# Chapter 3 Notes

## 3-1: Types of Chemical Compounds and Their Formulas

- Covalent bonds- involve sharing of electrons between atoms
- Ionic bonds- involve a transfer of electrons from one atom to another
- **Molecular Compounds**
  - Molecular compound- compound comprised of discrete molecules
  - Molecule- group of bonded atoms held together by covalent bonds and existing as a separate entity; smallest entity having the characteristic proportions of the constituent atoms present in a substance
  - Chemical formulas- represent molecular compounds; indicate the elements present and the relative number of atoms of each element
  - Empirical formula- simplest formula for a compound; shows the types of atoms present and their relative numbers
  - Molecular formula- based on an actual molecule of a compound; shows the types of atoms present and their relative numbers
  - Ex: empirical formula- $CH_2O$; molecular formula- $C_2H_4O_2$
  - Structural formula- indicates which atoms in a molecule are bonded together, and whether by single, double, or triple bonds
    - Covalent bonds are represented by –
    - Double covalent bonds are represented by =
  - Condensed structural formula- simplified representation of a structural formula; written on a single line (ex: $CH_3COOH$)
  - $CH_3CH(CH_3)CH_3$ ($CH_3$ is attached to CH, the central carbon atom)
  - Organic compounds- made up partially of carbon and hydrogen, with oxygen and/or nitrogen as important constituents in many of them; each carbon atom forms four covalent bonds
  - Line angle formula- shorthand representation of organic molecules in which bond lines are drawn, but chemical symbols are written only for elements other than carbon and hydrogen
  - Models are used to represent 3-D structures
  - Ball and stick model- atoms are represented by small balls, and bonds between atoms by sticks
  - Space-filling model- shows that the atoms in a molecule occupy space and that they are in actual contact with each other; constructed to scale
- **Ionic Compounds**
  - Consists of positive and negative ions that are held together by electrostatic forces of attraction
  - Metallic elements lose one or more electrons when they combine with nonmetal atoms; nonmetal atoms tend to gain two or more electrons
  - Metal atoms become positive cations; nonmetal atoms become negative anions
  - Formula unit- smallest electrically neutral collection of ions; ratio of ions in the formula unit is the same as in the chemical formula
  - Monatomic- consists of a single ionized atom
  - Polyatomic- made up of 2 or more atoms

**3-2: The Mole Concept and Chemical Compounds**

- Formula mass- mass of a formula unit of a compound, relative to a mass of exactly 12 u for carbon-12
- Molecular mass- mass of a molecule relative to a mass of exactly 12 u for carbon-12
- Have same meaning; molecular mass used for molecules, formula mass used for ionic compounds
- Molar mass- mass of one mole of atoms, formula units, or molecules of a substance
- Allotropy- the existence of an element in more than one molecular form (ex: oxygen, $O_2$ and ozone, $O_3$)

**3-3: Composition of Chemical Compounds**

- To find percent composition from a chemical formula:
  - Determine the molar mass of the compound
  - Determine the contribution of the given element to the molar mass
  - Formulate the ratio of the mass of the given element to the mass of the compound as a whole
  - Multiply this ratio by 100%
- To find formulas from percent composition:
  - Convert masses of elements in a 100.00 g sample to amounts in moles
  - Write a tentative formula based on numbers of moles determined
  - Convert subscripts to whole numbers by dividing each by the smallest one
- Combustion analysis- used to find empirical formulas for compounds that are easily burned

**3-4: Oxidation States: A Useful Tool in Describing Chemical Compounds**

- Oxidation state (oxidation number)- relates to the number of electrons an atom loses, gains, or shares in combining with other atoms to form molecules polyatomic ions
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**3-5: Naming Compounds: Organic and Inorganic Compounds**

- Nomenclature- systematic method of assigning names
- Organic compounds- made up of carbon and hydrogen or carbon, hydrogen, and a small number of other elements, such as oxygen, nitrogen, and sulfur
- Inorganic compounds- any combination of elements that does not fit into the category of organic compounds

**3-6: Names and Formulas of Inorganic Compounds**

- Binary Compounds of Metals and Nonmetals
  - Binary compounds- formed between two elements
  - If it is made up of a metal and nonmetal, it usually made up of ions; called binary ionic compound

- To name, write the unmodified name of the metal and the name of the nonmetal ending in –ide
- Must be electronically neutral
- Some metals form several ions [ex: $Fe^{2+}$ and $Fe^{3+}$; iron(II) and iron(III) ]
- Older way of naming: lower oxidation state is –ous, higher one is –ic

- Binary Compounds of Two Nonmetals
  - If two compounds are both nonmetals, it is a molecular compound
  - –ide rule still applies
  - Element with positive oxidation is written first
  - Some pairs of nonmetals form more than one binary molecular compound; relative number of atoms is indicated through prefixes: mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca… etc.
- Binary Acids
  - Acid- substance that ionizes or breaks down in water to produce hydrogen ions and anions
  - Binary acid- two-element compound of hydrogen and a nonmetal
  - Use prefix hydro- followed by the name of the other nonmetal modified with an –ic ending
- Polyatomic ions
  - Two or more atoms are joined together by covalent bonds
  - Polyatomic anions are more common than cations
  - Very few end in –ide; most end in –ite or –ate and begin with hypo- or per-
  - Oxoanions- consist of a nonmetal and oxygen
  - Certain nonmetals (Cl, N, P, and S) form a series of oxoanions containing different numbers of oxygen atoms; named as hypo___ite, ___ite, ___ate, per___ate
  - Common oxoanions of Cl, Br, and I carry a charge of 1-
  - Some contain various numbers of H atoms (hydrogen, dihydrogen)
  - The prefix thio- signifies that a sulfur atom has been substituted for an oxygen atom
- Oxoacids
  - Ternary compounds- contain 3 different elements- hydrogen and two other nonmetals
  - Oxoacid- contain hydrogen, oxygen, and another nonmetal
  - Named using rules for oxoanions, except –ous is used instead of –ite, and –ic instead of –ate
  - Salts- hydrogen of oxoacid is replaced by a metal such as sodium
  - Acids are molecular compounds; salts are ionic compounds
- Some Compounds of Greater Complexity
  - Hydrate- each formula unit of the compound has associated with it a certain number of water molecules

**3-7: Names and Formulas of Organic Compounds**

- Hydrocarbons
  - Consist of only carbon and hydrogen
  - Alkanes- hydrocarbons containing only single bonds
  - Named with word stem (ex: meth-, eth-, prop-) and –ane (methane, propane)