Chemical Nomenclature

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Ionic Charges of Representative Elements

Ionic Charges of Representative Elements

1A	2A	3A	5A	6A	7A
Li^+	Be^{2+}		N^{3-}	O^{2-}	F^-
Na^+	Mg^{2+}	Al^{3+}	P^{3-}	S^{2-}	Cl^-
K^+	Ca^{2+}		As^{3-}	Se^{2-}	Br^-
Rb^+	Sr^{2+}				I^-
Cs^+	Ba^{2+}				

Ions

Ions are charged particles formed when an atom gains or loses electrons. **Monatomic ions** are ions consisting of only one element. **Polyatomic ions** are tightly bound groups of atoms that behave as a unit and carry a charge.

Cations are positively charged ions formed when atoms lose electrons. **Metals** tend to form cations.

Anions are negatively charged ions formed when atoms gain electrons. **Nonmetals** tend to form anions.

Some Common Polyatomic Ions

1^- Charge		2^- charge		3^- charge	
ClO-	hypochlorite	SO_3^{2-}	sulfite	PO_3^{3-}	phosphite
ClO_2-	chlorite	SO_4^{2-}	sulfate	PO_4^{3-}	phosphate
ClO_3-	chlorate	CO_3^{2-}	carbonate		
ClO_4-	perchlorate	CrO_4^{2-}	chromate	1^+ Charge	
NO_2-	nitrite	$Cr_2O_7^{2-}$	dichromate	NH_4^+	ammonium
NO_3-	nitrate	SiO_3^{2-}	silicate		
CN-	cyanide	$C_2O_4^{2-}$	oxalate		
OH-	hydroxide				
$C_2H_3O_2^-$	acetate				

Formulas and Names of Common Metal Ions with More than One Common Ionic Charge

Formula	Name	Formula	Name
Cu^+	Copper(I) ion	Sn^{2+}	Tin(II) ion
Cu^{2+}	Copper(II) ion	Sn^{4+}	Tin(IV) ion
Fe^{2+}	Iron(II) ion	Cr^{2+}	Chromium(II) ion
Fe^{3+}	Iron(III) ion	Cr^{3+}	Chromium(III) ion
Hg_2^{2+}	Mercury(I) ion	Mn^{2+}	Manganese(II) ion
Hg^{2+}	Mercury(II) ion	Mn^{3+}	Manganese(III) ion
Pb^{2+}	Lead(II) ion	Co^{2+}	Cobalt(II) ion
$Pb4^+$	Lead(IV) ion	Co^{3+}	Cobalt(III) ion

Note: Zn^{2+}, Cd^{2+}, and Ag^+ do not require Roman numerals when naming them because these metals only have one common ionic charge.

Naming Polyatomic Ions

The names of most polyatomic anions end in *–ite or –ate*. However, there are three important exceptions: the positively charged ammon*ium* cation (NH_4^+) and two polyatomic anions that end in *–ide*, the cyan*ide* ion (CN^-) and the hydrox*ide* ion (OH^-).

The *–ite* form of a polyatomic ion contains one less oxygen than the *–ate* form.
Example: SO_3^{2-} is sulfite, SO_4^{2-} is sulfate

Naming Monatomic Ions

Monatomic anions are named by adding the ending *–ide* to the root .
Example: F^- is the fluoride ion

Monatomic cations are identified simply by the element's name.
Example: Ca^{2+} is the calcium ion

Some metals have more than one common ionic charge. A Roman numeral indicating the charge of the ion must be used when naming these ions.
Example: Fe^{2+} is the iron(II) ion and Fe^{3+} is the iron(III) ion

Naming Binary Ionic Compounds

Binary ionic compounds are named by first naming the cation and then naming the anion. The name of a monatomic anion ends in *-ide*. Remember to use a Roman numeral with the cations that have more than one common ionic charge.

Examples:
LiCl Lithium chloride
Ba_3N_2 Barium nitride
Fe_2O_3 Iron(III) oxide

Writing Formulas for Binary Ionic Compounds

Empirical formulas (lowest whole number ratio of the atoms in a compound) are used when writing the formulas for ionic compounds.
Steps in writing a formula for a binary ionic compound:
1. Identify the ions involved.
2. Balance the charges. The overall charge for an ionic compound is zero.

Examples:

Barium sulfide	Ba^{2+}, S^{2-}	BaS
Lead(II) phosphide	Pb^{2+}, P^{3-}	Pb_3P_2

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Writing Formulas for Ternary Ionic Compounds

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Naming Ternary Ionic Compounds

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Binary Molecular Compounds

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Prefixes Used in Naming Binary Molecular Compounds

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Naming Binary Molecular Compounds

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Writing Formulas for Binary Molecular Compounds

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Acids

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Naming Binary Acids

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Naming Ternary Ionic Compounds

Ternary ionic compounds are named by first naming the cation and then naming the anion. Remember to use a Roman numeral with the cations that have more than one common ionic charge.

Examples:

Na_2SO_3	sodium sulfite
$Cr_3(PO_4)_2$	chromium(II) phosphate
NH_4Cl	ammonium chloride

Writing Formulas for Ternary Ionic Compounds

You write the formula for a ternary ionic compound the same way as you do for a binary ionic compound. However, parenthesis must be used to indicate more than one of a polyatomic ion.

Examples:

Copper(II) sulfate	Cu^{2+}, SO_4^{2-}	$CuSO_4$
Ammonium phosphate	NH_4^+, PO_4^{3-}	$(NH_4)_3PO_4$
Silver carbonate	Ag^+, CO_3^{2-}	Ag_2CO_3

Prefixes Used in Naming Binary Molecular Compounds

Prefixes are used to show how many atoms of each element are present in each molecule of a molecular compound.

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

Binary Molecular Compounds

Binary molecular compounds are composed of two nonmetallic elements. The ionic charges are not used in writing formulas for molecular compounds. When two nonmetallic elements combine, they often do so in more than one way.

Ex. CO_2, CO

Writing Formulas for Binary Molecular Compounds

Do **not** balance the ionic charges when writing formulas for binary molecular compounds. Write down the number of atoms of each element indicated by the name.

Ex.

dinitrogen tetrahydride	N_2H_4
sulfur dioxide	SO_2

A few inorganic molecular compounds have common names that all scientists use in place of formal names. CH_4 is methane, H_2O is water and NH_3 is ammonia.

Naming Binary Molecular Compounds

The names of molecular compounds have this form: (prefix + element name) (prefix + element root + ide)
Ex. Cl_2O_3 is dichlorine trioxide

Note: The prefix mono is usually omitted if there is just a single atom of the first element.
Example: CO_2 is carbon dioxide.

Note: If the vowel combinations o-o or a-o appear next to each other in the name, the first of the pair is omitted to simplify the name.
Example: N_2O is dinitrogen monoxide

Naming Binary Acids

Binary acids have the general formula of H + Nonmetal. They are named by writing hydro + root + ic acid

Ex.

HCl	Hydrochloric acid
H2S	Hydrosulfuric acid

Acids

Acids are compounds that produce hydrogen ions (H+) in solution. Two common types of acids exist – binary acids and oxyacids.

Ex. HI	binary acid	(hydroiodic acid)
HNO_2	oxyacid	(nitrous acid)

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Writing Formulas for Binary Acids

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Chemical Nomenclature

Oxyacids

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Naming Oxyacids

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Writing Formulas for Oxyacids

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Oxyacids

Oxyacids are acids that contain hydrogen and an oxyanion. An oxyanion is a polyatomic ion that contains oxygen and another element (usually a nonmetal). Oxyacids have the general formula H + polyatomic ion.

Ex. HIO_3 iodic acid

Writing Formulas for Binary Acids

The charges must be balanced when writing the formulas for binary acids.

Hydrofluoric acid	H^+, F^-	HF
Hydroselenic acid	H^+, S^{2-}	H_2Se

Writing Formulas for Oxyacids

When writing formulas for oxyacids, you must always balance the charges.

Ex.

Nitrous acid comes from nitrite (1 less O than the refererence)
H^+, NO_2^- HNO_2

Carbonic acid comes from carbonate (reference)
H^+, CO_3^{2-} H_2CO_3

Periodic acid comes from periodate (1 more O than the reference)
H^+, IO_4^- HIO_4

Hyponitrous acid comes from hyponitrite (2 less O than the reference)
H^+, NO^- HNO

Naming Oxyacids

There are two methods used to help name acids.

First method:

Ending of Polyatomic Ion	Acid Ending	Example
-ate	-ic	$HBrO_3$ bromic acid
-ite	-ous	$HClO_2$ chlorous acid

Second method:

$HClO_3$ chlorIC acid	reference form
$HClO_2$ chlorOUS acid	1 less oxygen
HClO HYPOchlorOUS acid	2 less oxygen
$HClO_4$ PERchlorIC acid	1 more oxygen