Chapter 22: Chemical Bonding Notes

Section 1: Electrons and Chemical Bonding

Chemical bonding – joining of atoms to form new substances
Chemical bond – interaction that holds 2 atoms together

Valence electrons
- e^- in outermost shell
- Determines an atom's chemical properties
- Used to form bonds
- Within a group, or family, atoms have the same # of valence e^-
- Atoms with fewer than 8 valence e^- are more likely to form bonds than an atom with 8 e^-

Types of Bonds: Ionic, Covalent, Metallic

Atoms bond by sharing, gaining or losing e^- to have a filled outermost energy level.
- A full set = 2 e^- for a few of the elements
- A full set = 8 e^- for most elements
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Section 2: Ionic Bonds

- Bonds form by gaining or losing e^-, resulting in charged atoms called ions.
- Oppositely charged ions are attracted to one another
- Metal + Nonmetal
- Positive and negative charges cancel each other out to form an overall neutral compound

Metal Atoms
- Have few valence electrons
- Usually lose these valence e^- and form positive ions (cations)
- Some transition metal ions can have multiple charges. For example, iron can have a +2 or a +3 charge.
- The charge is written as a superscript of the symbol

Nonmetal Atoms
- Have almost full valence shells
- Tend to gain e^- from other atoms and form negative ions (anions)
- The charge is written as a superscript of the formula:

Polyatomic Ions
- Poly = "many"
- Polyatomic = "many atoms"
- A group of atoms that behave as a single ion with an overall positive or negative charge
- Treat the polyatomic ion as a <u>single unit with a single charge.</u>

<u>Writing formulas for ionic compounds:</u>
- The number of positive charges and negative charges must <u>balance</u> in an ionic compound
- The formula represents this balance
- Subscripts are used to indicate the ratio of elements in the compound (no "1")

1. Find oxidation number (charge) for both parts
   a. For elements in groups 1 and 2, use group #. Boron family is 3+, Carbon family ± 4, Nitrogen family is -3, Oxygen family is -2 and halogens are -1.
   b. For cations followed by a roman numeral, the roman numeral <u>is</u> the oxidation #

c. For polyatomic ions check the list. Do not change the subscripts within the polyatomic ion formula.

2. Write symbols. The positive ion first and negative ion second.
3. Put polyatomic ions in parentheses if more than one is needed.
4. Use subscripts to designate the number of each part for the total + and – charges to be =
   a. Find the least common multiple of both charges
   b. determine the factor needed to get that charge and use that as the subscript.

Writing names for ionic compounds:

1. Write the names of the + and - part of the formula
2. The + part is the name of the element or polyatomic ion
3. Check the list of elements to see if it needs a roman numeral. If so, use the negative part of the formula to figure out the positive charge on the metal.
4. To name the second/- part, if it is an element change the ending to "-ide"
5. If it is a polyatomic ion, keep the name as is

Section 3: Covalent and Metallic Bonds

- Covalent bonds are formed when atoms share one or more pairs of valence e^-.
- Form between 2 nonmetals.
- Covalent bonds result in the formation of molecules.

Octet Rule: Atoms combine in such a way so as to fill the valence shell (usually that means 8 e^- but could be just 2 e^-)

How many bonds?

- The number of e^- that an atom needs to fulfill its valence is equal to the number of covalent bonds it can form.
- Ex. N can make 3 covalent bonds because it has 5 e^- in its valence shell
- Ex. H can make 1 covalent bond because it has 1 e^- its valence shell.

Diatomic Molecules

- Certain elements exist as pairs in nature because that is how they are most stable.
- Di = 2
- Just remember Professor BrINClHOF (Bromine, Iodine, Nitrogen, Chlorine, Hydrogen, Oxygen and Fluorine)
- You need to memorize the 7 diatomic elements!!

Double Bonds: When atoms share 2 pairs of e^-, it is a double bond
Triple Bonds: When atoms share 3 pairs of e^-, it is a triple bond

Naming Covalent Compounds

- Many compounds have common names such as "methane", "ammonia" and "water"
- Simple covalent compounds can be named using prefixes to indicate how many atoms of each element are in the formula.
- The ending of the last (most negative) element is changed to -ide.

Prefixes:

Mono = 1
Di = 2
Tri = 3
Tetra = 4
Penta = 5
Hexa = 6

*If there is just 1 of the first element no prefix is used

Metallic Bonds: A bond formed by the attraction between positively charged metal ions and surrounding e^-

Think of a metal as being made up of positive ions with electrons “swimming” around keeping the ions together

Because e^- can move freely about, metals have particular propeties.

- Conduct electricity well
- Metals can be reshaped (ductile, malleable)
- Metals can bend without breaking