Chapter 8 – Nomenclature

8.1 Names of Atoms

Simple neutral atoms with no charge are named as is: Na is sodium atom, Ne is neon atom
⇒ Know the names and symbols for elements #1-20

and Ba, Co, I, Cu, Fe, Pb, Hg, Ag, Au, Zn, Sn, Sr, Ni, Br, Cr, Mn, Cd

<table>
<thead>
<tr>
<th>Ba</th>
<th>barium</th>
<th>Cu</th>
<th>copper</th>
<th>Hg</th>
<th>mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co</td>
<td>cobalt</td>
<td>Fe</td>
<td>iron</td>
<td>Ag</td>
<td>silver</td>
</tr>
<tr>
<td>I</td>
<td>iodine</td>
<td>Pb</td>
<td>lead</td>
<td>Au</td>
<td>gold</td>
</tr>
<tr>
<td>Zn</td>
<td>zinc</td>
<td>Sn</td>
<td>tin</td>
<td>Ni</td>
<td>nickel</td>
</tr>
<tr>
<td>Br</td>
<td>bromine</td>
<td>Cr</td>
<td>chromium</td>
<td>Mn</td>
<td>manganese</td>
</tr>
<tr>
<td>Cd</td>
<td>cadmium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Definitions:

- **Ionic compound**: metal + nonmetal(s) (eg. NaCl, CaBr₂, KMnO₄, BaSO₄)
- **Covalent compound**: 2 or more nonmetals (eg. NH₃, CCl₄)
- **Monoatomic ion**: charged ion from a single atom (eg Na⁺, Cl⁻, O²⁻)
- **Polyatomic ion**: charged ion containing 2 or more atoms (eg. OH⁻, SO₄²⁻)

Charges

○ All elements **alone** have a charge of zero in their elemental state
○ Atoms get a charge and become ions when they have lost or gained electrons

**CATIONS** - positively charged ion resulting from a neutral metal atom losing one or more e⁻’s.

Fixed Charge – The charge is always the same value – based on electron configuration.

➢ Typically group “A” representative metals.
   ▪ Group IA metals always have a +1 charge when they become an ion.
     Example: Na⁺ is sodium ion, K⁺ is potassium ion
   ▪ Group IIA metals always have a +2 charge when they become an ion.
     Example: Mg²⁺ is magnesium ion, Sr²⁺ is strontium

➢ Group IIIA metals always have a +3 charge when they become an ion.
   Example: Al³⁺ is aluminum ion, Ga³⁺ is gallium ion

➢ Exceptions: The transition metals Ag⁺¹, Zn²⁺, and Cd²⁺ have fixed charges.

Variable Charge – The charge can be a different value.

➢ Typically group “B” transition metals.
   ▪ Use a Roman Numeral to indicate the charge of the cation if there is more than one possible charge.
Example: Fe can have two charges
Fe$^{2+}$ is iron (II) ion
Fe$^{3+}$ is iron (III) ion

- Exceptions: Group A metals Sn and Pb
  - Sn$^{2+}$ is tin (II) ion, Sn$^{4+}$ is tin (IV) ion
  - Pb$^{2+}$ is lead (II) ion, Pb$^{4+}$ is lead (IV) ion

ANIONS – negatively charged ion resulting from a neutral nonmetal atom gaining one or more e$^-$'s.

- **Monatomic anions**: Name changes for these anions by adding –ide ending.
  - **Always** a fixed charged - based on electron configuration
    - Group VA – gain 3 e$^-$’s to make 3- ions.
      - N$^{3-}$ nitride ion
      - P$^{3-}$ phosphide ion
    - Group VIA – gain 2 e$^-$’s to make 2- ions
      - O$^{2-}$ oxide ion
      - S$^{2-}$ sulfide ion
    - Group VIIA – gain 1 e$^-$ to make 1- ions
      - F$^-$ fluoride ion
      - Cl$^-$ chloride ion
      - Br$^-$ bromide ion
      - I$^-$ iodide ion

POLYATOMICS – two or more nonmetals covalently bonded with an overall charge.

Here is the complete list of Polyatomic Ions you are responsible for this semester:

**Most Common Polyatomic Ions**

<table>
<thead>
<tr>
<th>Ion</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH$_4^+$</td>
<td>ammonium</td>
</tr>
<tr>
<td>NO$_3^-$</td>
<td>nitrate</td>
</tr>
<tr>
<td>NO$_2^-$</td>
<td>nitrite</td>
</tr>
<tr>
<td>C$_2$H$_5$O$_2^-$</td>
<td>acetate</td>
</tr>
<tr>
<td>OH$^-$</td>
<td>hydroxide</td>
</tr>
<tr>
<td>CN$^-$</td>
<td>cyanide</td>
</tr>
<tr>
<td>MnO$_4^-$</td>
<td>permanganate</td>
</tr>
<tr>
<td>CO$_3^{2-}$</td>
<td>carbonate</td>
</tr>
<tr>
<td>HCO$_3^-$</td>
<td>hydrogen carbonate or bicarbonate</td>
</tr>
</tbody>
</table>

*These are given to you on your [CHM130 Periodic Table](#) for quizzes and exams.

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8.2 Ionic Formulas

**Compounds are Neutral**

They have no net charge so you must have enough cations and anions to equal zero.

- Na$^+$ and Cl$^-$ make NaCl since +1 and −1 = 0
- Na$^+$ and CN$^-$ make NaCN since +1 and −1 = 0
- Ba$^{2+}$ and Cl$^-$ make BaCl$_2$ since +2 and 2(−1) = 0

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Al\(^{3+}\) and O\(^{2-}\) make Al\(_2\)O\(_3\) since \(2(+3) + 3(-2) = 0\)
Cu(II) and Br make CuBr\(_2\) since \(+2 + 2(-1) = 0\)

Polyatomic ions are just the same, remember to keep them together as a group

\[\text{Express more than one polyatomic ion with subscripts and parentheses.}\]

Sr\(^{2+}\) and NO\(_3^-\) make Sr(NO\(_3\))\(_2\) since \(+2 + 2(-1) = 0\)
Fe\(^{3+}\) and CO\(_3^{2-}\) make Fe\(_2\)(CO\(_3\))\(_3\) since \(2(+3) + 3(-2) = 0\)

### 8.3 Ionic Names

- The name is always the cation (usually metal) first then the anion + -ide ending.
  
  **Fixed Charge Metal:** metal name + nonmetal name + “ide”
  
  **Variable Charge Metal:** metal name (charge of metal) + nonmetal name + “ide”

- Don’t change the name for polyatomic ions to end in ide.
- For variable charge metals use a Roman Numeral to indicate the metal’s charge.

How do you figure out the charge on a variable charge metal? Well you look at the anion’s charge.

Given the formula of a compound, predict the name:

- What is the name for NaCl? sodium chloride (no Roman # since know Na is +1)
- What is the name for K\(_2\)SO\(_4\)? potassium sulfate (keep the polyatomic name as is)
- What is the name for CuCl? copper (I) chloride since Cl is –1 so Cu must be +1
- What is the name for FePO\(_4\)? iron (III) phosphate since PO\(_4\) is –3 so Fe must be +3
- Name for Ca(NO\(_3\))\(_2\)? calcium nitrate
- Name for Na\(_2\)O? sodium oxide

*Note: Never capitalize the names of compounds!*

Given the name of a compound, predict the formula:

- You must know charges on ions formed by Group A main elements.
- Know how to use polyatomic ions given on your Periodic Table!

  - lithium sulfide Li\(_2\)S since Li is +1 and S is –2 you need two Li’s
  - calcium oxide CaO since Ca is +2 and O is –2 you just need one of each
  - iron (II) bromide FeBr\(_2\) since Fe is +2 and Br is –1 you need two Br’s
  - potassium acetate KC\(_2\)H\(_3\)O\(_2\) since K is +1 and acetate is –1, need one of each
  - gold (II) nitrite Au(NO\(_2\))\(_2\) since Au is +2 and NO\(_2\) is –1, need two nitrites
  - sodium iodide NaI since Na is +1 and I is –1, just need one of each

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8.4 Covalent Names

Molecular Compounds: compounds consisting of 2 nonmetals.
These are NOT ions, so no charges.
You are not trying to add up to zero charge with these.
Number of atoms of element indicated by Greek prefix before element name.

### Examples:
- CO₂ = carbon dioxide
- PCl₃ = phosphorus trichloride
- N₂S₅ = dinitrogen pentasulfide
- SF₆ = sulfur hexafluoride
- Cl₂O₇ = dichlorine heptaoxide

Prefixes are ONLY used with molecular compounds.
Roman numerals are ONLY used with variable charged metal ionic compounds.
Polyatomic ions never change their name.

### Table:

<table>
<thead>
<tr>
<th># of atoms</th>
<th>Greek prefix</th>
<th># of atoms</th>
<th>Greek prefix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mono</td>
<td>6</td>
<td>hexa</td>
</tr>
<tr>
<td>2</td>
<td>di</td>
<td>7</td>
<td>hepta</td>
</tr>
<tr>
<td>3</td>
<td>tri</td>
<td>8</td>
<td>octa</td>
</tr>
<tr>
<td>4</td>
<td>tetra</td>
<td>9</td>
<td>nona</td>
</tr>
<tr>
<td>5</td>
<td>penta</td>
<td>10</td>
<td>deca</td>
</tr>
</tbody>
</table>

N₂O₄
2 nitrogen atoms = di
4 oxygen atoms = tetra

Dinitrogen tetraoxide
or
dinitrogen tetroxide

### Practice Problems

**Example 1:** Circle all the examples below that are ionic compounds.

HCl  K₂O  MgCl₂  PF₅  CuBr₂  CaSO₄  CH₂O

**Example 2:** Circle all the examples below that are covalent compounds.

HCl  K₂O  MgCl₂  PF₅  CuBr₂  CaSO₄  CH₂O
Example 3: What ions are the following atoms most likely to make?

calium = __________

potassium = __________
sulfur = __________
aluminum = __________
nitrogen = __________
chlorine = __________
silver = __________
zinc = __________

Example 4: What is the name for: CuCl2, SrS, NiCrO4, Mg(NO3)2, Na3P, ZnCO3, KOH, Ca(CN)2

Example 5: What is the formula for sodium carbonate, copper(II) bromide, strontium fluoride, iron(III) nitride, silver sulfite, nickel(II) nitrate, cadmium phosphate, ammonium hydroxide, magnesium sulfate?

Example 6: What is the name for CF4, CO, PO5, N2F4? What is the formula for diphosphorus tetraiodide, tribromine octaoxide, tetraphosphorus decasulfide, carbonic acid?

Answers to Practice Problems

Example 1: Circle all the examples below that are ionic compounds. metal-nonmetal

HCl  K2O  MgCl2  PF5  CuBr2  CaSO4  CH2O

Example 2: Circle all the examples below that are molecular compounds. nonmetals

HCl  K2O  MgCl2  PF5  CuBr2  CaSO4  CH2O

Example 3:

calium = Ca2+
potassium = K+
sulfur = S2-
aluminum = Al3+
nitrogen = N3-
chlorine = Cl-
silver = Ag+-
zinc = Zn2+

Example 4:

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>CuCl2</td>
<td>copper(II) chloride</td>
</tr>
<tr>
<td>SrS</td>
<td>strontium sulfide</td>
</tr>
<tr>
<td>NiCrO4</td>
<td>nickel(II) chromate</td>
</tr>
<tr>
<td>Mg(NO3)2</td>
<td>magnesium nitrate</td>
</tr>
<tr>
<td>ZnCO3</td>
<td>zinc carbonate</td>
</tr>
<tr>
<td>Na3P</td>
<td>sodium phosphide</td>
</tr>
<tr>
<td>KOH</td>
<td>potassium hydroxide</td>
</tr>
<tr>
<td>Ca(CN)2</td>
<td>calcium cyanide</td>
</tr>
</tbody>
</table>

Example 5:

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium carbonate</td>
<td>Na2CO3</td>
</tr>
<tr>
<td>copper(II) bromide</td>
<td>CuBr2</td>
</tr>
<tr>
<td>strontium fluoride</td>
<td>SrF2</td>
</tr>
<tr>
<td>iron(III) nitride</td>
<td>FeN</td>
</tr>
<tr>
<td>silver sulfite</td>
<td>Ag2SO3</td>
</tr>
<tr>
<td>nickel(II) nitrate</td>
<td>Ni(NO3)2</td>
</tr>
<tr>
<td>cadmium phosphate</td>
<td>Cd3(PO4)2</td>
</tr>
<tr>
<td>ammonium hydroxide</td>
<td>NH4OH</td>
</tr>
<tr>
<td>magnesium sulfate</td>
<td>MgSO4</td>
</tr>
</tbody>
</table>

Example 6: carbon tetrafluoride, carbon monoxide, phosphorus pentaoxide, dinitrogen tetrafluoride, P2I4, Br3O8, P4S10, H2CO3