Chapter 7

Formulas and Compounds

Ionic Charges

Main Group 1: Alkali metals

- Li, Na, K = 1+

Main Group 2: Alkaline earth metals

- Mg, Ca = 2+

Main Group 13: Other metals (drop the "1")

- Al(only metal) = 3+

Ionic Charges:

Main Group : non- metals

- Determined by subtracting 8 from the group number

Example Group 17 (7) elements

- F, Cl = (7 - 8 = -1)

Ionic Charges:

Example: Group 16 (6)

- O, S = (6 – 8 = -2)

Example: Group 15 (5)

- N = (5 – 8 = -3)

Ionic Charges:

- Group 0 (or group 18) and Group 14 usually do not form ions
- Group 18 (0): Noble gases
- Group 14 (4): (Carbon family)nonmetals that form molecular compounds

Ionic Charges:

Stock system:

- For naming cations with more than one possible charge (transition metals)
- Example: **Iron**
  - Has two possibilities (+2), (+3)
  - Written as Iron(II) ion (Fe^{2+}) and Iron(III) ion (Fe^{3+})
- Exceptions: Ag^{+}, Zn^{2+}

Ionic Charges:

Can also use the root word with a different suffix to designate between multiple charged cations:

- Example: Iron(II): *ferrous* (Fe^{2+})
- Iron(III): *ferric* (Fe^{3+})

Binary ionic compounds:

- Composed of a non- metallic element and a metallic element
- Ionic charges used to assign **formulas** or **names**

Writing Names from Formulas for Ionic Compounds

Rules for Binary Compounds

1. Write the name of the cation (usually a metal ion)
   - If the cation is a transition metal, use a Roman numeral for the charge
2. Write the name of the non-metal (anion) with an *–ide* ending

Binary compounds

1. NaCl
   - Sodium chloride
2. KCl
   - Potassium chloride
3. $CaBr_2$
   - Calcium bromide

Naming Binary Compounds

Example: CuO

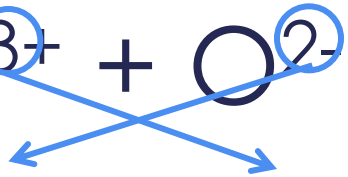
- Copper(II) oxide
  - Copper is a transition metal
  - Copper has two possibilities:
    - Copper (I) and Copper (II)

Writing Ionic Formulas from Names

Ionic Compounds:

Example: rust (Iron (III) oxide)

$Fe^{3+} + O^{2-}$



To write the formula use the crisscross method:

Fe_2O_3

Ionic Compounds:

Crisscross method:

- The numerical charge of each ion is crossed over and used as a subscript for the other ion
- The signs of the numbers are dropped

Ternary Ionic Compounds:

- Ionic compound that contains atoms of three different elements
- Usually contain a polyatomic ion
- Use the same procedure for writing formulas as binary compounds
- If there are more than one of a polyatomic ion in the formula, you must use parentheses:

$$Mg(OH)_2$$

Ternary Ionic Compounds:

To write the name from the formula:

1. Name the cation first
2. If the cation is a transition metal, use a Roman numeral to indicate the charge
3. Name the polyatomic anion (note: the suffix will be the same as the polyatomic ion!)

Naming Molecular Compounds

Binary molecular compounds:

- Composed of two non-metallic elements
- Ionic charges are not used to assign **formulas** or **names**

Binary molecular compounds:

- When two non- metallic elements combine, they can often combine in more than one way
- Example: Carbon and Oxygen

Binary molecular compounds:

Two molecular compounds composed of only carbon and oxygen:

- Carbon dioxide CO_2
- Carbon monoxide CO

Binary molecular compounds:

- Prefixes- tell how many atoms of each element are present in each molecule

Binary molecular compounds:

PREFIX	NUMBER
MONO	1
DI	2
TRI	3
TETRA	4
PENTA	5
HEXA	6
HEPTA	7
OCTA	8
NONA	9
DECA	10

Rules for writing names for molecular compounds:

1. Use a prefix to indicate the subscript of each element in the formula. If there is only one of the first element, do NOT use a prefix!
2. Write the name of each element using the appropriate prefixes.

Binary molecular compounds:

CO: Carbon **Mono**xide

- prefix: *mono* = one

CO_2: Carbon **Di**oxide:

- prefix: *di* = two

Note: no prefix for carbon since there is only one carbon in each of the formulas!

Rules for writing formulas for molecular compounds:

1. Use the prefix to tell you the subscript of each element in the formula.
2. Write the correct symbols for the two elements, with the appropriate subscripts

Example:

Tetraiodine nonoxide

- tetra = four, so I_4
- non or nona = nine, so O_9

- Formula: I_4O_9

Naming acids:

Naming Common Acids

Acids: molecular substances that release hydrogen ions when dissolved in water.

Acids are composed of a hydrogen ion combined with any anion (negative ion). They are named by modifying the name of the anion.

Naming Common Acids

Acids are neutral compounds.

- The cation is hydrogen
- They have as many hydrogens as needed to make the compound electrically neutral

Naming Acids

Anion ends with:	Change ending to:
-ate	-ic acid
-ite	-ous acid
-ide	Hydro- ____ -ic acid

Writing Formulas for Acids

Write formulas the same as for ionic compounds.

Anion	Formula	Name
Cl^- Chloride	HCl	Hydrochloric acid
ClO_3^- Chlorate	$HClO_3$	Chloric acid
ClO_2^- Chlorite	$HClO_2$	Chlorous acid

Six Common Acids:

- Hydrochloric acid: HCl
- Sulfuric acid: H_2SO_4
- Nitric acid: HNO_3
- Acetic acid: $HC_2H_3O_2$
- Phosphoric acid: H_3PO_4
- Carbonic acid: H_2CO_3

OXIDATION NUMBERS

Oxidation Numbers

Numbers assigned to the atoms in molecules, to show the general distribution of electrons among the bonded atoms

Oxidation Number RULES

1. All uncombined elements have an oxidation number of zero.
   Example: K, N_2, P_4, S_8
2. All the charges in a formula must add to zero.
   Example: NaCl, $MgCl_2$
3. All group IA metals are +1
   Example: LiCl, K_2S
4. All group IIA metals are +2
   Example: $SrCl_2$, CaO, Ba_3N_2
5. Fluorine (in compounds), always has a charge of –1.
   Example: HF, CaF_2

Oxidation Number RULES

6. Hydrogen shows a charge of +1, except in hydrides, it is –1.

   Example: HCl, HF, LiH, CaH_2

7. Oxygen shows a charge of –2, except in peroxides it is –1, and with halogens it is a +2.

   Example: H_2O, H_2O_2, OI_2

8. Elements found in a polyatomic ion must have charges that add up to the ion's charge.

   Example: CO_3^{2-}, PO_4^{3-}, MnO_4^-

Determine the oxidation number of each element in the following:

- KCl
- NaClO
- HF
- ZnO
- $WCrO_4$
- H_2SO_4
- OF_2
- H_2
- $Mg_3(PO_4)_2$
- $NaClO_4$