Chemical Names and Formulas of Compounds

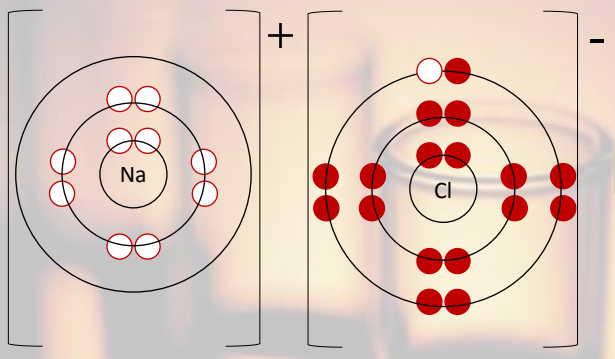
PowerPoint 4.2

Reminder of the Information in PowerPoint 4.1

Ionic compounds and molecules can be represented in drawings utilizing Bohr models or Lewis diagrams. These compounds can also be represented in the following ways,

- Chemical formulae
- Chemical names
- Chemical equations

Bohr diagram of the ionic compound sodium chloride

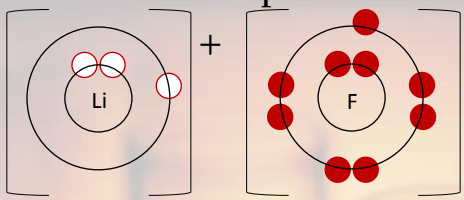


Chemical formula	NaCl
Chemical name,	sodium chloride
Chemical equation,	$Na^+ + Cl^- \rightarrow NaCl$

Things to Know about Ionic Compounds

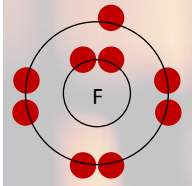
- Each ionic compound has a positive ion and a negative ion.

cation anion

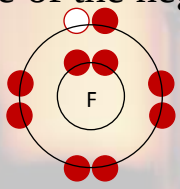


Metal Non-metal

- The name of the negative non-metal ion always ends in *–ide*.



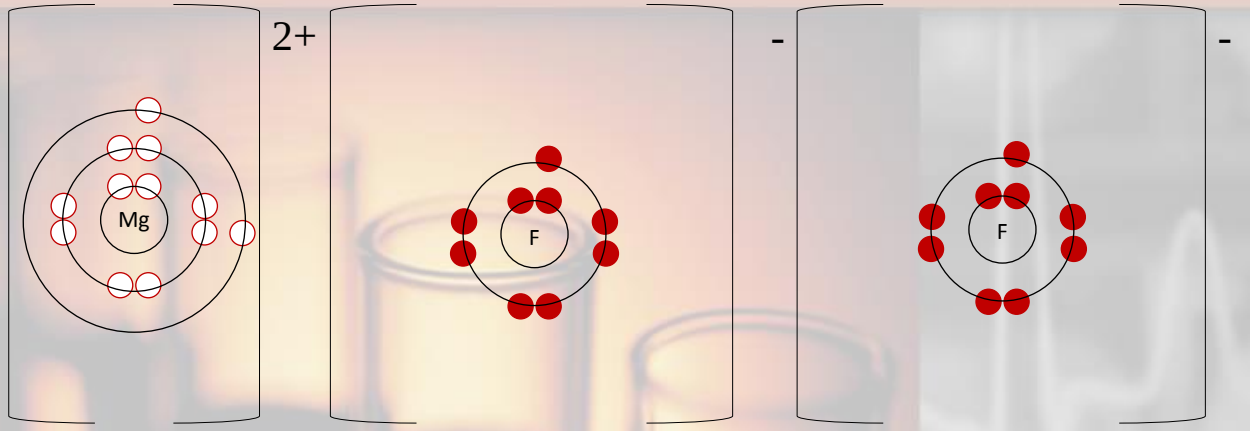
Fluor***ine***



Fluor***ide***

Chloride	Cl^-	Sulfide	S^{2-}	Metalloids can also act like non-metals
Bromide	Br^-	Selenide	Se^{2-}	
Iodide	I^-	Nitride	N^{3-}	-Arsenide As^{3-}
Oxide	O^{2-}	Phosphide	P^{3-}	-Telluride Te^{2-}

Utilizing the ionic compound MgF_2, review the steps for naming an ionic compound



How to Determine the ***Chemical Name of an Ionic Compound***

MgF_2

1. Name the metal ion, the cation. Magnesium

   Magnesium donates two electrons, one to each florine, leaving it with a charge of 2+.

2. Name the non-metal, the anion, adding the suffix *–ide*. Fluoride

   Each fluorine atom receives an electron from magnesium thereby forming the fluoride anion.

3. Write the name of the compounds, with the cation first.

   Magnesium fluoride

Try naming the compound Li_3N

1. Name the cation. Lithium
2. Name the anion adding the –ide suffix. Nitride
3. Write the name of the cation followed by the name of the anion.

   Lithium nitride

How to Determine the ***Chemical Formula for an Ionic Compound***

1. Identify each ion and their respective charges.
2. Determine the number of each ion needed to balance the positive and negative charges.
3. Note the ratio of positive and negative ions
4. Write the formula with the ratio in subscript numbers
   - A "1" is not written in the formula.
   - Usually, the ratio is simplified if possible.

Magnesium and fluoride

Mg^{2+} and F^-

Mg^{2+}	+2 = +2	1 Mg^{2+}
F^-	-1-1 = -2	2 F^-

There are 2 F^- for each 1 Mg^{2+}.

MgF_2

Chemical equation, $Mg^{2+} + 2F^- \rightarrow MgF_2$

Try writing the chemical formula for the ionic compound formed between lithium and nitrogen

1. Identify each ion and their respective charges.
2. Determine the number of each ion needed to balance the positive and negative charges.
3. Note the ratio of positive and negative ions
4. Write the formula with the ratio in subscript numbers
   - A "1" is not written in the formula.
   - Usually, the ratio is simplified if possible.

Lithium and nitrogen

Li^+ and N^{3-}

Li^+	+1 +1 +1 = +3	3 Li^+
N^{3-}	-3 = -3	1 N^{3-}

There are 3 Li^+ for each 1 N^{3-}.

Li_3N

Chemical equation, $3Li^+ + N^{3-} \rightarrow Li_3N$

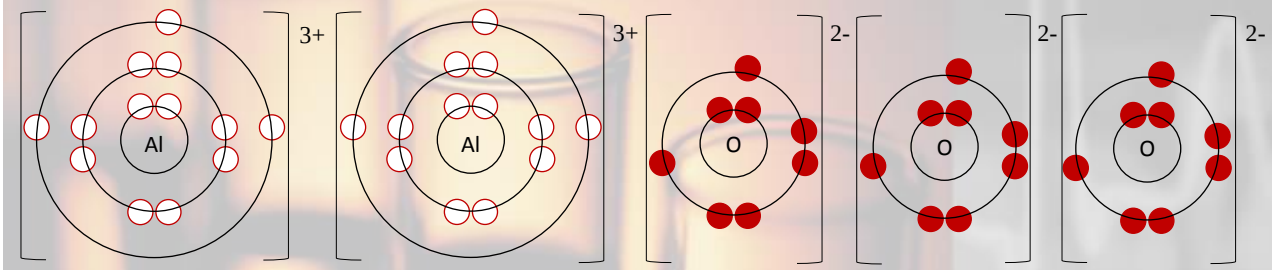
A Shortcut, the Cross-Over Rule

The Cross-Over Rule is a trick utilized to arrive at the chemical formula of an ionic compound after identifying the ions present.

Aluminum and oxygen

Al^{3+} O^{2-}

Al_2O_3



Multivalent Elements

9 **F** Fluorine 19.0 — (-) → Ionic charge

29 **Cu** Copper 63.5 — (2+, 1+) → Elements with more that one possible ionic charge are called ***multivalent*** elements.

- Only the most common ionic charges are written on your periodic tables
- The most common charge written on top.

Ions of the same element with different charges can have very different properties. →

V^{2+} V^{3+} V^{4+} V^{5+}

How to Determine the ***Chemical Formula for Ionic Compounds with Multivalent Metals***

Chromium (III) nitride

1. Identify each ion and their respective charges.

Cr^{3+} and N^{3-}

2. Determine the number of each ion needed to balance the positive and negative charges.

Cr^{3+} $+3 = +3$ $1\ Cr^{3+}$

N^{3-} $-3 = -3$ $1\ N^{3-}$

3. Note the ratio of positive and negative ions

There is 1 Cr^{3+} for each 1 N^{3-}.

4. Write the formula with the ratio in subscript numbers

Cr_3N_3

CrN $\quad \frac{3}{3} = \frac{1}{1}$

- A "1" is not written in the formula.
- The ratio is typically simplified if possible.

"Chromium three nitride"

Cross-Over rule $Cr^{3+}N^{3-} \rightarrow CrN$

Chemical equation, $Cr^{3+} + N^{3-} \rightarrow CrN$

How to Determine ***Chemical Name for Ionic Compounds with Multivalent Metals***

Cu_3P

1. Identify the metal and its possible ions.

Cu, copper $\quad Cu^{+}$ ou Cu^{2+}

2. Note the charge on the anion from the Periodic Table and determine the charge on the metal taking into account the number of each ion.

- The positive and negative charges must balance.
- Determine the positive charge needed to balance

P^{3-} $\quad 1(-3) = -3$

Cu^{x} $\quad 3(x) = +3$

$x = +1$

The copper ion in this compound is copper (I).

4. Write the name of the compound with the cation first.

Copper (I) phosphide

Utilizing the Cross-Over Rule in Reverse in order to Determine the Charge on the Multivalent Metal

Cu_2O

$Cu_2^{+}O_1^{-}$

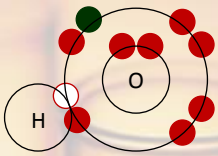
$\underline{2}\ Cu^{1+} + \underline{1}\ O^{2-} \leftrightarrow Cu_2O$

In this case, copper (I) is present.
The name is, therefore, Copper (I) oxide.

Polyatomic Ions

Polyatomic ions are covalent compouds, molecules, that carry a charge.

Hydroxyde, OH^-, is a polyatomic ion.



There are 9p and 10e in this compound, therefore the overall charge is -1.

Basically, for writing formulas and names,

TREAT POLYATOMIC IONS LIKE ANY OTHER ION.

Common Polyatomic Ions

Table 4.11 Names, Formulas, and Charges of Some Polyatomic Ions

Positive Ions	Negative Ions		
NH_4^+ ammonium	CH_3COO^- acetate	HCO_3^- hydrogen carbonate, bicarbonate	NO_2^- nitrite
	CO_3^{2-} carbonate	HSO_4^- hydrogen sulfate, bisulfate	ClO_4^- perchlorate
	ClO_3^- chlorate	HS^- hydrogen sulfide, bisulfide	MnO_4^- permanganate
	ClO_2^- chlorite	HSO_3^- hydrogen sulfite, bisulfite	PO_4^{3-} phosphate
	CrO_4^{2-} chromate	OH^- hydroxide	PO_3^{3-} phosphite
	CN^- cyanide	ClO^- hypochlorite	SO_4^{2-} sulfate
	$Cr_2O_7^{2-}$ dichromate	NO_3^- nitrate	SO_3^{2-} sulfite

How to Determine the ***Chemical Name for Ionic Compounds with Polyatomic Ions***

$Al_2(SO_4)_3$

1. Identify each ion and their respective charges. Al^{3+} and SO_4^{2-}

- Tip - If you don't find the element on the Periodic Table check the list of polyatomic ions.

2. Write the name of the compound with the cation first. Aluminum sulfate

How to Determine the ***Chemical Formula for Ionic Compounds with Polyatomic Ions***

Ammonium phosphate

1. Identify each ion and their respective charges.
   - Tip - If you don't find the element on the Periodic Table check the list of polyatomic ions.

NH_4^+ and PO_4^{3-}

2. Determine the ratio of ions needed to balance the positive and negative charges.
   - The positive and negative charges must balance.

PO_4^{3-} 1(-3) = -3
NH_4^+ x(1) = +3
x = 3
There are 3 NH_4^+ for each 1 PO_4^{3-}.

3. Write the name of the compound with the cation first.
   - Place brackets around polyatomic ions if more than one is needed.

$(NH_4)_3PO_4$

In Order to Determine Chemical Formulas and Chemical Names with Polyatomic Ions, Follow the Same Steps.

Remember, ***TREAT THESE LIKE ANY OTHER ION***.

$Al_2(Cr_2O_7)_3$

$Al_2^{+}(Cr_2O_7)_3^{-}$

$2\ Al^{3+} + 3\ Cr_2O_7^{2-} \leftrightarrow Al_2(Cr_2O_7)_3$

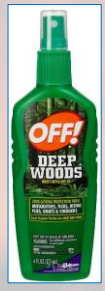
Notice that the polyatomic ion's, Cr_2O_7, formula is the same before and after the reaction.

The chemical name for $Al_2(Cr_2O_7)_3$ is Aluminum dichromate

Names of Covalent Compounds

Binary compound → Covalent compound with two non-metals joins by on or more covalent bonds

DEET, $C_{12}H_{17}NO$



N,*N*-diethyl-*m*-toluamide

Water, H_2O

Dihydrogen monoxide

Tylenol, $C_8H_9NO_2$

N-(4-hydroxyphenyl)acetamide

Alcohol, C_2H_5OH

Ethanol

Naming Binary Covalent Compounds

N_2O_3

1. Name the first (leftmost) element in the formula	Nitrogen
2. Name the second element in the formula adding the suffix –ide.	Oxy*gen* → oxide
3. Add prefixes to each element's name indicating the number of atoms or each element in the compound	2 nitrogen → ***di***nitrogen 3 oxides → ***tri***oxide
4. Write the name in the same order as the elements are written in the compound's formula	dinitrogen trioxide

Summary

Ionic Compounds

Chemical name

Roman numeral indicating the charge on multivalent metal only.

Chromium (III) nitride

Cation written first

Anion written second with the suffix -ide

Chemical formula

Cation written first

Cr_2N_3

Subscript numbers indicate the ratio between ions

Covalent Compounds

Chemical name

Prefixes indicate the number of atoms of each element

Carbon disulfide

Second with the suffix *-ide*

No prefix if there is only one of the first element

Chemical formula

Ratios of atoms are not simplified in covalent compounds as they are in ionic compounds

CS_2

Subscript numbers indicate the ratio between ions