Chemical Nomenclature	Name:	
	Lab Section:	
	Date:	Sign-Off

Prepared by

Dr. Gary Evett, Professor of Biophysical Sciences,
WNC-Fallon Campus

Edited by

Dr. Steve Carman, Professor of Biophysical Sciences,
WNC-Carson Campus
and
Dr. Elizabeth Tattersall, Instructor of Biophysical Sciences,
WNC-Douglas Campus

for

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CHEMICAL NOMENCLATURE

The International Union of Pure & Applied Chemists (IUPAC) has established rules for naming chemical compounds (chemical nomenclature). Therefore, uniformity is achieved in chemistry especially in the scientific literature. Different nomenclature rules are used for inorganic and organic compounds.

INORGANIC NOMECLATURE

I. NAMING IONIC COMPOUNDS

Monoatomic cations are named by the elemental name followed by ion.

Ca^{2+} calcium ion

Many transition metal cations have more than one charge. In this case when naming these cations the "stock nomenclature system" is used by writing a roman numeral in parenthesis after the elemental name.

Fe^{2+} iron (II) ion	Cu^{1+} copper (I) ion	Hg_2^{2+} mercury (I) ion
Fe^{3+} iron (III) ion	Cu^{2+} copper (II) ion	Hg^{2+} mercury (II) ion

An older method is also used to distinguish between cations that can vary in charge, using the 2 most common oxidation states ("charges"). The Latin root of the elemental name is followed by –ic or –ous. The –ic ending indicates a larger positive charge than –ous.

Fe^{2+} ferrous ion	Cu^{1+} cuprous ion	Hg_2^{2+} mercurous ion
Fe^{3+} ferric ion	Cu^{2+} cupric ion	Hg^{2+} mercuric ion

The older nomenclature is not used much in chemistry texts, but it is used commonly to label chemical bottles containing ionic compounds.

Monoatomic anions are named by replacing the end of the element with –ide.

Cl chlorine atom
Cl^- chloride ion

Many anions are **polyatomic ions**. Some of these also end in –ide.

OH^- hydroxide ion
CN^- cyanide ion

Most **polyatomic ions** are oxyanions meaning they contain oxygen with other elements. If two oxyanions are in a common series, the ion with more oxygens ends in –ate (the originating acid name ends in –ic) and the ion with one less oxygen ends in –ite (the originating acid name ends in –ous).

NO_3^- nitrate ion	SO_4^{2-} sulfate ion
NO_2^- nitrite ion	SO_3^{2-} sulfite ion

Some **polyatomic anions** form a common series with four different oxyanions.

ClO_4^- perchlorate ion (from perchlorIC acid)
ClO_3^- chlorate ion
ClO_2^- chlorite ion
ClO^- hypochlorite ion (from hypochlorOUS acid)

per___ ate means the most oxygen atoms in the ion – usually 4
____ate means one less oxygen than per__ate
____ite means one less oxygen than -ate
hypo__ite means one less oxygen than –ite (least oxygen atoms in the ion) – usually 1

Hydrogen ion, H^+, can be added to polyatomic anions one step at a time until a neutral acid is produced. Each added H^+ neutralizes one negative charge.

PO_4^{3-} phosphate ion
HPO_4^{2-} hydrogenphosphate ion
$H_2PO_4^-$ dihydrogenphosphate ion
H_3PO_4 phosphoric acid

When naming ionic compounds, also known as salts, the cation is named first followed by the name of the anion. The word ion is dropped from each ion name. Subscripts representing how many ions are in the empirical formula are not named with ionic nomenclature, because they can be figured out by logic. So remember with salts DO NOT USE PREFIXES TO NAME THE SUBSCRIPTS.

$CaCl_2$	Calcium chloride	**not** calcium dichloride.
$Ca_3(PO_4)_2$	Calcium phosphate	**not** tricalcium diphosphate

Even though ionic crystalline solids contain ions, the sum of the positive charges equals the sum of the negative charges so the salt crystals are neutral. Since the size of a salt crystal can vary, a neutral empirical formula is used to represent a salt crystal.

$Al_2(SO_4)_3$ the cation is Al^{3+} and the anion is SO_4^{2-} so the name is aluminum sulfate.

$Al_2(SO_4)_3$ this neutral empirical formula represents 2 Al^{3+} for every 3 SO_4^{2-} in the salt

To make a neutral formula from ions the crossover method is used.

Al^{3+} and SO_4^{2-} becomes $Al_2(SO_4)_3$

The 3 superscript from the aluminum ion will become the subscript for the sulfate and, the 2 superscript from the sulfate will become the subscript on the aluminum atom to produce the neutral salt formula $Al_2(SO_4)_3$. When more than one polyatomic ion is needed in the formula, the subscript is placed outside of parenthesis. In the neutral salt formula, superscripted charges are not used to represent ions in the empirical formula. They are omitted. One can tell it is a salt formula because the metal is always first in the formula and the nonmetal is always second in the formula.

II. NAMING BINARY MOLECULAR COMPOUNDS

Binary molecular compounds contain covalent bonds between two different **nonmetal** atoms. Greek prefixes are used to indicate the number of atoms of each element in the molecule. The Greek prefixes are:

TABLE 1. Prefixes Used in Binary Molecular Compounds

Prefix	**Meaning**
Mono	1
Di	2
Tri	3
Tetra	4
Penta	5
Hexa	6
Hepta	7
Octa	8
Nona	9
Deca	10

Common names are still used to name some molecules such as the ones in Table 2.

TABLE 2.

Common name	Formula
Water	H_2O
Ammonia	NH_3
Hydrogen peroxide	H_2O_2
Nitric oxide	NO
Nitrous oxide	N_2O

RULES FOR NAMING BINARY MOLECULAR COMPOUNDS

1. The elemental name of the most metallic atom is written first (the one farther to the left in a period or the one farthest down a group).
2. For the second element in the molecule, the ending is dropped from the elemental name and -ide is added. For example, chlorine becomes chloride.
3. Greek prefixes are used to indicate the number of atoms of each element. If there is only one atom of the first element, then the mono is dropped. If the prefix ends in a or o, and the second element begins with a vowel the a or o is often dropped from the prefix.

Cl_2O_7 Dichlorine heptoxide
CO_2 Carbon dioxide

III. NAMING ACIDS

Acids are named according to the anion they contain.

Anion ending	Acid name
-ide	hydro_____ic acid
Cl^-	HCl
chloride	hydrochloric acid
per ____ate	per____ic acid
ClO_4^-	$HClO_4$
perchlorate	perchloric acid
-ate	_____ic acid
NO_3^-	HNO_3
nitrate	nitric acid
-ite	_____ous acid
ClO_2^-	$HClO_2$
chlorite	chlorous acid

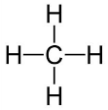
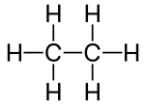
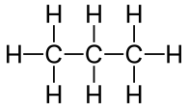
hypo_____ite	hypo_____ous acid
ClO^-	$HClO$
hypochlorite	hypochlorous acid

IV. NAMING SOME SIMPLE ORGANIC COMPOUNDS

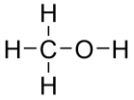
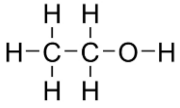
We will just learn to name a few organic compounds.

Alkanes consist of only carbon and hydrogen and all the bonds are single.

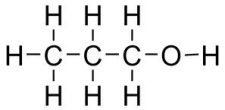
Prefixes for alkanes
meth- means one carbon
eth- means two carbons
prop- means three carbons

Name	Formula	Structural Formula
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	

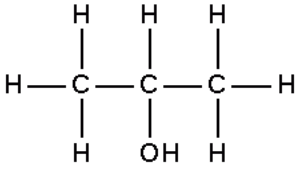
Alcohols have an –OH group bound to a carbon atom. The name ends in –ol. With propanol, locant numbers are used to distinguish whether the –OH group is on C-1 or C-2. Locant numbers are always separated form letters with a dash.

Methanol	CH_4O or CH_3OH	
Ethanol	C_2H_6O or C_2H_5OH	

1-Propanol $CH_3CH_2CH_2OH$



2-Propanol (isopropyl alcohol)
$CH_3CHOHCH_3$



Helpful Reference Materials

COMMON IONS

Positive Ions (Cations)

1+

Ammonium (NH_4^+)
Cesium (Cs^+)
Copper(I) or cuprous (Cu^+)
Hydrogen (H^+)
Lithium (Li^+)
Potassium (K^+)
Silver (Ag^+)
Sodium (Na^+)

2+

Barium (Ba^{2+})
Cadmium (Cd^{2+})
Calcium (Ca^{2+})
Chromium(II) or chromous (Cr^{2+})
Cobalt(II) or cobaltous (Co^{2+})
Copper(II) or cupric (Cu^{2+})
Iron(II) or ferrous (Fe^{2+})
Lead(II) or plumbous (Pb^{2+})
Magnesium (Mg^{2+})
Manganese(II) or manganous (Mn^{2+})
Mercury(I) or mercurous (Hg_2^{2+})
Mercury(II) or mercuric (Hg^{2+})
Strontium (Sr^{2+})
Nickel(II) (Ni^{2+})
Tin(II) or stannous (Sn^{2+})
Zinc (Zn^{2+})

3+

Aluminum (Al^{3+})
Chromium(III) or chromic (Cr^{3+})
Iron(III) or ferric (Fe^{3+})

Negative Ions (Anions)

1–

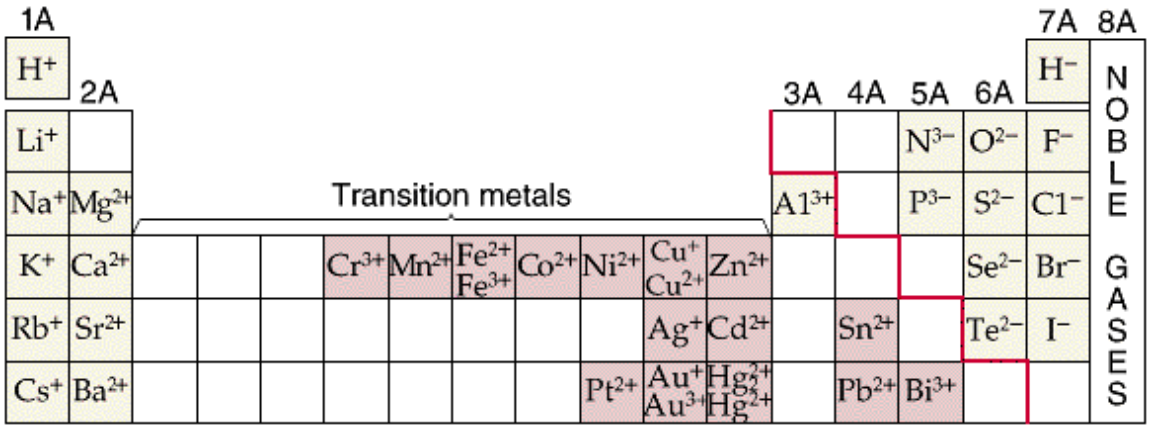
Acetate ($C_2H_3O_2^-$)
Bromide (Br^-)
Chlorate (ClO_3^-)
Chloride (Cl^-)
Cyanide (CN^-)
Dihydrogen phosphate ($H_2PO_4^-$)
Fluoride (F^-)
Hydride (H^-)
Hydrogen carbonate or bicarbonate (HCO_3^-)
Hydrogen sulfite or bisulfite (HSO_3^-)
Hydroxide (OH^-)
Iodide (I^-)
Nitrate (NO_3^-)
Nitrite (NO_2^-)
Perchlorate (ClO_4^-)
Permanganate (MnO_4^-)
Thiocyanate (SCN^-)

2–

Carbonate (CO_3^{2-})
Chromate (CrO_4^{2-})
Dichromate ($Cr_2O_7^{2-}$)
Hydrogen phosphate (HPO_4^{2-})
Oxide (O^{2-})
Peroxide (O_2^{2-})
Sulfate (SO_4^{2-})
Sulfide (S^{2-})
Sulfite (SO_3^{2-})

3–

Arsenate (AsO_4^{3-})
Phosphate (PO_4^{3-})


1A
2A
3A
4A
5A
6A
7A
8A
H+
Li+
Na+
Mg2+
K+
Ca2+
Rb+
Sr2+
Cs+
Ba2+
Transition metals
Cr3+
Mn2+
Fe2+
Fe3+
Co2+
Ni2+
Cu+
Cu2+
Zn2+
Ag+
Cd2+
Pt2+
Au+
Au3+
Hg22+
Hg2+
Al3+
Sn2+
Pb2+
N3−
P3−
O2−
S2−
Se2−
Te2−
Bi3+
H−
F−
Cl−
Br−
I−
NOBLE GASES

NOMENCLATURE WORKSHEET

Name the following ionic compounds. Complete before leaving lab.

$KMnO_4$ _____ $Al(NO_3)_3$_____

Na_2CrO_4 _____ MgO_____

AgCl _____ AlN_____

Na_2O _____$Ca_3(PO_4)_2$ _____

$NaC_2H_3O_2$_____K_3N_____

$CuSO_4$ _____LiH_2PO_4_____

$Sn(ClO)_4$_____

Give the formula for the following ionic compounds.

Sodium carbonate _____

nickel (III) sulfide_____

Sodium bicarbonate _____

Calcium sulfide _____

Calcium sulfate _____

Iron (III) hydroxide _____

Name the following molecules.

H_2O _____ NH_3 _____

PCl_5 _____ Cl_2O_7 _____

O_2 _____ P_4O_{10} _____

Cl_2_____ H_2_____

N_2O_5_____H_2O_2_____

CO _____SO_2 _____

Write the formula for the following molecules.

Antimony tribromide _____

Pentaphosphorus pentoxide _____

Phosphorus triiodide _____

Tetraphosphorus pentasulfide _____

Nitrogen trifluoride _____

Name the following acids

H_2SO_4_____

HCl _____

$HClO_4$ _____

HBr _____

HI _____

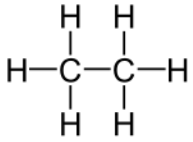
HNO_3_____

$HClO_3$ _____

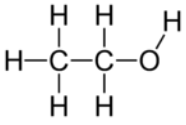
$HC_2H_3O_2$ or CH_3COOH (or HOAc) _____

Name the following organic molecules

CH_4 _____



C_2H_6_____



, CH_3CH_2OH _____

Added 21 September 2014, 2005 hours, PDT.