

NOMENCLATURE IONIC-COVALENT COMPOUNDS

Created by: Julio Cesar Torres Orozco

Background: Before there was an established naming (nomenclature) system for chemical compounds, chemists assigned compounds a specific name for reference. Table salt (NaCl), water (H₂O) and ammonia (NH₃) are some of the most common examples of this.

There are two types of chemical compounds that are important in general chemistry: *Ionic and Covalent compounds*. This handout will aim to explain the nomenclature system there exist for these type of compounds.

Ionic compounds: METAL + NON-METAL

RULES:

- Name of ionic compounds is composed of the name of the *positive ion* (from the metal) and the name of the negative ion.

Examples:

NaBr	Sodium bromide
MgCl ₂	Magnesium chloride
(NH ₄) ₂ SO ₄	Ammonium sulfate

- It is important that we learn how to name *monoatomic positive ions*. These are some examples:

Na ⁺	sodium	Zn ²⁺	zinc
Ca ²⁺	calcium	H ⁺	hydrogen
K ⁺	potassium	Sr ²⁺	strontium

- When there are positive ions that have more than one oxidation state (number), as in the case of *transition metals*, we would have to indicate the charge of the ion in Roman numeral in parentheses (**I,II,III,IV,V,VI,VI**) after the name of the specific element.

Examples:

Fe ²⁺	iron(II)	Fe ³⁺	iron (III)
Sn ²⁺	tin(II)	Sn ⁴⁺	tin(IV)
Cu ⁺	copper(I)	Cu ²⁺	copper(II)

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- Positive polyatomic ions have common names ending in suffix **-onium**

Examples:



Now that we have covered positive monoatomic and polyatomic ions, let us look at the naming of negative ions.

RULES:

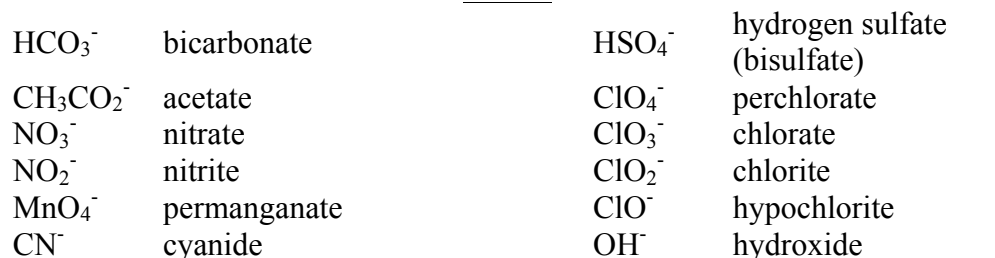
- Monoatomic negative ions are named simply by adding suffix **-ide** to the stem of the element name

Examples:

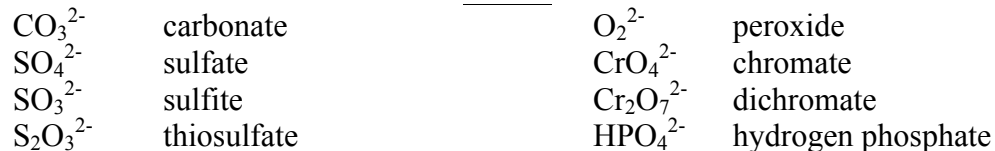


- This is the list of the most common polyatomic negative ions:

-1 ions



-2 ions



-3 ions



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- The name of polyatomic ions ends in either **-ite** or **-ate**. If **-ite** is seen, it means a low oxidation state (also a lower number of oxygen atoms present – example Nitrite as NO_2^- , in this case Nitrogen has an oxidation number of +3)
- If **-ate** is seen, it means a higher oxidation state (higher amount of oxygen atoms present – example Nitrate as NO_3^- In this case Nitrogen has an oxidation number of +5)
- Prefix **hypo-** indicates lowest oxidation state. BrO^- ion is called *hypobromite* ion.
- Prefix **per-** indicates highest oxidation state. IO_4^- ion is called *periodate* ion
- Some ions such as hydroxide (OH^-), cyanide (CN^-) and peroxide (O_2^{2-}) ions are exception to the aforementioned rule.

Covalent compounds: **NON-METAL + NON-METAL**

RULES:

- When naming covalent compounds, oxidation states play a key role. The name of the atom that has the positive oxidation state is named first. Then, the suffix **-ide** is added to the stem of the name of the atom with the negative oxidation state-number.

Examples:

HI	hydrogen iodide
NO	nitrogen oxide
BrF _l	bromine flouride

- In simple covalent compounds, the amount of atoms of an element is indicated by Greek prefixes added to the name of the element:

1 mono-	6 hexa-
2 di-	7 hepta-
3 tri-	8 octa-
4 tetra-	9 nona-
5 penta-	10 deca-

- The prefix **mono-** is usually not necessary because of its redundancy. An exception to this would be Carbon monoxide (CO)
- Do not use **mono-** for the first element in the name.

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- The **o** or **a** at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel. Example: N₂O₅. Dinitrogen Pentaoxide is not correct. The correct name is Dinitrogen pentoxide after dropping the **a** from **penta-**
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1. PRACTICE PROBLEM: Write the formula for the following ionic compounds:

sodium bicarbonate _____

magnesium chloride _____

sodium fluoride _____

silver nitrate _____

iron (III) chloride _____

aluminum sulfate _____

sodium carbonate _____

calcium hydroxide _____

copper (II) sulfate _____

calcium sulfate _____

magnesium hydroxide _____

mercury (II) nitrate _____

barium nitrate _____

lead (IV) nitrate _____

lithium sulfate _____

magnesium iodide _____

sodium nitride _____

ANSWER KEY:

sodium bicarbonate NaHCO₃

sodium fluoride NaF

iron (III) chloride FeCl₃

sodium carbonate Na₂CO₃

copper (II) sulfate CuSO₄

magnesium hydroxide Mg(OH)₂

barium nitrate Ba(NO₃)₂

lithium sulfate Li₂SO₄

magnesium chloride MgCl₂

silver nitrate AgNO₃

aluminum sulfate Al₂(SO₄)₃

calcium hydroxide Ca(OH)₂

calcium sulfate CaSO₄

mercury (II) nitrate Hg(NO₃)₂

lead (IV) nitrate Pb(NO₃)₄

magnesium iodide MgI₂

sodium nitride Na₃N

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2. PRACTICE PROBLEM: Write the names of the following ionic compounds

NaCl _____

Fe₂(CO₃)₃ _____

Cu(OH)₂ _____

(NH₄)₂SO₄ _____

LiNO₃ _____

BaSO₄ _____

Mg(NO₃)₂ _____

AgCl _____

Al(OH)₃ _____

CaSO₄ _____

FeS _____

FeCl₃ _____

NaI _____

MgCO₃ _____

ANSWER KEY:

NaCl sodium chloride

Fe₂(CO₃)₃ iron(III) carbonate

Cu(OH)₂ copper(II) hydroxide

(NH₄)₂SO₄ ammonium sulfate

LiNO₃ lithium nitrate

BaSO₄ barium sulfate

Mg(NO₃)₂ magnesium nitrate

AgCl silver chloride • (note: silver is one of the transition metals that only occurs as a (1+) ion) Al(OH)₃ aluminum hydroxide

CaSO₄ calcium sulfate

FeS Iron(II) sulfide

FeCl₃ iron(III) chloride

NaI sodium iodide

MgCO₃ magnesium carbonate

3. PRACTICE PROBLEM: Write the formula for the following covalent compounds:

a. disulfur tetrafluoride _____

b. carbon trioxide _____

c. nitrogen pentoxide _____

d. nitrogen tribromide _____

e. dinitrogen heptachloride _____

f. carbon tetrachloride _____

g. hydrogen monochloride _____

h. trihydrogen monophosphide _____

i. dihydrogen monoxide _____

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ANSWER KEY:

- | | |
|------------------------------------------------------------|-----------------------------------------------|
| a. disulfur tetrafluoride S ₂ F ₄ | f. carbon tetrachloride CCl ₄ |
| b. carbon trioxide CO ₃ | g. hydrogen monochloride HCl |
| c. nitrogen pentoxide NO ₅ | h. trihydrogen monophosphide H ₃ P |
| d. nitrogen tribromide NBr ₃ | i. dihydrogen monoxide H ₂ O |
| e. dinitrogen heptachloride N ₂ Cl ₇ | |

4. PRACTICE PROBLEM: Write the names of the following covalent compounds

- | | |
|-----------------------------------------|----------------------------------------|
| a. Br ₂ I ₄ _____ | d. NBr ₃ _____ |
| b. P ₅ F ₈ _____ | e. N ₂ O ₅ _____ |
| c. NO ₅ _____ | f. BrCl ₃ _____ |
- Remember: The o or a at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel
- | | |
|---------------------------|---------------------------|
| g. H ₂ S _____ | h. N ₂ O _____ |
|---------------------------|---------------------------|

ANSWER KEY:

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| a. Br ₂ I ₄ dibromine tetriodide | d. NBr ₃ nitrogen tribromide |
| b. P ₅ F ₈ pentaphosphorus octafluoride | e. N ₂ O ₅ dinitrogen pentoxide |
| c. NO ₅ nitrogen pentoxide o The o or a at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel § NOTE, we did not write pentaoygen because of this rule! | f. BrCl ₃ bromine trichloride |
| | g. H ₂ S dihydrogen monosulfide |
| | h. N ₂ O dinitrogen monoxide |

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Reference:

The following resources were referenced during the creation of this handout: [Purdue's Nomenclature](#) and ["Naming Compounds Tutoring and Worksheet"](#).