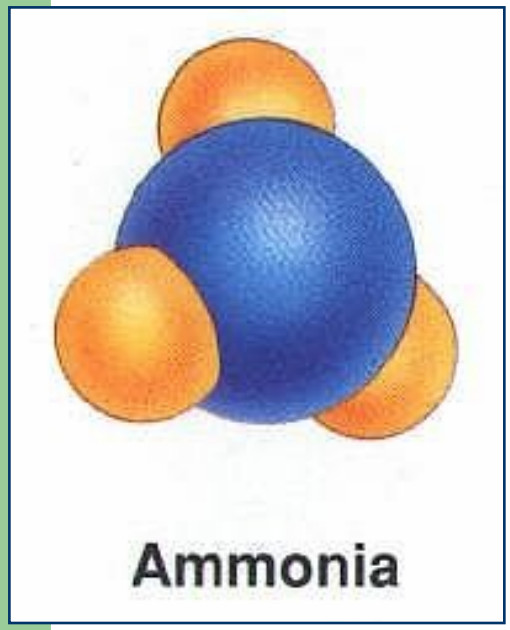
Ionic Bonding

- **Ionic Bond**: a total ***transfer*** of one or more electrons from one atom to another
  - Ionic compounds form into crystals of repeating **formula units**
  - Ionic bonds are extremely strong
- Reactions between metals and nonmetals (representative) tend to form ionic bonds
  - A positively charged ion (**CATION**) is attracted to a negatively charged ion (**ANION**)—attraction between ions is due to their opposite charges

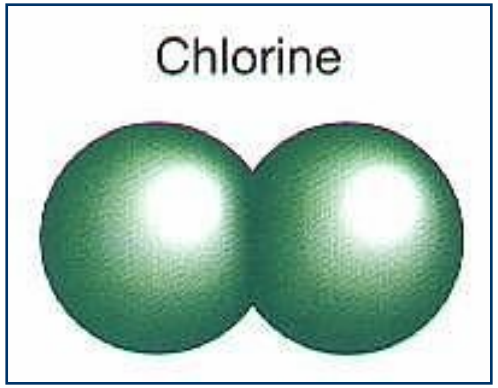
    Example: $Na^+ + Cl^- \rightarrow NaCl$

A. Types of Bonds

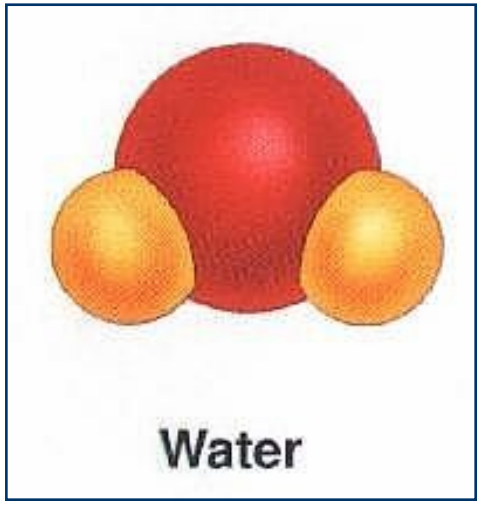
Covalent Bonding - True Molecules



Ammonia



Diatomic Molecule



Water

In ***covalent bonding***, atoms still want to achieve a noble gas configuration (the octet rule).

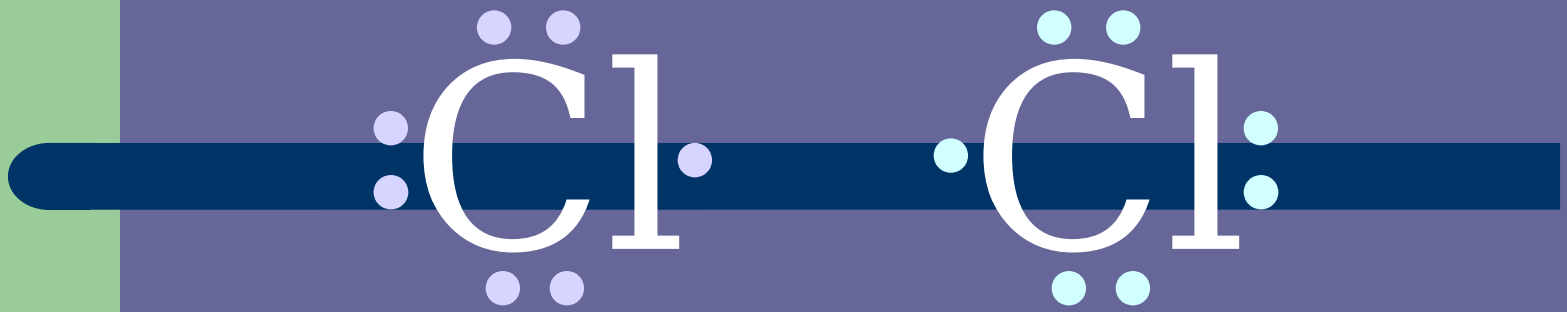
But rather than losing or gaining electrons, atoms now **share** an electron pair.

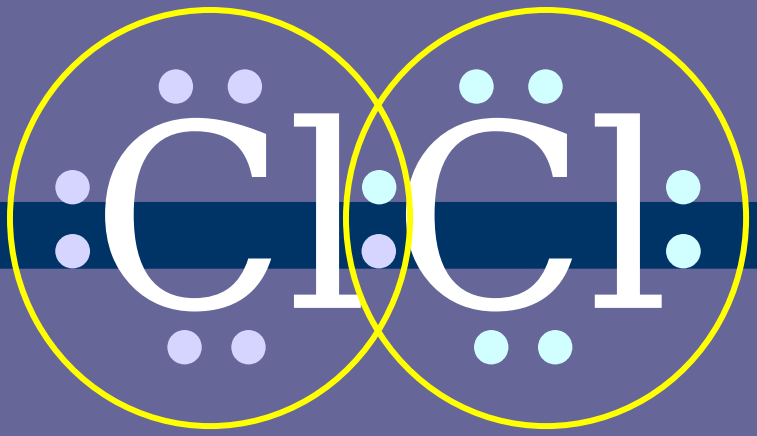
Covalent Bonding

- **Covalent Bond**: attractive forces due to the ***sharing*** of electrons between atoms
  - A group of covalently bonded atoms (with no overall charge) is called a **molecule**

Covalent Bonds

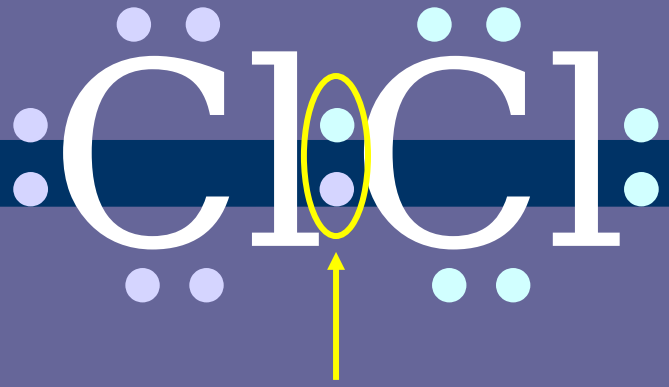
- Result from ***sharing*** of electrons (so that all atoms have filled outer energy levels ⇒ stable)
- In addition to hydrogen, atoms in Groups 4A, 5A, 6A, & 7A often form covalent bonds.
- Covalent compounds can contain single, double or triple bonds between atoms
  - Single covalent bond: formed by a shared pair of electrons between two atoms
  - Bond strength increases as the number of bonds between the atoms increases


Cl
Cl

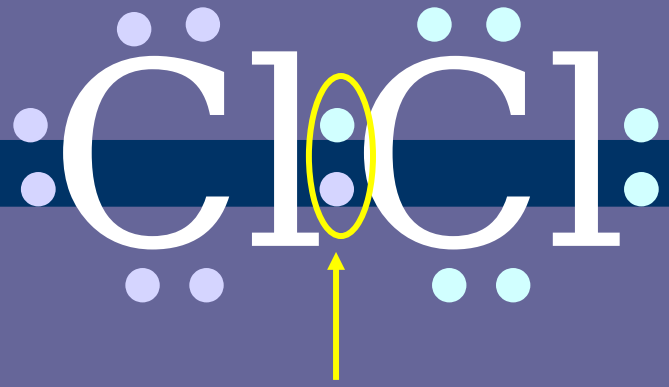


The octet is achieved by each atom sharing the electron pair in the middle

circle the electrons for each atom that complet their octets

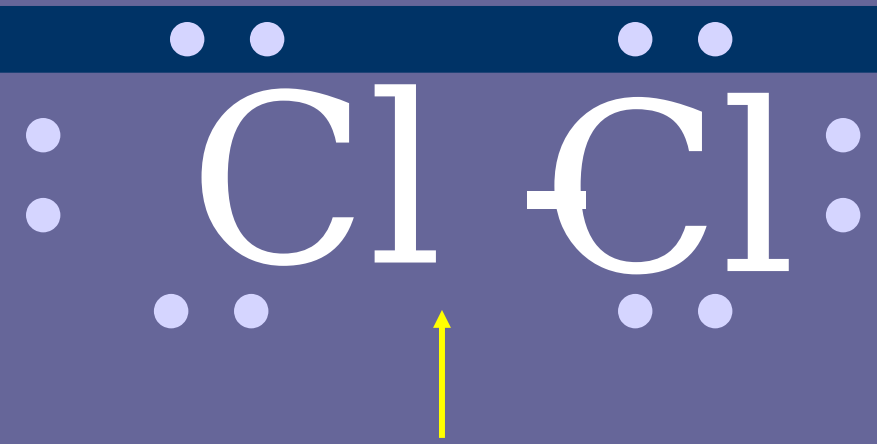


This is the bonding pair

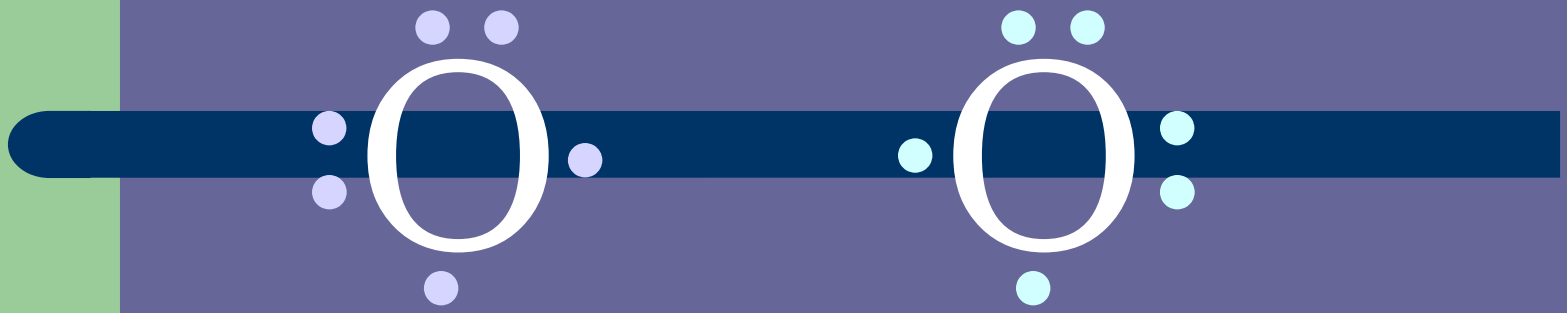


It is called a **SINGLE BOND**

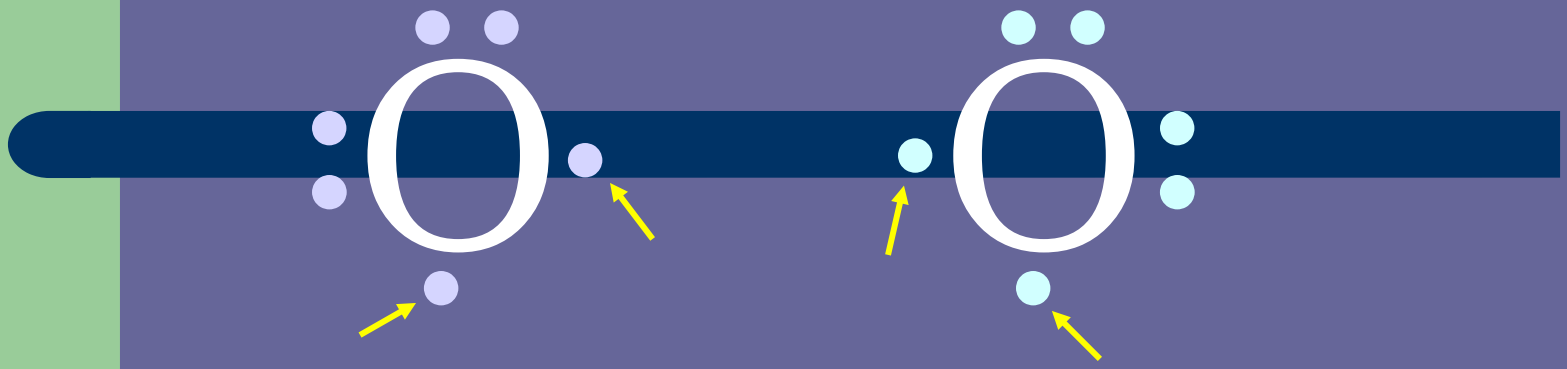
circle the electrons for each atom that complet their octets



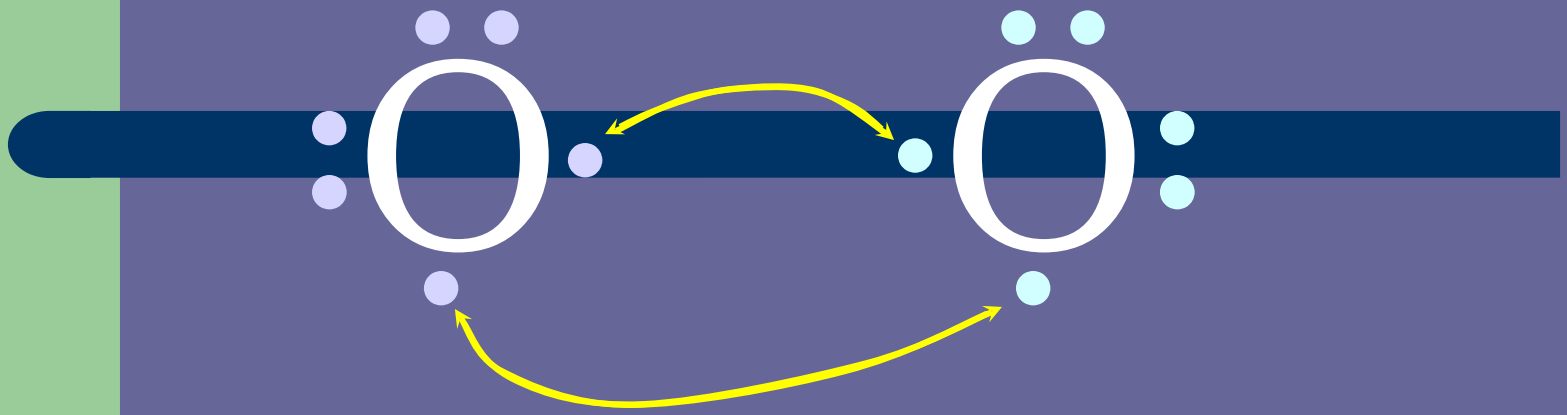
Single bonds are abbreviated with a dash



How will two oxygen atoms bond?

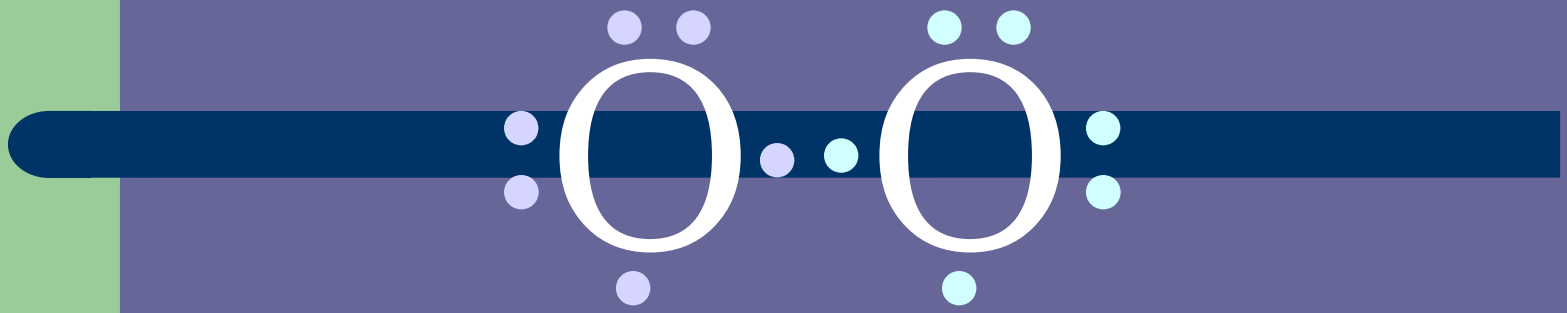


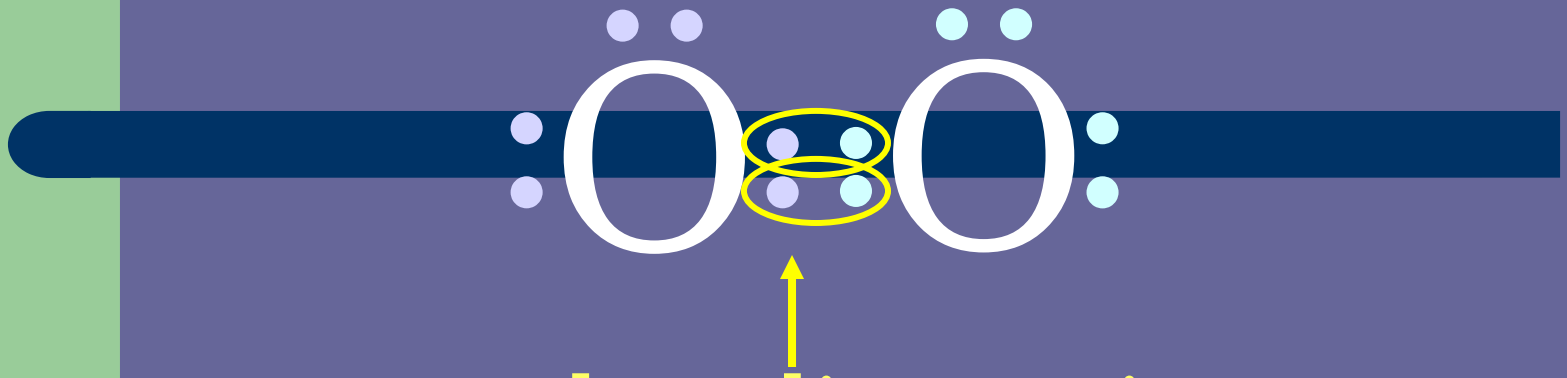
Each atom has two unpaired electrons



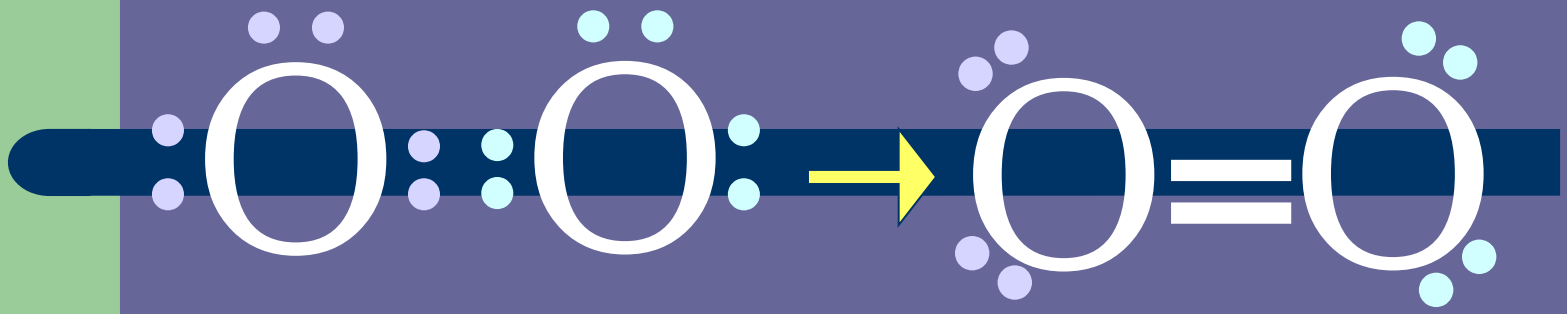
Oxygen atoms are highly electronegative.

So both atoms want to gain two electrons.





two bonding pairs,
making a ***double bond***



For convenience, the double bond can be shown as two dashes.

B. Vocabulary

CHEMICAL FORMULA

IONIC

COVALENT

Formula Unit

Molecular Formula

NaCl

Sodium

CO_2

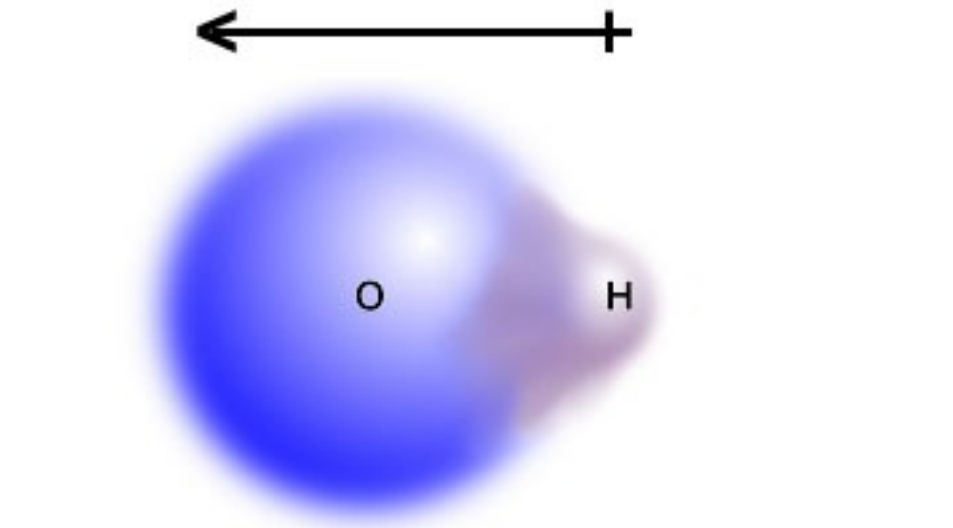
Carbon

Yes, there are 2 kinds of covalent bonds!

- **Polar covalent:** the electrons are shared, but one atom is pulling on the electrons a lot more. The electrons spend more time around that atom.

- **Nonpolar covalent:** the electrons are evenly shared between the two atoms.

O(3.5) – H (2.1) = 1.4
Polar covalent bond



The electrons are unevenly shared between the O and H atoms, forming a polar covalent bond.

- The closer the elements are on the periodic table, their electronegativities are more similar… more likely to form covalent bonds
- Farther away… greater difference in electronegativity… more likely to form ionic bonds.
  - **Metal + nonmetal = usually ionic**
  - **Nonmetal + nonmetal = usually covalent.**

Properties of Covalent Compounds

1) Covalent compounds generally have much lower melting and boiling points than ionic compounds.

2) Covalent compounds are soft and squishy (compared to ionic compounds, anyway)

Properties, Cont’d

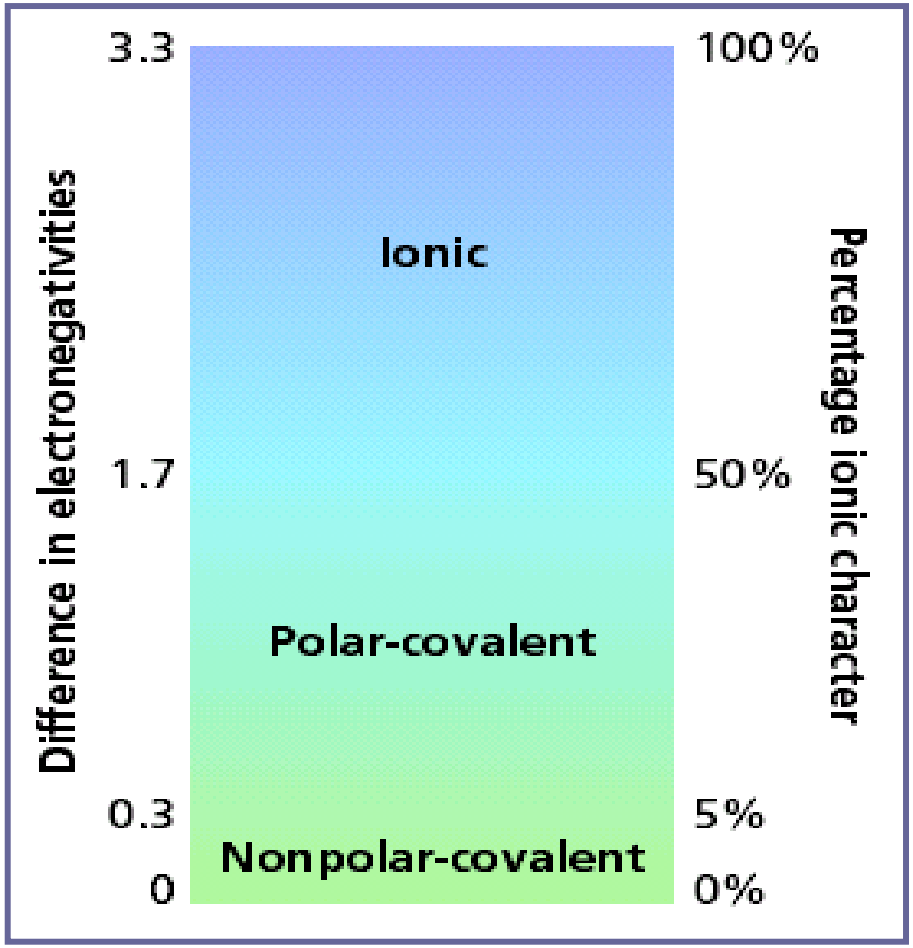
- **3) Covalent compounds tend to be more flammable than ionic compounds.**
  - There are exceptions to this rule!
- **4) Covalent compounds don't conduct electricity in water.**

A. Types of Bonds

	IONIC	COVALENT
Bond Formation	e^- are transferred from metal to nonmetal	e^- are shared between two nonmetals
Type of Structure	crystal lattice	true molecules
Physical State	solid	liquid or gas
Melting Point	high	low
Solubility in Water	yes	usually not
Electrical Conductivity	yes (solution or liquid)	no
Other Properties		

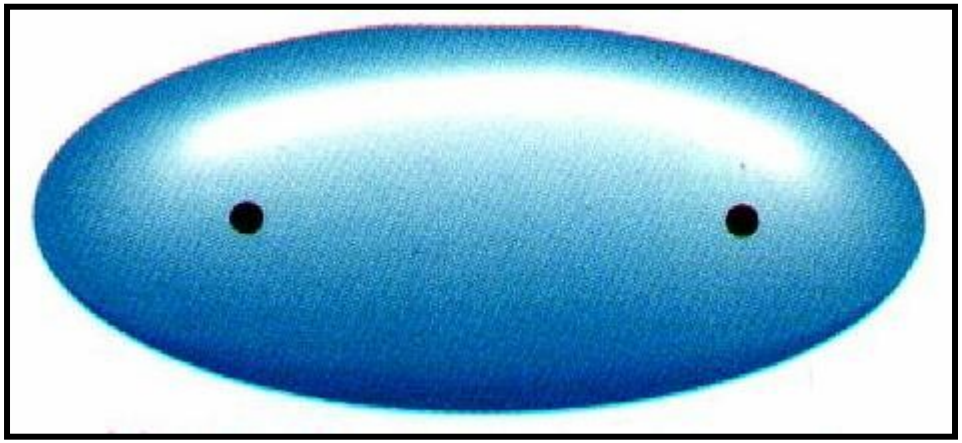
C. Bond Polarity

- Most bonds are a blend of ionic and covalent characteristics.



C. Bond Polarity

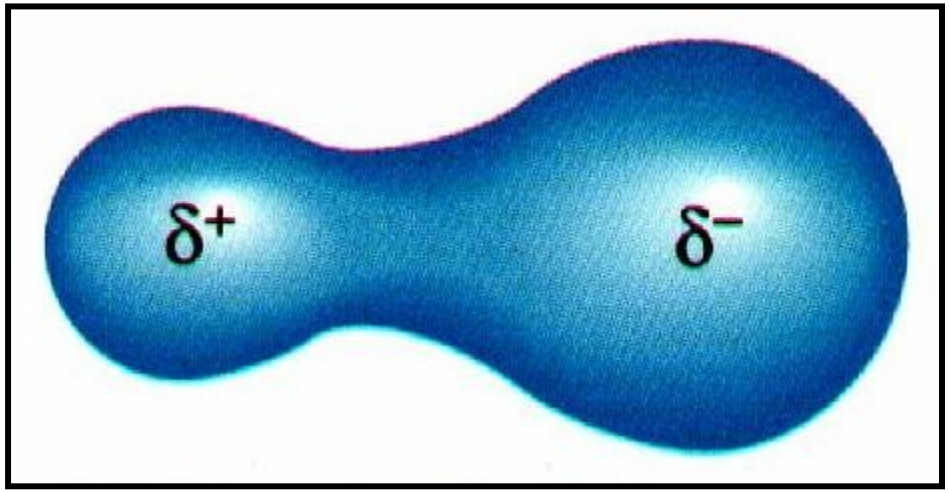
- **Nonpolar Covalent Bond**
  - e^- are shared equally
  - symmetrical e^- density
  - usually identical atoms



C. Bond Polarity

- **Polar Covalent Bond**
  - e^- are shared unequally
  - asymmetrical e^- density
  - results in partial charges (dipole)

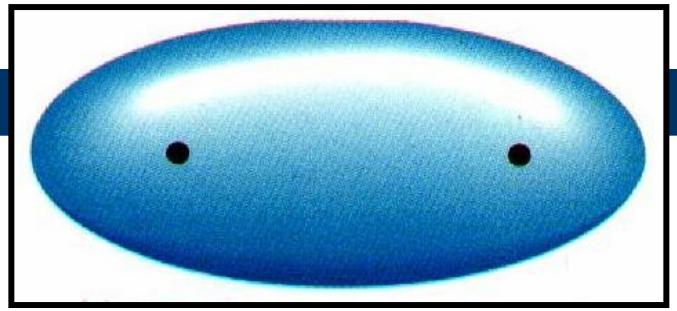
$\delta+$



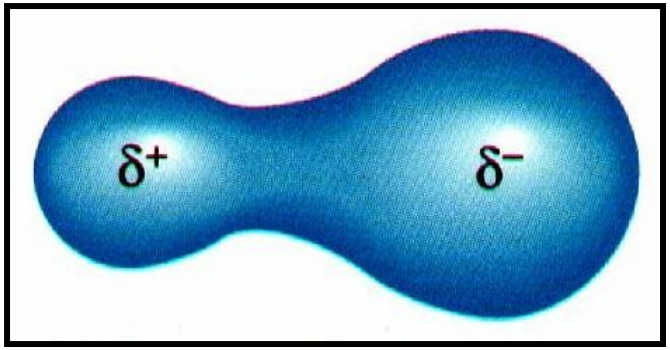
$\delta-$

C. Bond Polarity

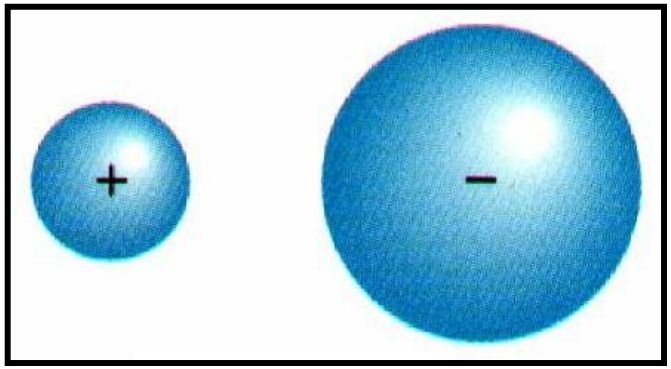
- Nonpolar



- Polar

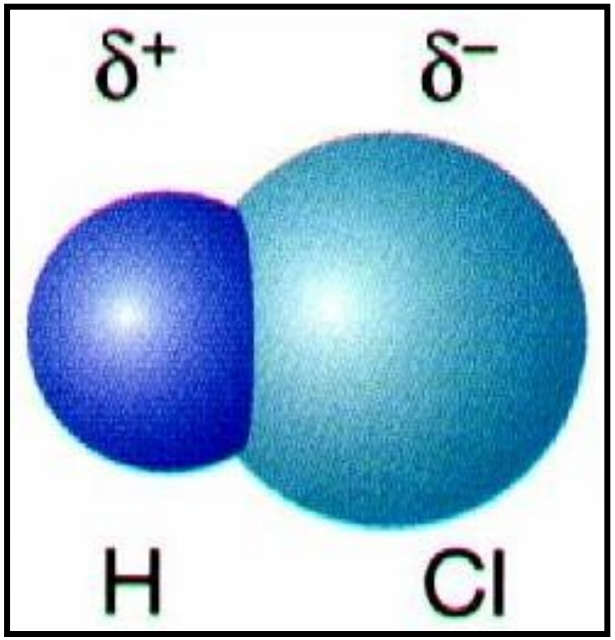


- Ionic



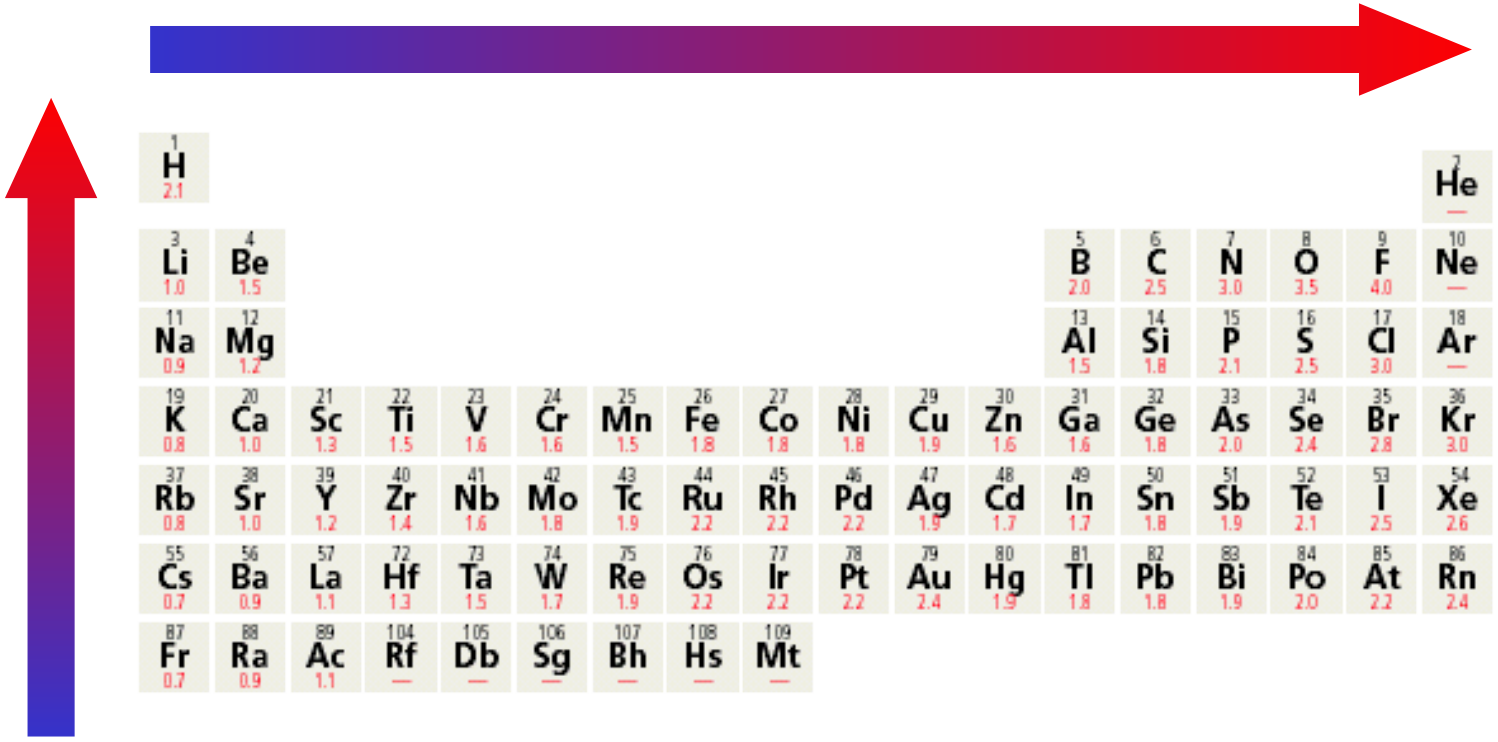
C. Bond Polarity

- **Electronegativity**
  - Attraction an atom has for a shared pair of electrons.
  - higher e$^-$neg atom $\Rightarrow \delta^-$
  - lower e$^-$neg atom$\Rightarrow \delta^+$



C. Bond Polari

- **Electronegativity Trend**
  - Increases up and to the right.



C. Bond Polarity

Electronegativity differences used to predict polarity of a bond.

- **ionic:** electronegativity difference ≥ 2
- **polar covalent:** electronegativity difference 0.5 - 2
- **nonpolar covalent:** electronegativity difference < 0.5

- **Which one of these bonds would be *least polar?*** **B-C** **C-N** **B-Si**

Boron: 2.04

Carbon: 2.55

Nitrogen: 3.04

Silicon: 1.90