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Ch 100: Fundamentals for Chemistry

Chapter 6: Nomenclature of Inorganic Compounds

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Types of Compounds

- When compounds are formed they are held together by the association of electrons
- This association is called a chemical bond
- There are 3 general types of chemical bonds:
  1. Ionic
  2. Covalent (or molecular)
  3. Polar covalent
- Simple compounds are classified (and thus named) according to the type of chemical bond(s) that hold together its atoms

Note: *many compounds have more than one type of chemical bond present, but we will focus on only "simple compounds"*

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Types of Compounds (cont.)

For "practical" purposes will separate all simple compounds into 2 general categories:

1. Ionic Compounds
   a. Made up of ions (both positive and negative charge)
   b. Must have no net charge (i.e. combined charge of zero)
   c. Depend on the attraction between positive and negative charges of the ions
   d. Usually a metal is present as a cation and a nonmetal is present as an anion
2. Non-Ionic *(aka: Molecular or Covalent)* Compounds
   a. Made up of atoms that share their outer electrons
   b. Electric charge plays no direct role in their formation
   c. There are usually no metals are present in these compounds

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Naming Compounds

The easiest way (usually) to identify an ionic compound is to ask whether or not there is a metal present in the chemical formula (or the name):

Is a metal present?

- **Yes** -> it is an Ionic Compound (e.g. $CaCl_2$)
- **No** -> it is a Non-Ionic Compound (e.g. CCl_4) *or an Acid*

Notes:

1. Ionic compounds do not use the Greek prefixes and are named according to the identity of the ions present
2. Non-Ionic compounds require the use of Greek prefixes to indicate the number of each element present in one molecule

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Naming Simple Compounds

A "simple" or binary compound is a compound made of only 2 types of elements

- When the first element is a metal:
  - The first element (metal) keeps its full name
  - The non-metal goes by its root with the suffix "-ide" added to the end

  Example: NaCl is sodium chloride
- When there are no metals present
  - Same as above except
  - Greek prefixes must be used to identify the number of each element present in the compound

  Example: CO_2 is carbon dioxide

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Determining Chemical Formula of an Ionic Compound

To determine the chemical formula of an ionic compound from its chemical name:

1. Identify the ions present, both cation(s) and anion(s), from the name.

Example: potassium sulfide

Cation: potassium

Anion: sulfide

2. Determine the ionic charge of the ions

Example: *{from above}*

potassium ion, K^+

sulfide ion, S^{2-}

3. Determine the number of each ion needed to obtain a neutral compound

Example: *{from above}* $\rightarrow$ 2 K^+ ions are needed for every S^{2-}

3. Combine the chemical sysmbols of the ions to get the final chemical formula

Example: *{from above}* $\rightarrow$ K_2S is the formula for potassium sulfide

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Ionic Charges & the Periodic Table

The position of an element in the Periodic Table is a useful indicator of the type of ion an element is capable of forming:

1. Group 1 metals form 1+ cations (Na^+ sodium ion)
2. Group 2 metals form 2+ cations (Ca^{2+} calcium ion)
3. Group 13 metals form 3+ cations (Al^{3+} aluminum ion)
4. *Group 3-12 Metals (plus Sn, Pb, & Bi) can form more than one type of cation*

   Roman numerals are used to indicate the charge of the cation

   Example:

   Fe^{3+} is called iron(III)

   $FeCl_3$ is called iron(III) chloride

   Notable Exceptions:

   Ag^+, Cd^{2+} & Zn^{2+}
5. Group 15 nonmetals form 3- anions (e.g. N^{3-} nitride ion)
6. Group 16 nonmetals form 2- anions (e.g. O^{2-} oxide ion)
7. Group 17 nonmetals form 1- anions (e.g. Cl^- chloride ion)
8. Group 18 elements do not form ions

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Greek Prefixes for Compound Names

1) Mono-
2) Di-
3) Tri-
4) Tetra-
5) Penta-
6) Hexa-
7) Hepta-
8) Octa-
9) Nona-
10) Deca-

CCl_4 is carbon tetrachloride

C_3H_8 is tricarbon octahydride

Notes:

1) Prefixes are used when the compound does not have a metal present (or when H is the first element in the formula)
2) Prefixes must be used for every element present in the compound
3) Mono- is not used for the first element in a compound name (e.g. carbon dioxide)

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Ionic Compounds containing Polyatomic ions

- Some ionic compounds are made up of polyatomic ions
- Polyatomic ions are usually ions formed from non-ionic molecules

  e.g. The sulfate ion, SO_4^{2-}, is essentially a molecular compound containing S and O with 2 additional electrons
- When you encounter polyatomic ions in compounds, *do not freak out!!*
- Become familiar with the common polyatomic ions on the handout

  Example: The nitrate ion (NO_3^-)
- Fortunately, the naming of ionic compounds containing polyatomic ions is similar to that for ionic compounds

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Acids

- From the Latin term for "sour" {Acids are sour to the taste}
- Acids are substances that donate or release hydrogen cations, H^+, (usually when dissolved in water)
- The chemical formula for acids usually begins with H

Example: hydrochloric acid (HCl)

$$\mathbf{HCl(aq) \rightarrow H^+ + Cl^- (aq)}$$

Bases

- Taste bitter *(Note: it is not advised to taste strong bases…)*
- Usually metal containing hydroxides
- Substances that accept hydrogen cations (H^+) when dissolved in water

Example: potassium hydroxide (KOH)

$$\mathbf{KOH(aq) + H^+ \rightarrow K^+(aq) + H_2O (l)}$$

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Naming Acids

Lets separate acids into 2 types:

1. Acids that contain oxygen
2. Acids that do not contain oxygen

Naming acids containing oxygen:

1. For acids containing "-ate" anions:
   a. Use root of the anion (for sulfate, SO_4^{2-}, use sulfur)
   b. Add "-ic" suffix then end with "acid"

   Example: H_2SO_4 is sulfuric acid

2. For acids with "-ite" anions:
   a. Use root of the anion (for sulfite, SO_3^{2-}, use sulfur)
   b. Add "-ous" suffix then end with "acid"

   Example: H_2SO_3 is sulfurous acid

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Naming Acids (cont.)

Naming acids not containing oxygen:

1. Add "hydro-" prefix to beginning
2. Use root of the anion (i.e. Cl^- use chlor)
3. Add "-ic" suffix then end with "acid"

Example: HCl is hydrochloric acid

Name the following acids:

HF
HNO_2
HCN
H_3PO_4

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Antoine Lavoisier (1743-1794)

- Considered by many to be the “Father of Modern Chemistry”
- Major contributions included
  1. Demonstrated that water cannot be transmuted to earth
  2. Established the Law of Conservation of Mass
  3. Developed a method of producing better gunpowder
  4. Observed that oxygen and hydrogen combined to produce water (dew)
  5. Invented a system of chemical nomenclature (still used in part today!)
  6. Wrote the 1st modern chemical textbook