# **Naming Ionic & Covalent Compounds**

# **General Information:**

# **Common Polyatomic Ions**

+1 Charge		
$NH_4^+$	ammonium	
$H_3O^+$	H <sub>3</sub> O <sup>+</sup> hydronium	
$Hg_2^{2+}$	mercury(I)	

	-1 Charge
$AlO_2^-$	aluminate
BrO <sup>-</sup>	hypobromite
$BrO_2^-$	bromite
BrO <sub>3</sub>	bromate
BrO <sub>4</sub>	perbromate
CH <sub>3</sub> COO	acetate
HCO <sub>3</sub>	hydrogen carbonate
ClO <sup>-</sup>	hypochlorite
ClO <sub>2</sub>	chlorite
ClO <sub>3</sub>	chlorate
ClO <sub>4</sub>	perchlorate
CN <sup>-</sup>	cyanide
CNO <sup>-</sup>	cyanate
CNS <sup>-</sup>	thiocyanate
CrO <sub>2</sub>	chromite
HSO <sub>3</sub>	hydrogen sulfite
HSO <sub>4</sub>	hydrogen sulfate
IO <sup>-</sup>	hypoiodite
IO <sub>2</sub>	iodite
IO <sub>3</sub>	iodate
$\mathrm{IO_4}^-$	periodate
MnO <sub>4</sub>	permanganate
NO <sub>2</sub>	nitrite
NO <sub>3</sub>	nitrate
$N_3^-$	azide
OH-	hydroxide
$O_2^-$	superoxide
$H_2PO_3^{-}$	dihydrogen phosphite
$\mathrm{H_2PO_4}^-$	dihydrogen phosphate

−2 Charge		
$HPO_3^{2-}$	hydrogen phosphite	
HPO <sub>4</sub> <sup>2-</sup>	hydrogen phosphate	
$CO_3^{2-}$	carbonate	
CO <sub>3</sub> <sup>2-</sup> SO <sub>3</sub> <sup>2-</sup>	sulfite	
$SO_4^{2-}$	sulfate	
$S_2O_3^{2-}$ $SiO_3^{2-}$ $C_2^{2-}$	thiosulfate	
SiO <sub>3</sub> <sup>2-</sup>	silicate	
$C_2^{2-}$	carbide	
$C_2O_4^{2-}$ $CrO_4^{2-}$	oxalate	
	chromate	
$\operatorname{Cr}_2\operatorname{O}_7^{2-}$	dichromate	
$C_4H_4O_6^{2-}$	tartrate	
$C_4H_4O_6^{2-}$ $MoO_4^{2}$	molybdate	
$O_2^{2-}$	peroxide	
$S_2^{2-}$	disulfide	

−3 Charge		
PO <sub>3</sub> <sup>3-</sup> phosphite		
PO <sub>4</sub> <sup>3-</sup>	phosphate	
PO <sub>2</sub> <sup>3-</sup> hypophosphite		
AsO <sub>3</sub> <sup>3-</sup> arsenite		
$AsO_4^{3-}$	arsenate	

−4 Charge		
$P_2O_7^{4-}$	pyrophosphate	

<sup>\*\*</sup>Most commonly encountered ions in bold.

- ◆ Polyatomic Ions A group of atoms held together by covalent bonds found in ionic compounds.
  - ◆ Know/ memorize/ recognize names, formulas and charges!

### **General Information:**

# **Recognizing Ionic vs. Covalent Compounds:**



lonic—held together thru mutual attraction of oppositely charged ions, "opposites attract"

Covalent/ molecular—held together by covalent bonds; shared electron pairs

### **Ionic:**

# **Molecular/ Covalent:**

- ♦ Metal plus non-metal or
- Metal plus polyatomic ion or
- ♦ Polyatomic ion plus polyatomic ion
- ◆ Contains only non-metal atoms

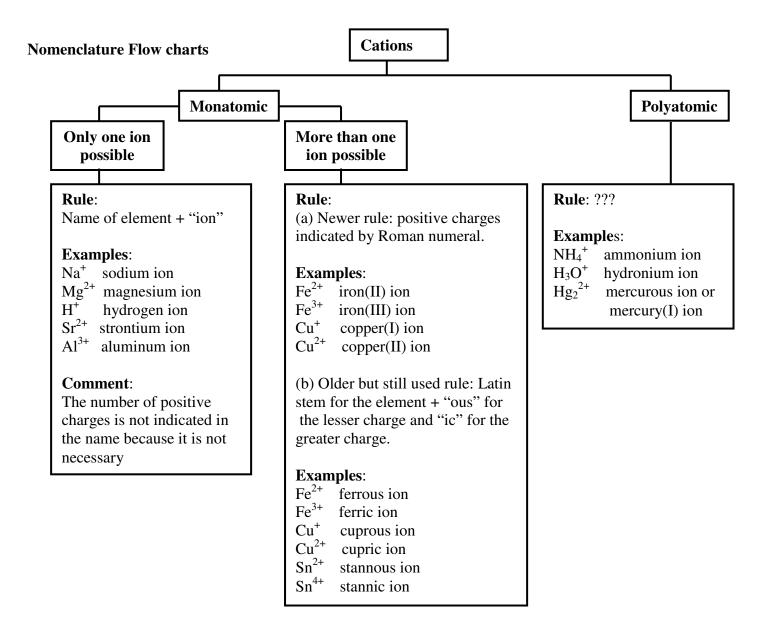
• Chemical Formula - Indicates the number and type of atoms in the base unit of a compound.

Type of compound	Base unit	
Ionic	Formula unit (f.u.)	
Molecular	Molecule	

- ♦ Valence Electrons Electrons in the outermost shell of an atom
  - ♦ The only e<sup>-</sup>s involved in bonding and chemical reactions.
  - For the S- & P-blocks: # Valence  $e^- = Group \ number$
- ♦ **Ionic Compounds:** An electrostatic attraction between a positive ion and a negative ion, where one or more electrons have been transferred from the valence shell of one atom to the valence shell of the other atom.
- ♦ Molecular Compounds: Sharing valence electrons between atoms of different elements form COVALENT bonds
  - ◆ Octet Rule An atoms tends to gain, lose or share such that it achieves eight valence electrons. There are some exceptions to the "Octet" Rule!

# **Formation of Ionic Compounds:**

- ♦ All compounds are electrically neutral ⇒ possess no net charge.
- ♦ Number of positives = number of negatives



**Anions Oxy-anions containing** Anion **Oxy-anions** Hydrogen **Rules: Rules: Rules:** Stem of the H oxy-anion: hydrogen + name least oxygen: hypo\_\_ite ion of oxy-anion or "bi" + name of element + "ide" less oxygen: \_\_ite ion oxy-anion. more oxygen: \_\_ate ion **Examples:** most oxygen: per\_\_ate ion Hhydride ion H<sub>2</sub> oxy-anion: "dihydrogen" F fluoride ion + name of oxy-anion **Examples**:  $O^{2-}$ oxide ion hypochlorite ion ClO  $N^{3-}$ nitride ion **Examples**: ClO<sub>2</sub> chlorite ion HCO<sub>3</sub> hydrogen carbonate ion carbide ion ClO<sub>3</sub> chlorate ion or bicarbonate ion perchlorate ion  $ClO_4$  $SO_3^{2-}$  $SO_4^{2-}$ HSO<sub>4</sub> hydrogen sulphate ion sulfite ion HPO<sub>4</sub><sup>2</sup>-Hydrogen phosphate ion sulfate ion or biphosphate ion  $NO_2$ nitrite ion H<sub>2</sub>PO<sub>4</sub> dihydrogen phosphate ion  $NO_3$ nitrate ion **Comment: Comment:** H<sub>2</sub>CO<sub>3</sub> is not named according to Halogens (except F) form all this rule because it is a compound four ions. When only two of and not an ion. the four ions exist, they are "ite" and "ate" ions.

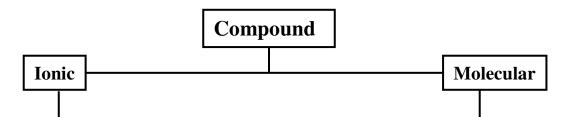
# **Others and Exceptions**

# **Rules:**

These items do not follow any rules; they must be memorized

### **Examples:**

OH hydroxide ion
CN cyanide ion
SCN thiocyanide ion
OCN cyanate ion
O2 peroxide ion
O2 superoxide ion
MnO4- permanganate ion
C2H3O2 acetate ion
C $_2O_7^{2-}$  dichromate ion
C $_2O_4^{2-}$  oxalate ion



# Rule:

Name of the cation + name of anion (word "ion" dropped)

# **Examples**:

NaCl sodium chloride MgCl<sub>2</sub> magnesium chloride Fe<sub>3</sub>N<sub>2</sub> iron(II) nitride Na<sub>2</sub>CO<sub>3</sub> sodium carbonate NH<sub>4</sub>OH ammonium hydroxide CaH<sub>2</sub> calcium hydride

### **Comment:**

The name does not indicate the numbers of cations and anions because there is only one possibility for the ions to combine and form a compound.

# **Rule**:

a. Less electronegative atom first (exceptions: when one of the elements is hydrogen.)

b. Number of each kind is specified by Greek prefixes.

c. prefix 'mono" at beginning is dropped.

### **Prefixes**:

1=mono 6=hexa

2=di 7=hepta

3=tri 8=octa

4=tetra 9=nona

5=penta 10=deca

# **Examples**:

N<sub>2</sub>O<sub>4</sub> dinitrogen tetraoxide

CO carbon monoxide

CO<sub>2</sub> carbon dioxide

NO<sub>2</sub> nitrogen dioxide

N<sub>2</sub>O dinitrogen monoxide

# **Note:** several trivial names

H<sub>2</sub>O water

H<sub>2</sub>O<sub>2</sub> hydrogen peroxide

NH<sub>3</sub> ammonia

# Compounds containing hydrogen (AKA—Acids) H-Nonmetal H-oxyanion

### Rule 1:

w/o presence of H<sub>2</sub>O: hydrogen \_\_ide

# **Examples:**

HCl hydrogen chlorideHF hydrogen fluorideH<sub>2</sub>S hydrogen sulfide

### Rule 2:

when dissolved in H<sub>2</sub>O: hydro\_\_ic acid

# **Examples**:

HCl(aq) hydrochloric acid HF (aq) hydrofluoric acid H<sub>2</sub>S(aq) hydrosulfuric acid

### **Comment:**

a. These H containg compounds are named as if they were ionic compounds.

b. The (aq) is often omitted when it is obvious from the context that they are acids.

# Rule:

when dissolved in H<sub>2</sub>O: hypo\_ous acid

\_\_ous acid

\_\_ic acid

per\_\_ic acid

# **Examples**:

HClO hypochlorous acid

HClO<sub>2</sub> chlorous acid

ClO<sub>3</sub> chloric acid

ClO<sub>4</sub> perchloric acid

SO<sub>3</sub> sulfous acid

SO<sub>4</sub> sulfic acid

NO<sub>2</sub> nitrous acid

NO<sub>3</sub> nitric acid

H<sub>2</sub>SO<sub>3</sub> sulfurous acid

H<sub>2</sub>SO<sub>4</sub> sufuric acid

H<sub>3</sub>PO<sub>3</sub> phosphorous acid

H<sub>3</sub>PO<sub>4</sub> phosphoric acid

HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> acetic acid

H<sub>2</sub>C<sub>2</sub>O<sub>4</sub> oxalic acid

H<sub>2</sub>CO<sub>3</sub> carbonic acid

### **Comment:**

The (aq) is usually omitted

	Cation	Anion		Cation	Anion		Cation	Anion
CaS			MgF <sub>2</sub>			Cs <sub>2</sub> O		
Fe <sub>2</sub> O <sub>3</sub>			Al <sub>2</sub> S <sub>3</sub>			NaBr		
FeSO <sub>3</sub>			Mg <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>			KNO <sub>3</sub>		
Na <sub>2</sub> SO <sub>4</sub>			Ba(NO <sub>3</sub> ) <sub>2</sub>			Fe <sub>2</sub> (SO <sub>3</sub> ) <sub>3</sub>		
MgCl <sub>2</sub>			NaCl			Ba <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>		
KI			Sr(MnO <sub>4</sub> ) <sub>2</sub>			Fe <sub>3</sub> As <sub>2</sub>		
$Mn_2(SO_3)_7$			NaF			PbSO <sub>4</sub>		
SnBr <sub>4</sub>			Cr(PO <sub>4</sub> ) <sub>2</sub>			Pb(OH) <sub>4</sub>		
Mg <sub>3</sub> P <sub>2</sub>			Al <sub>2</sub> Se <sub>3</sub>			$Cu(C_2H_3O_2)_2$		

	ving compounds.	
NaBr	$B_2H_4$	
CaSO <sub>4</sub>	СО	
$P_2O_5$	IO <sub>2</sub>	
$Zn(NO_2)_2$	BBr <sub>3</sub>	
K <sub>3</sub> N	VO <sub>2</sub>	
$V_2S_3$	PbS	
$Ca(C_2H_3O_2)_2$	Cr(CO <sub>3</sub> ) <sub>3</sub>	
SO <sub>2</sub>	$N_2O_3$	
$Ag_3P$	CH <sub>4</sub>	
FePO <sub>4</sub>	FeSO <sub>4</sub>	
CuOH	NH <sub>3</sub>	
Ti(SO <sub>4</sub> ) <sub>2</sub>	$P_2O_5$	
$C_2Br_6$	SiO <sub>2</sub>	
GaCl <sub>3</sub>	Na <sub>2</sub> CO <sub>3</sub>	
$CoBr_2$	H <sub>2</sub> O	

Write the correct chemical formula for the fol	llowing chemical compounds.
tin (IV) selenide	dinitrogen trioxide
nickel (III) sulfide	lithium acetate
silver acetate	phosphorus trifluoride
silicon dioxide	vanadium (V) oxide
manganese (II) phosphate	aluminum hydroxide
ammonium oxide	zinc sulfide
diboron tetrabromide	silicon tetrafluoride
magnesium sulfate heptahydrate	silver phosphate
potassium carbonate	iron (II) phosphide
carbon tetrachloride	potassium acetate
tetrasulfur dinitride	disilicon hexabromide
diselenium diiodide	titanium (IV) nitrate
copper (I) phosphate	tetraphosphorus triselenide
gallium oxide	Dihydrogen monoxide

Provide the con	Provide the correct name for the following acids or bases.		
NaOH	NH	H <sub>3</sub>	
H <sub>2</sub> SO <sub>3</sub>	НС	CN	
$H_2S$	Ca	a(OH) <sub>2</sub>	
H <sub>3</sub> PO <sub>4</sub>	Fe(	e(OH) <sub>3</sub>	

Write the correct chemical formula for	the following acids or bases.
hydrofluoric acid	cobalt (II) hydroxide
hydroselenic acid	sulfuric acid
chlorous acid	beryllium hydroxide
lithium hydroxide	hydrobromic acid
nitrous acid	perchloric acid
sulfurous acid	potassium hydroxide
hypochlorous acid	chloric acid
carbonic acid	phosphoric acid