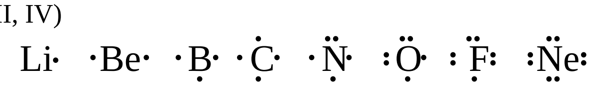
5 • Chemical Bonding: Gen Concepts
Some Properties of Ionic and Molecular Compounds
(1 of 12)

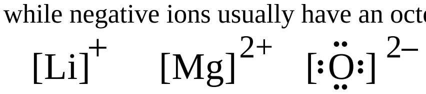
Compound	Molecular	Ionic
Conducts as Solid	NO	NO
Conducts as Liquid	NO	YES
Conducts in Solution	NO	YES
Conducts as Gas	NO	YES
Hardness	soft	hard
MP / BP	low	high
Bonding	covalent	ionic
Examples	He, CH_4, CO_2, $C_6H_{12}O_6$	NaCl, KI, $AgNO_3$

5 • Chemical Bonding: Gen Concepts
Lewis Symbols of Atoms and Ions
(2 of 12)

Lewis symbols conisist of the atomic symbol surrounded by valnece electrons. The four sides represent the four valence orbitals. Atoms are usually shown in their excited states (II, III, IV)



Ions include brackets. Positive ions show no valence electrons while negative ions usually have an octet.



5 • Chemical Bonding: Gen Concepts
The Ionic Bond
Noble and Pseudonoble Gas Configurations
(3 of 12)

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: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

A **pseudo**noble gas configuration is:

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

This is found in Cu^{+} Zn^{2+} Ga^{3+} and Ge^{4+}
Similar configurations are found in the next two periods.

The importance of this configuration is that there is more than one reason why ions form what they do. Many ions are not explained.

5 • Chemical Bonding: Gen Concepts
Factors that Influence the Formation of Ionic Bonds
(4 of 12)

Know the 5 steps that can be thought to occur when an ionic bond forms. Note whether each is exo- or endothermic... whether a larger energy helps or hinders the bond formation.

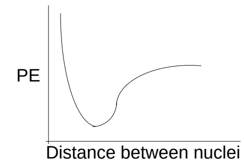
Overall: $Li(s) + 1/2F_2(g) \rightarrow LiF(s)$

1. heat of vaporization — $Li(s) + NRG \rightarrow Li(g)$
2. heat of decomposition — $1/2F_2(g) + NRG \rightarrow F(g)$
3. ionization energy — $Li(g) + NRG \rightarrow Li^{+}(g) + e^{-}$
4. electron affinity — $F(g) + e^{-} \rightarrow F^{-}(g)$
5. lattice energy — $Li^{+}(g) + F^{-}(g) \rightarrow LiF(s)$

Large energy values for 1,2,3 hinder ionic bond formation.

5 • Chemical Bonding: Gen Concepts
The Covalent Bond
Attractions and Repulsions
(5 of 12)

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**.

---

5 • Chemical Bonding: Gen Concepts
Groves' Electron Dot System
Multiple & Extended Valence Bonds
(6 of 12)

Count up your <u>valence</u> electrons.

Give every atom who "wants" and octet an octet.
[the first 5 elements do not need octets... too small]
[Family I, II, and III do not form octets]

If you have drawn **too many** electrons...
"Take away a lone pair... take away a lone pair...
make these two atoms share"

If you have drawn **too few** electrons... place the extra electrons on the central atom **(extended valence shell)**

---

5 • Chemical Bonding: Gen Concepts
Bond Order: Bond Length, Strength, &
Vibrational Frequency
(7 of 12)

Bond order is the number of <u>pairs</u> of electrons bonding two atoms together.

single bond	bond order = 1
double bond	bond order = 2
triple bond	bond order = 3

single bonds have the **longest** bond **length**
single bonds have the **weakest** bond **strength**
single bonds have the **lowest vibrational frequency**
(think of single bonds as soft, springy springs...
triple bonds are tight springs...sproinnnnng)

Bonds in resonance structure must be averaged... the S-O bond in SO_2 has a bond order of 1.5. C-O in CO_3^{2-} is 1.33

---

5 • Chemical Bonding: Gen Concepts
Resonance
(8 of 12)

When you draw a **Lewis** structure (SO_2, O_3, CO_3^{2-}, etc.) in which you must make a **choice** as to who gets a double bond, the structure is actually a **blend** of two or three structures.

We "say" that the structure "**resonates**" or we say that the structure contains contributions from each of the resonance structures.

Resonance occurs simply because the electron-dot model (while very useful) is **too limited** to show how the electrons are being shared between the atoms... wait for π bonding.

5 • Chemical Bonding: Gen Concepts Coordinate Covalent Bonds (Preview: Lewis Acids) (9 of 12)

Coordinate covalent bond: When a covalent bond is formed by sharing a pair of electrons BUT the electron pair belonged to only <u>one</u> of the atoms.

Classic Example: $NH_3 + BF_3 \rightarrow NH_3BF_3$
The bond between the N and the B is coordinate covalent.

The lone pair donor is called a Lewis Base.
(this atom has a **lone pair** of electrons)
The lone pair acceptor is called a Lewis Acid.
(this atom has an **empty orbital**)

"Have Pair Will Share" --Lewis Base

5 • Chemical Bonding: Gen Concepts Electronegativity and Polar Bonds (10 of 12)

You will be given a chart of **electronegativity values.** **Memorize** the most electronegative element s (F = 4.0) then oxygen (O = 3.5) and chlorine (Cl = 3.0). The noble gases have no electronegativity values… no bonds.
Trend is **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	Δe > **1.7**

The **more electronegative** atom is more **negative**.
Polar covalent bonds have **partial** charges δ+ and δ–

5 • Chemical Bonding: Gen Concepts Naming Ionic Compounds Traditional and Stock Names (11 of 12)

The Stock System of naming compounds is used…
• when a positive ion has **more than one** possible charge

Traditional:	mercurous, Hg_2^{2+}	mercuric, Hg^{2+}
Stock:	mercury(I)	mercury(II)
Traditional:	cuprous, Cu^+	cupric, Cu^{2+}
Stock:	copper(I)	copper(II)

• for molecular compounds where the elements have many **different oxidation states** (i.e. N in NO_2, NO, N_2O, etc.)

	Stock Name:	Traditional Name:
NO_2	nitrogen(IV) oxide	nitrogen dioxide
NO	nitrogen (II) oxide	nitrogen monoxide
N_2O	nitrogen(I) oxide	dinitrogen monoxide

5 • Chemical Bonding: Gen Concepts Naming Acids (12 of 12)

Acids are ionic formulas in which the <u>positive</u> ion is H^+.
Use as many H^+ ions as the charge on the negative ion.

Three rules for naming:

if the anion ends with:	the acid is named:
–ite	********ous acid
–ate	********ic acid
–ide	hydro********ic acid

• Acids from sulfide, sulfite, and sulfate include a "ur"
H_2S is hydrosulf<u>ur</u>ic acid, not hydrosulfic acid
• Acids from phosphate and phosphite include a "or"
H_3PO_4 is phoph<u>or</u>ic acid, not phosphic acid