15 • Chemical Bonding
Three Types of Bonding
(1 of 8)

There are **three** general **classes** of **bonds** that form between atoms. You can predict which will form by classifying the atoms as **metals** or **nonmetals**:

metal + metal	metallic bond	Au-Ag alloy
metal + nonmetal	ionic bond	$MgCl_2$
nonmetal + nonmetal	covalent bond	SO_2 or CH_4

Some compounds can contain **both ionic** and **covalent** bonds such as K_2SO_4... the sulfate ion is held together with covalent bonds... the potassium ions are ionically bonded to the sulfate ions.

Acids are **exceptions**... they are **ionic** only when **dissolved**.

15 • Chemical Bonding
The Ionic Bond
(2 of 8)

Many ions can be explained because they have gained or lost electrons and attain a **noble gas configuration.**

For example: P^{3-} S^{2-} Cl^{-} **Ar** K^{+} Ca^{2+}

all have the same electron arrangement: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

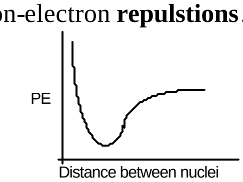
The importance of this configuration is that this is one reason why ions form. After these ions form, they stick together in a crystal lattice because **opposites attract**:

+ - + - + - + -
- + - + - + - +
+ - + - + - + -
- + - + - + - +

There are other reasons why some ions (ex: Cu^{+} or Zn^{2+}) form.

15 • Chemical Bonding
The Covalent Bond
(3 of 8)

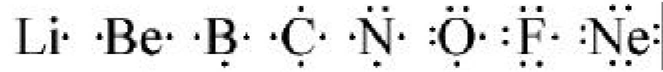
The covalent bond between two atoms depends on the **balance** of **attractions** between one atom's + nucleus and the other atom's – electrons and the proton-proton **repulsions** as well as electron-electron **repulstions**.



If two atoms have **half-filled orbitals**, the interactions balance at a **small enough distance** so the e^{-}'s can be **close to both nuclei** at the same time... this is a **covalent bond**.

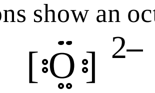
15 • Chemical Bonding
Lewis Electron Dot Structures
(4 of 8)

Lewis symbols consist of the atomic symbol surrounded by valence electrons. The four sides represent the four valence orbitals. Atoms are usually shown in their excited states. (Families II, III, & IV can also be in their "ground state.")



Ions include brackets and charges. Positive ions show no valence electrons while negative ions show an octet.

$[Li]^{+}$ $[Mg]^{2+}$



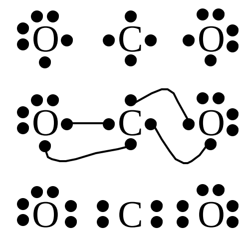
15 • Chemical Bonding
Drawing Electron Dot Structures
The (Chris) Bednarski Method
(5 of 8)

Example: CO_2

Draw the Lewis symbols for each atom.

Connect the unpaired electrons.

Clean up your drawing.



15 • Chemical Bonding
Comparing Ionic & Molecular Substances
(6 of 8)

Compound	Molecular	Ionic
Conducts as Solid	NO	NO
Conducts as Liquid	NO	YES
Conducts in Solution	NO	YES
Conducts as Gas	NO	YES
Hardness	soft	hard
MP / BP	low	high
Bonding	covalent	ionic
Examples	He, CH_4, CO_2, $C_6H_{12}O_6$	NaCl, KI, $AgNO_3$

15 • Chemical Bonding
Electronegativity and Polar Bonds
(7 of 8)

You will be given a chart of **electronegativity values.**
Memorize (F = 4.0) (O = 3.5) and (Cl = 3.0).
The noble gases have no values… no bonds.
Large electronegativity in the **upper right** of the per. table and **small** in the **lower left** portion of the table.
Classify the bond between any two atoms by subtracting their electronegativity values (Δe)

Non-polar covalent	$0 < \Delta e <$ **0.5**
Polar covalent	**0.5** Δe **1.7**
Ionic	$\Delta e >$ **1.7**

The **more electronegative** atom is more **negative**.
Polar covalent bonds have **partial** charges $\delta+$ and $\delta-$

15 • Chemical Bonding
Shapes and Polar Molecules
(8 of 8)

Use **VSEPR** theory to predict the shape of molecules. The **Steric Number** (the # of lone pairs + bonded atoms) relates the shape of the electron pairs around a central atom.
[1=linear, 2=linear, 3=trigonal planar, 4=tetrahedral]

If each shape is **symmetrical**, the bond dipoles will cancel resulting in a **nonpolar** molecule.

If a shape has **lone pairs** of electrons on the central atom, the shape is often **unsymmetrical**, the molecule is **polar**.

Polar molecules and **ions** dissolve well in **polar** solvents while **nonpolar** molecules dissolve in **nonpolar** solvents.

"Like Dissolves Like"