Naming compounds and writing formulas

Go over periodic chart.

Symbols

- **Symbols are a shorthand way of writing elements.**
- **Some of the symbols originate from the Greek or Latin name**
- **Chemical formulas are combinations of symbols to represent a compound**

Subscripts

- **Subscripts are the small number after the symbol that indicates the number of that type of atom in a compound.**
- **Example: H_2O means that there is 2 hydrogen to 1 oxygen**
- **Oxidation numbers - are numbers assigned to different elements to determine the ratio in which the combine (the combining ability of the atom)**

Ions

- **Ion is an atom that has gained or lost electrons thus having an electric charge**
- **Polyatomic ion is an ion that is made of two or more atoms together that act as one ion.**
- **Ionic compound is the result of two ions combining**

Molecules

- **Molecules are when two or more neutral atoms combine by sharing atoms**
- **Diatomic molecules are atoms that combine with them such as Cl_2, O_2 . . . .**
  - **The 7 + Hydrogen**

Writing Chemical Formulas

- **The sum of the oxidation numbers must equal zero**
  - **Put the positive oxidation # first**
  - **Fe_2O_3, H_2O, NaCl**
  - **NH_4OH, $Ba(NO_3)_2$**

Naming compounds

- **Put the + oxidation # first**
- **Change the name of the negative oxidation by adding the suffix ide**
- **Exception is when naming compounds that all the atoms are negative oxidation #s**
- **Atoms with more than one oxidation state are named by using roman numerals to indicate the oxidation state. Example: Iron (III) oxide**

Naming Compounds

Binary Ionic Compounds:

- **1. Cation first, then anion**
- **2. Monatomic cation = name of the element**
  - **Ca^{2+} = calcium ion**
- **3. Monatomic anion = root + -ide**
  - **Cl^- = chloride**
  - **$CaCl_2$ = calcium chloride**

Naming Binary Ionic Compounds

- **Examples:**

NaCl	sodium chloride
ZnI_2	zinc iodide
Al_2O_3	aluminum oxide

Learning Check

Complete the names of the following binary compounds:

Na_3N	**sodium**	**_____**
KBr	**potassium**	**_____**
Al_2O_3	**aluminum**	**_____**
MgS	**_____**	

Transition Metals

Elements that can have more than one possible charge MUST have a Roman Numeral to indicate the charge on the individual ion.

1+ or 2+	2+ or 3+
Cu^{+}, Cu^{2+}	Fe^{2+}, Fe^{3+}
copper(I) ion	iron(II) ion
copper (II) ion	iron(III) ion

Names of Variable Ions

These elements REQUIRE Roman Numerals because they can have more than one possible charge:

anything except Group 1A, 2A, Ag, Zn, Cd, and Al

(You should already know the charges on these!)

Or another way to say it is: Transition metals and the metals in groups 4A and 5A (except Ag, Zn, Cd, and Al) require a Roman Numeral.

$FeCl_3$	**(Fe^{3+})**	**iron (III) chloride**
CuCl	**(Cu^{+})**	**copper (I) chloride**
SnF_4	**(Sn^{4+})**	**tin (IV) fluoride**
$PbCl_2$	**(Pb^{2+})**	**lead (II) chloride**
Fe_2S_3	**(Fe^{3+})**	**iron (III) sulfide**

Examples of Older Names of Cations formed from Transition Metals

TABLE 4.2

Common Type II Cations

Ion	Systematic Name	Older Name
Fe^{3+}	iron(III)	ferric
Fe^{2+}	iron(II)	ferrous
Cu^{2+}	copper(II)	cupric
Cu^{+}	copper(I)	cuprous
Co^{3+}	cobalt(III)	cobaltic
Co^{2+}	cobalt(II)	cobaltous
Sn^{4+}	tin(IV)	stannic
Sn^{2+}	tin(II)	stannous
Pb^{4+}	lead(IV)	plumbic
Pb^{2+}	lead(II)	plumbous
Hg^{2+}	mercury(II)	mercuric
Hg_2^{2+}*	mercury(I)	mercurous

*Mercury(I) ions always occur bound together in pairs to form Hg_2^{2+}.

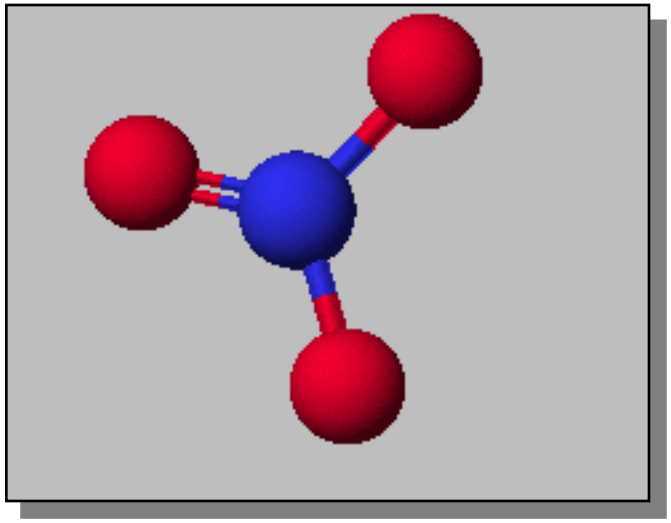
Learning Check

Complete the names of the following binary compounds with variable metal ions:

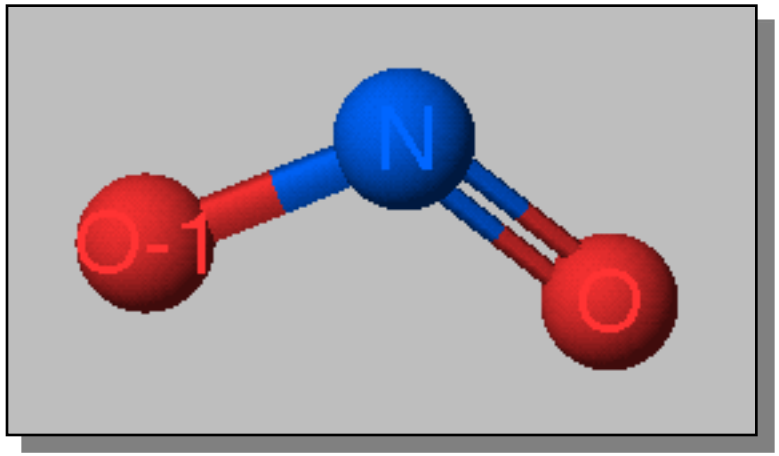
$FeBr_2$	**iron (_____) bromide**
CuCl	**copper (_____) chloride**
SnO_2	**___(_____) _____**
Fe_2O_3	**_____**
Hg_2S	**_____**

Polyatomic Ions

NO_3^-
nitrate ion



NO_2^-
nitrite ion



Ternary Ionic Nomenclature

Writing Formulas

- **Write each ion, cation first. Don't show charges in the final formula.**
- **Overall charge must equal zero.**
  - **If charges cancel, just write symbols.**
  - **If not, use subscripts to balance charges.**
- **Use parentheses to show more than one of a particular polyatomic ion.**
- **Use Roman numerals indicate the ion's charge when needed (stock system)**

Ternary Ionic Nomenclature

Sodium Sulfate

Na^{+} and SO_4^{-2}

Na_2SO_4

Iron (III) hydroxide

Fe^{+3} and OH^{-}

$Fe(OH)_3$

Ammonium carbonate

NH_4^{+} and CO_3^{-2}

$(NH_4)_2CO_3$

Learning Check

1. **aluminum nitrate**

   a) $AlNO_3$ b) $Al(NO)_3$ c) $Al(NO_3)_3$

2. **copper(II) nitrate**

   a) $CuNO_3$ b) $Cu(NO_3)_2$ c) $Cu_2(NO_3)$

3. **Iron (III) hydroxide**

   a) $FeOH$ b) Fe_3OH c) $Fe(OH)_3$

4. **Tin(IV) hydroxide**

   a) $Sn(OH)_4$ b) $Sn(OH)_2$ c) $Sn_4(OH)$

Naming Ternary Compounds

- **Contains at least 3 elements**
- **There MUST be at least one polyatomic ion**
  (it helps to circle the ions)
- **Examples:**

$NaNO_3$	Sodium nitrate
K_2SO_4	Potassium sulfate
$Al(HCO_3)_3$	Aluminum bicarbonate or Aluminum hydrogen carbonate

Learning Check

Match each set with the correct name:

1.	**Na_2CO_3**	**a) magnesium sulfite**
	$MgSO_3$	**b) magnesium sulfate**
	$MgSO_4$	**c) sodium carbonate**

2 .	**$Ca(HCO_3)_2$**	**a) calcium carbonate**
	$CaCO_3$	**b) calcium phosphate**
	$Ca_3(PO_4)_2$	**c) calcium bicarbonate**

Mixed Practice!

Name the following:

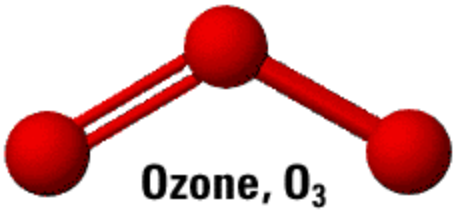
1. Na_2O
2. $CaCO_3$
3. PbS_2
4. Sn_3N_2
5. Cu_3PO_4
6. HgF_2

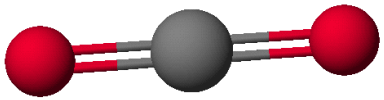
Mixed Up… The Other Way

Write the formula:

1. Copper (II) chlorate
2. Calcium nitride
3. Aluminum carbonate
4. Potassium bromide
5. Barium fluoride
6. Cesium hydroxide

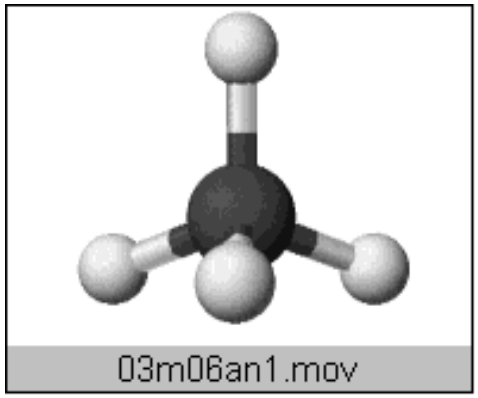
Naming Molecular Compounds



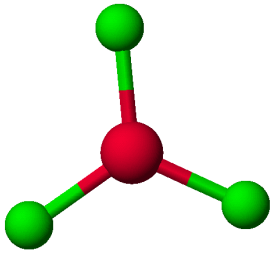


CO_2 Carbon dioxide

All are formed from two or more nonmetals.



CH_4 methane

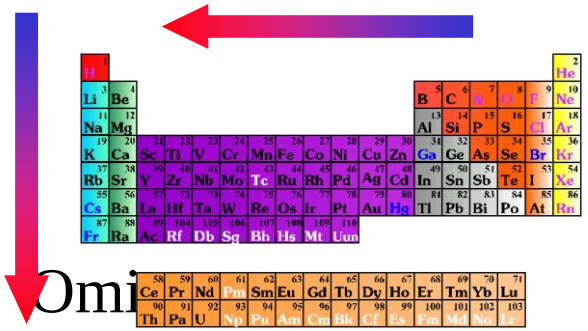


BCl_3
boron trichloride

Ionic **compounds generally involve a metal and nonmetal (NaCl)**

Molecular (Covalent) Nomenclature for two nonmetals

- **Prefix System** (binary compounds)



1. Less electronegative atom comes first.

2. Add prefixes to indicate # of atoms. Omit prefix on the FIRST element. Mono- is OPTIONAL on the SECOND element (in this class, it's NOT optional!).

3. Change the ending of the second element to -ide.

Molecular Nomenclature Prefixes

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

The Old System

- **The old system that named some compounds such as Carbon dioxide use prefixes to indicate the number of atoms**
- **Prefixes: mono-1, di-2, tri-3, tetra-4, etc. . . .**

Molecular Nomenclature: Examples

- **CCl_4**
  - carbon tetrachloride
- **N_2O**
  - dinitrogen monoxide
- **SF_6**
  - sulfur hexafluoride

More Molecular Examples

- **arsenic trichloride**
  - $AsCl_3$
- **dinitrogen pentoxide**
  - N_2O_5
- **tetraphosphorus decoxide**
  - P_4O_{10}

Learning Check

Fill in the blanks to complete the following names of covalent compounds.

CO	carbon _____oxide
CO_2	carbon _____
PCl_3	phosphorus _____chloride
CCl_4	carbon _____chloride
N_2O	_____nitrogen _____oxide

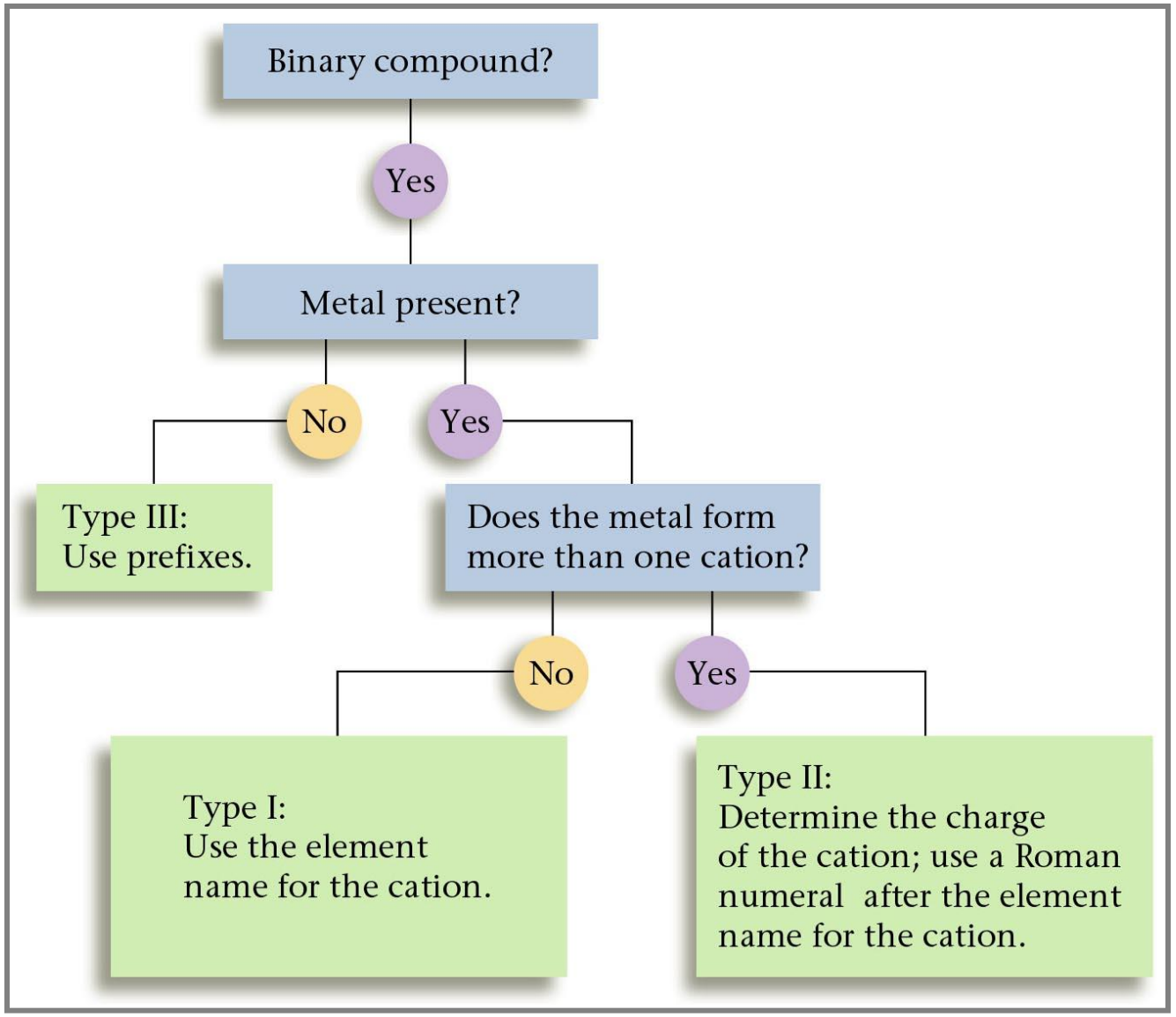
Learning Check

1. P_2O_5
   a) phosphorus oxide
   b) phosphorus pentoxide
   c) diphosphorus pentoxide

2. Cl_2O_7
   a) dichlorine heptoxide
   b) dichlorine oxide
   c) chlorine heptoxide

3. Cl_2
   a) chlorine
   b) dichlorine
   c) dichloride

A flow chart for naming binary compounds.



Mixed Review

Name the following compounds:

1. CaO

a) calcium oxide **b) calcium(I) oxide**
c) calcium (II) oxide

2. $SnCl_4$

a) tin tetrachloride **b) tin(II) chloride**
c) tin(IV) chloride

3. N_2O_3

a) nitrogen oxide **b) dinitrogen trioxide**
c) nitrogen trioxide

Solution

Name the following compounds:

1.	**CaO**	**a) calcium oxide**
2.	**$SnCl_4$**	**c) tin(IV) chloride**
3.	**N_2O_3**	**b) Dinitrogen trioxide**

Mixed Practice

1. Dinitrogen monoxide
2. Potassium sulfide
3. Copper (II) nitrate
4. Dichlorine heptoxide
5. Chromium (III) sulfate
6. Iron (III) sulfite
7. Calcium oxide
8. Barium carbonate
9. Iodine monochloride

Mixed Practice

1. BaI_2
2. P_4S_3
3. $Ca(OH)_2$
4. $FeCO_3$
5. $Na_2Cr_2O_7$
6. I_2O_5
7. $Cu(ClO_4)_2$
8. CS_2
9. B_2Cl_4

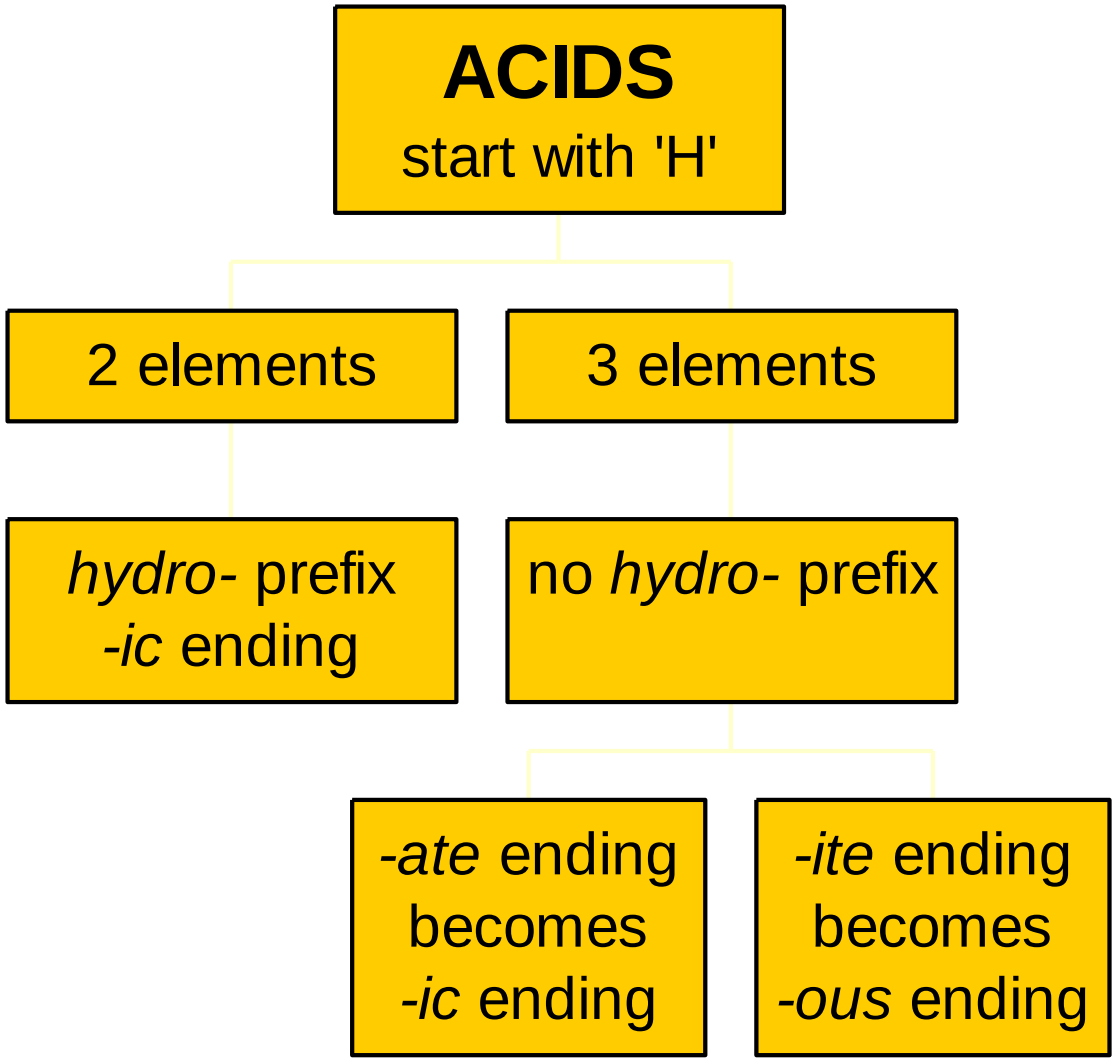
Acid Nomenclature

- **Acids**
  - **Compounds that form H^+ in water.**
  - **Formulas usually begin with 'H'.**
  - **In order to be an acid instead of a gas, binary acids must be aqueous (dissolved in water)**
  - **Ternary acids are ALL aqueous**
- **Examples:**
  - **$HCl_{(aq)}$ – hydrochloric acid**
  - **HNO_3 – nitric acid**
  - **H_2SO_4 – sulfuric acid**

Acid Nomenclature

	Anion Ending	Acid Name
Binary →	*-ide*	*hydro*-(stem)-*ic acid*
Ternary →	*-ate*	(stem)-*ic acid*
Ternary →	*-ite*	(stem)-*ous acid*

Acid Nomenclature Flowchart



Acid Nomenclature

- **$HBr_{(aq)}$**
  - 2 elements, *-ide* ⇒ hydrobromic acid
- **H_2CO_3**
  - 3 elements, *-ate* ⇒ carbonic acid
- **H_2SO_3**
  - 3 elements, *-ite* ⇒ sulfurous acid

Acid Nomenclature

- **hydrofluoric acid**
  - 2 elements $\Rightarrow$ $H^+ F^-$ $\Rightarrow$ $HF_{(aq)}$
- **sulfuric acid**
  - 3 elements, **-*ic*** $\Rightarrow$ $H^+ SO_4^{2-}$ $\Rightarrow$ H_2SO_4
- **nitrous acid**
  - 3 elements, **-*ous*** $\Rightarrow$ $H^+ NO_2^-$ $\Rightarrow$ HNO_2

Name ‘Em!

- $HI_{(aq)}$
- HCl
- H_2SO_3
- HNO_3
- HIO_4

Write the Formula!

- Hydrobromic acid
- Nitrous acid
- Carbonic acid
- Phosphoric acid
- Hydrotelluric acid

Formulas

Empirical formula: the lowest whole number ratio of atoms in a compound.

Molecular formula: the true number of atoms of each element in the formula of a compound.

- molecular formula = (empirical formula)$_n$ [n = integer]
- molecular formula = C_6H_6 = $(CH)_6$
- empirical formula = CH

Formulas (continued)

Formulas for ionic compounds are ALWAYS empirical (lowest whole number ratio).

Examples:

$NaCl$ $MgCl_2$ $Al_2(SO_4)_3$ K_2CO_3

Formulas (continued)

Formulas for molecular compounds **MIGHT** be empirical (lowest whole number ratio).

Molecular:	H_2O	$C_6H_{12}O_6$	$C_{12}H_{22}O_{11}$
	↓	↓	↓
Empirical:	H_2O	CH_2O	$C_{12}H_{22}O_{11}$