Ch. 4

NAMING COMPOUNDS
Nomenclature: Naming Compounds

• There are 2 main types of binary compound: *compounds composed of 2 or more elements.*
  1. **Ionic compound**: compounds that contain a metal and a non-metal.
  2. **Covalent molecule**: compounds that contain two non-metals.
TYPE I

BINARY IONIC COMPOUNDS

(Not transitional metals)
- Forms between 2 ions
- Cation (+) is always named first and the anion (-) second
- Cation takes its name from the name of the element
- End of name is “ide”
- The net charge on an ionic compounds is always zero.
• sodium chloride
  \[ \text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl} \]  
  \((+1) + (-1) = 0\)

Use crisscross method to determine # of atoms

• calcium chloride
  \[ \text{Ca}^{2+} + \text{Cl}^- \rightarrow \text{CaCl}_2 \]  
  \((+2) + 2(-1) = 0\)

• strontium nitride
  \[ \text{Sr}^{2+} + \text{N}^{3-} \rightarrow \text{Sr}_3\text{N}_2 \]  
  \(3(+2) + 2(-3) = 0\)
Practice

• Name the following Type I binary compounds:
  CsF
  AlCl$_3$
  MgI$_2$
  Rb$_2$O
  SrI$_2$
  K$_2$S
TYPE II
BINARY IONIC COMPOUNDS
(TRANSITION METALS)
• Many metals can form more than one type of cations, such as most of the transitions metals.
• The cation name still goes first, and the anion second. Ending is still “ide”
• Identify the charge of the anion to help determine the cation charge.
• Use roman numerals to indicate charge
  – If the roman numeral is I, charge is +1
  – If the roman numeral is II, charge is +2
  – If the roman numeral is III, charge is +3, etc.
- Write the cation name with the charge as Roman numerals in parenthesis.
- Ends in “ide”
- EXCEPTIONS...:
  Zn\(^{2+}\), Cd\(^{2+}\), Ag\(^{1+}\)
We will always use Roman Numerals
- Old Names (we will not use)
  - Ferric = Fe\(^{3+}\)   Ferrous = Fe\(^{2+}\)
  - Stannic = Sn\(^{4+}\)   Stannous = Sn\(^{2+}\)
# Common Type II Cations

<table>
<thead>
<tr>
<th>Ion</th>
<th>Systematic Name</th>
<th>Older Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe$^{3+}$</td>
<td>iron(III)</td>
<td>ferric</td>
</tr>
<tr>
<td>Fe$^{2+}$</td>
<td>iron(II)</td>
<td>ferrous</td>
</tr>
<tr>
<td>Cu$^{2+}$</td>
<td>copper(II)</td>
<td>cupric</td>
</tr>
<tr>
<td>Cu$^{+}$</td>
<td>copper(I)</td>
<td>cuprous</td>
</tr>
<tr>
<td>Co$^{3+}$</td>
<td>cobalt(III)</td>
<td>cobaltic</td>
</tr>
<tr>
<td>Co$^{2+}$</td>
<td>cobalt(II)</td>
<td>cobaltous</td>
</tr>
<tr>
<td>Sn$^{4+}$</td>
<td>tin(IV)</td>
<td>stannic</td>
</tr>
<tr>
<td>Sn$^{2+}$</td>
<td>tin(II)</td>
<td>stannous</td>
</tr>
<tr>
<td>Pb$^{4+}$</td>
<td>lead(IV)</td>
<td>plumbic</td>
</tr>
<tr>
<td>Pb$^{2+}$</td>
<td>lead(II)</td>
<td>plumbous</td>
</tr>
<tr>
<td>Hg$^{2+}$</td>
<td>mercury(II)</td>
<td>mercuric</td>
</tr>
<tr>
<td>Hg$_2$$^{2+}$</td>
<td>mercury(l)</td>
<td>mercurious</td>
</tr>
</tbody>
</table>

*Mercury(I) ions always occur bound together in pairs to form Hg$_2$$^{2+}$. 
Practice

Give the names for each of the following compounds:

- **CuCl**
  What is the charge on the Cl?
  -1;
  copper(I)chloride

- **HgO**
  What is the charge on the O?
  -2;
  mercury (II) oxide
Fe$_2$O$_3$  
Undo the crisscross.

Fe$_2$O$_3$  
Fe$^{3+}$ O$^{2-}$;  
Iron (III) oxide

MnO$_2$  
Undo the crisscross.

Mn$^{4+}$ O$^{2-}$  
Manganese (IV) oxide

Practice:

PbCl$_4$

FeO

CuCl$_2$
• Determine the molecular formula

• Lead (II) oxide

\[ \text{Pb}^{2+} + \text{O}^{2-} \rightarrow \text{PbO} \quad (do\ the\ charges\ add\ to\ 0?) \]
\[ +2 + (-2) = 0 \]

• Iron (III) sulfide

\[ \text{Fe}^{3+} + \text{S}^{2-} \rightarrow \text{Fe}_2\text{S}_3 \]
(crosscross)

• Copper (II) Nitride

\[ \text{Cu}^{2+} + \text{N}^{3-} \rightarrow \text{Cu}_3\text{N}_2 \]
(crosscross)
POLYATOMIC (IONIC)
• Forms with an ion made of many atoms: Act as a single ion; Mostly anions (exception $\text{NH}_4^+$)
• Need to use ( ) when there are multiples of a polyatomic ion
• Example: $\text{Ca(OH)}_2$
calcium hydroxide
### TABLE 4.4

**Names of Common Polyatomic Ions**

<table>
<thead>
<tr>
<th>Ion</th>
<th>Name</th>
<th>Ion</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{NH}_4^+ )</td>
<td>ammonium</td>
<td>( \text{CO}_3^{2-} )</td>
<td>carbonate</td>
</tr>
<tr>
<td>( \text{NO}_2^- )</td>
<td>nitrite</td>
<td>( \text{HCO}_3^- )</td>
<td>hydrogen carbonate</td>
</tr>
<tr>
<td>( \text{NO}_3^- )</td>
<td>nitrate</td>
<td>(bicarbonate is a widely used common name)</td>
<td></td>
</tr>
<tr>
<td>( \text{SO}_3^{2-} )</td>
<td>sulfite</td>
<td>( \text{ClO}^- )</td>
<td>hypochlorite</td>
</tr>
<tr>
<td>( \text{SO}_4^{2-} )</td>
<td>sulfate</td>
<td>( \text{ClO}_2^- )</td>
<td>chlorite</td>
</tr>
<tr>
<td>( \text{HSO}_4^- )</td>
<td>hydrogen sulfate</td>
<td>( \text{ClO}_3^- )</td>
<td>chlorate</td>
</tr>
<tr>
<td></td>
<td>(bisulfate is a widely used common name)</td>
<td>( \text{ClO}_4^- )</td>
<td>perchlorate</td>
</tr>
<tr>
<td>( \text{OH}^- )</td>
<td>hydroxide</td>
<td>( \text{C}_2\text{H}_3\text{O}_2^- )</td>
<td>acetate</td>
</tr>
<tr>
<td>( \text{CN}^- )</td>
<td>cyanide</td>
<td>( \text{MnO}_4^- )</td>
<td>permanganate</td>
</tr>
<tr>
<td>( \text{PO}_4^{3-} )</td>
<td>phosphate</td>
<td>( \text{Cr}_2\text{O}_7^{2-} )</td>
<td>dichromate</td>
</tr>
<tr>
<td>( \text{HPO}_4^{2-} )</td>
<td>hydrogen phosphate</td>
<td>( \text{CrO}_4^{2-} )</td>
<td>chromate</td>
</tr>
<tr>
<td>( \text{H}_2\text{PO}_4^- )</td>
<td>dihydrogen phosphate</td>
<td>( \text{O}_2^{2-} )</td>
<td>peroxide</td>
</tr>
</tbody>
</table>
• aluminum hydroxide

\[ \text{Al}^{3+} + \text{(OH)}^- \rightarrow \text{Al(OH)}^- \quad (\text{check the charge}) \]
\[ +3 + (-1) = -2 \quad (\text{what should we do}) \]
CRISSCROSS!!!!!! REMEMBER TO PUT ( ) AROUND THE POLYATOMIC

\[ \text{Al}^{3+} + \text{OH}^- \rightarrow \text{Al(OH)}_3 \]

• ammonium sulfate

\[ (\text{NH}_4)^+ + (\text{SO}_4)^{2-} \rightarrow \quad (\text{check the charge}) \]
\[ +1 + (-2) = -1 \quad (\text{what should we do}) \]

\[ (\text{NH}_4)^+ + (\text{SO}_4)^{2-} \rightarrow (\text{NH}_4)_2\text{SO}_4 \]
Practice

• Name the following compounds:
  
  $\text{Na}_2\text{CO}_3$
  
  $\text{Na}_3\text{PO}_4$
  
  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
TYPE III
BINARY COMPOUNDS
THAT ONLY CONTAIN
NONMETALS
(MOLECULAR)
Rules for naming

1. The first element in the formula is named first
2. The second element is named as though it were an anion. (ends in –ide)
3. Prefixes are used to denote the numbers of atoms present.
4. The prefix mono- is never used for naming the first element. For example, CO is carbon monoxide, never monocarbon monoxide.
• Forms between 2 or more nonmetals
• Ionic charges are NOT used
• Can be multiple combinations of the same atoms ex. CO & CO₂
<table>
<thead>
<tr>
<th>Number of atoms</th>
<th>Prefix</th>
<th>MEMORIZE THESE!!!!!!</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mono-</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>di-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>tri-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>tetra-</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>penta-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>hexa-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>hepta-</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>octa-</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>nona-</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>deca-</td>
<td></td>
</tr>
</tbody>
</table>
Examples:

$\text{CO} = \text{carbon monoxide}$

$\text{CO}_2 = \text{carbon dioxide}$

$\text{N}_2\text{O}_5 = \text{dinitrogen pentoxide}$

$\text{CCl}_4 = \text{carbon tetrachloride}$

$\text{H}_2\text{O} = \text{dihydrogen monoxide}$

**Memorize:** $\text{NH}_3 = \text{ammonia}$  
Remember ammonium?  
$\text{NH}_4^+$
Practice

• Name these Type III Binary Compounds:
  
  BF₃
  NO
  N₂O₃
  CCl₄
  IF₅
ACIDS
• A substance that produces a hydrogen ion in solution *HINT: look for H in the front of the formula*

• 3 types of names

#1- comes from binary compound ending in “-ide”

—change to *hydro_______ic acid*

HCl= hydrogen chloride rename as *hydrochloric acid*
H₃N= trihydrogen nitride rename as *hydronitric acid*
H₂S= dihydrogen sulfide rename as *hydrosulfic acid*
#2 - comes from polyatomic ion ending in “-ite”

– Change to “ous” acid

HNO₂ = hydrogen nitrite rename as nitrous acid

H₂SO₃ = dihydrogen sulfite rename sulfurous acid
#3 comes from polyatomic ion ending in “-ate”

- Change to -ic acid

\[ \text{HNO}_3 = \underline{\text{hydrogen nitrate}} \text{ rename as } \text{nitric acid} \]

\[ \text{H}_2\text{SO}_4 = \underline{\text{dihydrogen sulfate}} \text{ rename as } \text{sulfuric acid} \]
# Rule # 2 & 3 Examples

<table>
<thead>
<tr>
<th>Acid</th>
<th>Anion</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{H}_2\text{SO}_4$</td>
<td>$\text{SO}_4^{2-}$ (sulfate)</td>
<td>sulfuric acid</td>
</tr>
<tr>
<td>$\text{H}_3\text{PO}_4$</td>
<td>$\text{PO}_4^{3-}$ (phosphate)</td>
<td>phosphoric acid</td>
</tr>
<tr>
<td>$\text{HC}_2\text{H}_3\text{O}_2$</td>
<td>$\text{C}_2\text{H}_3\text{O}_2^{-}$ (acetate)</td>
<td>acetic acid</td>
</tr>
<tr>
<td>$\text{H}_2\text{SO}_3$</td>
<td>$\text{SO}_3^{2-}$ (sulfite)</td>
<td>sulfurous acid</td>
</tr>
<tr>
<td>$\text{HNO}_2$</td>
<td>$\text{NO}_2^{-}$ (nitrite)</td>
<td>nitrous acid</td>
</tr>
</tbody>
</table>
Practice

• Name the following acids
  HI
  HBr
  HCN
  H$_2$S
  HF
  HF
  HNO$_3$
Back of foldable

IONIC COMPOUNDS

• Form between a metal and a nonmetal
• Involves electrical charge between ions

opposites attract