Bonding

Forces of attraction that hold atoms together making compounds

Types of compounds

- All compounds are made of two or more elements held together by chemical bonds
- Ions of opposite charges are held together by ionic bonds
  - Usually: a **metal** with a **nonmetal**
- Ionic bonding is *non-directional*
  - There are no "ionic molecules"
  - Formulas of ionic compounds show the ratio of cation to anion
- Ionic compounds only exist in the solid state, in a 3-D crystal lattice

Covalent Bonding

Covalent bonding involves the **sharing** of ***electron*** ***pairs***

usually between **two nonmetals**

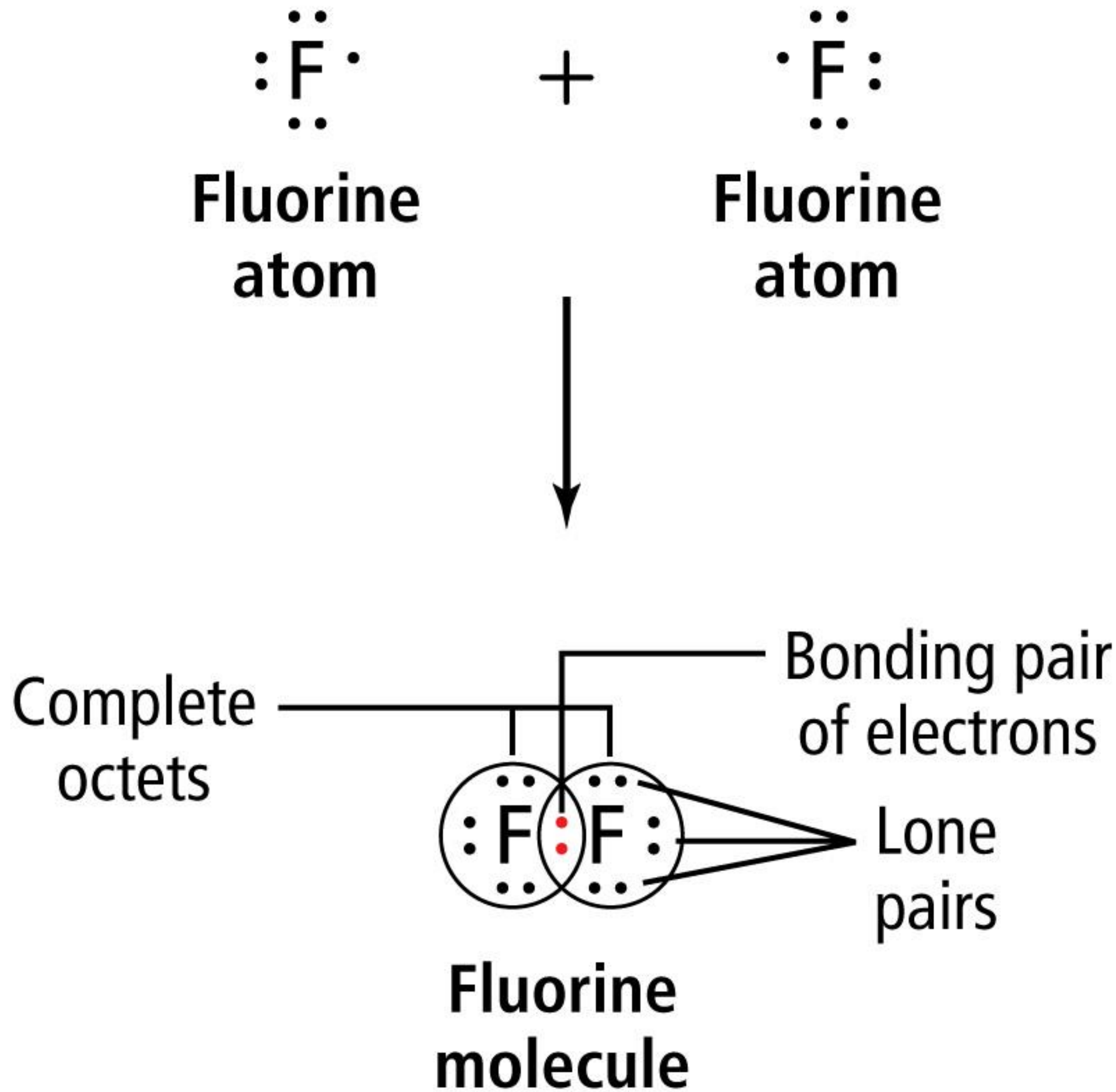
- high EA, high IE

- both tend to gain more e^-'s, neither is willing to lose the e^-'s they have

Covalent Bonding

- A “covalent” bond is formed when two atoms share one or more pairs of electrons
- Both atoms “see” the electrons, so the electrons count as valence electrons on both atoms
- Satisfies the octet rule

Covalent Bonding



Types of compounds

- Covalent compounds are made of two or more elements held together by covalent bonds
- Covalent bonding is directional
  - Between two individual atoms
- A group of covalently bonded atoms is referred to as a “molecule”
- Covalent compounds are also referred to as “molecular” compounds

- A nonmetal will form as many covalent bonds as necessary to fulfill the octet rule
- example: C, with 4 valence e^-'s, will form 4 covalent bonds
  - results in 8 valence e^-'s around the carbon atom at least part of the time
- double and triple covalent bonding is a possibility

Binary Molecular Nomenclature

- Two nonmetals
- no charges to balance
- multiple subscripts possible
  - –ex: N_2O, NO, NO_2, N_2O_4, N_2O_5

Use prefixes to represent subscripts

- mono = 1
- di = 2
- tri = 3
- tetra = 4
- penta = 5
- hexa = 6
- hepta = 7
- octa = 8
- nona = 9
- deca = 10

Rules, continued..

- Change second name to end in “ide”
- do *not* use prefixes on the *first* word if the prefix is “mono”
- always use prefixes on the second name

NEVER, EVER, EVER, EVER, EVER, EVER, EVER,

USE ***PREFIXES*** WITH A **<u>METAL</u>**!

Examples…

- CO_2
- carbon = first word
- subscript = 1, so no prefix
- oxide = second word
- subscript = 2, so prefix = di
- carbon dioxide

Examples…

- CO
- carbon = first word
- subscript = 1, so no prefix
- oxide = second word
- subscript = 1, so prefix = mono
- carbon monoxide

Try to name these…

- **N_2O**
  dinitrogen monoxide
- **NO**
  nitrogen monoxide
- **NO_2**
  nitrogen dioxide
- **N_2O_4**
  dinitrogen tetroxide
- **N_2O_5**
  dinitrogen pentoxide
- **H_2O**
  dihydrogen monoxide

DHMO.org

Writing formulas...

- Dinitrogen tetroxide
  - ✓ di = 2, so two nitrogen's
  - ✓ tetra = 4, so 4 oxygens
  - ✓ N_2O_4
- Note: do **NOT** reduce subscripts for *molecular* compounds

Rules for Drawing structural formulas

- 1) Determine the central atom, place the other atoms evenly spaced around the outside
- 2) Count the total number of valence electrons
- 3) Draw single bonds between the central atoms and each of the outside atoms

- 4) Complete the octet on the outside atoms by placing electrons in pairs around the outside atoms (*lone pairs*)
- 5) Place any remaining electrons on the central atom in pairs
- 6) If the central atom does not have its minimum number of electrons (usually 8), form double bonds by moving lone pairs off of the outside atoms and drawing them as bonding pairs

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When does the octet rule fail?

H, He and Li

- Helium strives for 2 valence electrons
  - $1s^2$ configuration
- Hydrogen will sometimes will share its one electron with another atom, forming a single covalent bond
- Lithium will lose its lone valence electron, gaining the $1s^2$ configuration of He

Be

- Be will sometimes lose its 2 valence electrons, gaining the *Is*^{2} configuration of He
- Be will sometimes form 2 covalent bonds, giving it 4 valence electrons
  - –nuclear charge of +4 cannot handle 8 valence electrons

B

- Boron will often make three covalent bonds using its three valence electrons
  - nuclear charge of +5 cannot handle 8 valence electrons in a stable manner

“organometallic” compounds

- Some metals will form covalent compounds with nonmetals
  - –Hg, Ga, Sn, and others
- The octet rule is not followed for the metals,but is for nonmetals
- Form 2 or more covalent bonds

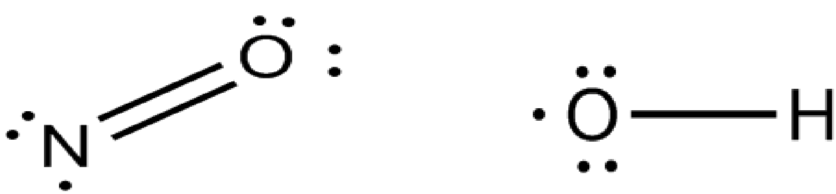
P, S, Cl, Se, Br, I

- Elements in the third period and lower have empty *d* orbitals
- there is room for more than 8 valence electrons
- These elements will *at times* make more than 4 covalent bonds as a central atom

Free Radicals

- These have an odd number of valence electrons
- Often highly reactive

  ex: NO, OH



- Place the unpaired electron on the central atom

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