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 (H_2O) and ammonia (NH_3) 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
$(NH_4)_2SO_4$	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:

H_3O^+	Hydronium
NH_4^+	Ammonium

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:

F^-	fluoride	O^{2-}	oxide
Cl^-	chloride	S^{2-}	sulfide
Br^-	bromide	N^{3-}	nitride
I^-	iodide	P^{3-}	phosphide
H^-	hydride	C^{4-}	carbide

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

-1 ions

HCO_3^-	bicarbonate	HSO_4^-	hydrogen sulfate (bisulfate)
$CH_3CO_2^-$	acetate	ClO_4^-	perchlorate
NO_3^-	nitrate	ClO_3^-	chlorate
NO_2^-	nitrite	ClO_2^-	chlorite
MnO_4^-	permanganate	ClO^-	hypochlorite
CN^-	cyanide	OH^-	hydroxide

-2 ions

CO_3^{2-}	carbonate	O_2^{2-}	peroxide
SO_4^{2-}	sulfate	CrO_4^{2-}	chromate
SO_3^{2-}	sulfite	$Cr_2O_7^{2-}$	dichromate
$S_2O_3^{2-}$	thiosulfate	HPO_4^{2-}	hydrogen phosphate

-3 ions

PO_4^{3-}	phosphate	AsO_4^{3-}	arsenate
BO_3^{3-}	borate		

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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 *hypo*bromite ion.
- Prefix ***per-*** indicates highest oxidation state. IO_4^- ion is called *per*iodate 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
BrFl	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: N_2O_5. 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 _____

sodium fluoride _____

iron (III) chloride _____

sodium carbonate _____

copper (II) sulfate _____

magnesium hydroxide _____

barium nitrate _____

lithium sulfate _____

magnesium chloride _____

silver nitrate _____

aluminum sulfate _____

calcium hydroxide _____

calcium sulfate _____

mercury (II) nitrate _____

lead (IV) nitrate _____

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 S2F4

b. carbon trioxide CO3

c. nitrogen pentoxide NO5

d. nitrogen tribromide NBr3

e. dinitrogen heptachloride N2Cl7

f. carbon tetrachloride CCl4

g. hydrogen monochloride HCl

h. trihydrogen monophosphide H3P

i. dihydrogen monoxide H2O

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

a. Br2I4 _____

b. P5F8 _____

c. NO5 _____

• Remember: The o or a at the end of the Greek pre-fix is usually dropped when the element name begins with a vowel

d. NBr3 _____

e. N2O5 _____

f. BrCl3 _____

g. H2S _____

h. N2O _____

ANSWER KEY:

a. Br2I4 dibromine tetriodide

b. P5F8 pentaphosphorus octafluoride

c. NO5 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 pentaoxygen because of this rule!

d. NBr3 nitrogen tribromide

e. N2O5 dinitrogen pentoxide

f. BrCl3 bromine trichloride

g. H2S dihydrogen monosulfide

h. N2O 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".