Chemical Nomenclature

- **The first names for chemicals were common names:**
  - **Sugar, quicklime, Epsom salts, milk of magnesia, gypsom, laughing gas**
  - **Simple, but not practical, the tell us little about the chemicals involved in the compounds**
  - **More than four million chemical compounds are known**

<u>Chemical Nomenclature:</u> **“ A systematic system for naming chemical compounds that will tell you something about the composition of the compound “**

- **Once the system is known a compound can be named from its chemical formula**

Naming Chemical Compounds

Binary Compounds: " Compounds composed of two elements "

- There are two classes of binary compounds:
  - Compounds that contain a metal and a nonmetal atom
  - Compounds that contain two nonmetals

Naming Compounds that Contain a Metal and a Nonmetal Atom

Binary Ionic Compound: " A substance that contains a positive ion (cation) and a negative ion (anion) "

- The positive ion is always written first in the formula

Example:

$$Na^{+} + Cl^{-} \longrightarrow NaCl$$

Sodium Chloride is a Binary Ionic Compound

Atoms and ions

Atoms are electrically neutral.
Same number of protons and electrons.
Ions are atoms, or groups of atoms, with a charge.
Different numbers of protons and electrons.
Only electrons can move.
Gain or lose electrons.

Anion

A negative ion.
Has gained electrons.
Non metals can gain electrons.
Charge is written as a super script on the right.

F^{-1} **Has gained one electron**

O^{-2} **Has gained two electrons**

Cations

- Positive ions.
- Formed by losing electrons.
- More protons than electrons.
- Metals form cations.

K^{+1} Has lost one electron

Ca^{+2} Has lost two electrons

Naming Ionic Compounds: a Metal and a Nonmetal Atom

Type I Compounds: " The metal present forms only one type of cation "

Example: These metals always form only one cation

Na^{+} K^{+}

Ca^{2+} Rb^{+}

Cs^{+} Al^{3+}

These are called Type I cations

You Must Commit These and Other Type I Cations to Memory

Naming Compounds that Contain a Metal and a Nonmetal Atom (cont)

Type II Compounds: " The metal preset can form two (or more) cations that have different charges "

Example: These metals can form more than one cation

Fe^{2+}	Fe^{3+}	
Cu^{+}	Cu^{2+}	These are called Type II cations
Cr^{2+}	Cr^{3+}	
Cr^{6+}		

You Must Commit These and Other Type II Cations to Memory

Naming Type I Binary Ionic Compounds

Rules for naming Binary Ionic Compounds:

1) The cation is always named first and the anion second

2) A simple cation (obtained from a single element) takes its name from the name of the element

   - K^+ is named potassium in the name of compounds containing this ion

3) A simple anion (obtained from a single element) is named by taking the first part of the element name (the root) and adding *- ide*

   - F^- from the element fluorine becomes fluoride

KBr	Potassium bromide	$MgCl_2$	Magnesium chloride
CsI	Cesium iodide	NaBr	Sodium bromide
CaO	Calcium oxide	RbI	Rubidium iodide
Al_2O_3	Aluminum oxide		

continue….

Naming Type II Binary Ionic Compounds

- Iron can exist as one of 2 cations:

Fe^{2+} Fe^{3+}

- Copper can exist as one of 2 cations:

Cu^{+} Cu^{2+}

The name " copper chloride " alone would not tell the state of the copper cation in the compound

CuCl or $CuCl_2$?

Naming Type II Binary Ionic Compounds (cont)

Type II binary ionic compounds are named using roman numerals to designate the charge on the cation

copper(I) chloride	⚿	**Cu^{+}**	⚿	**CuCl**
copper(II) chloride	⚿	**Cu^{2+}**	⚿	**$CuCl_2$**

- **The roman numeral tells the charge on the element copper in the compound**

iron(II) chloride	⚿	**Fe^{2+}**	⚿	**$FeCl_2$**
iron(III) chloride	⚿	**Fe^{3+}**	⚿	**$FeCl_3$**

Naming Binary Compounds that Contain Only Nonmetal Atoms -

Rules for naming Type III Binary Compounds

1) The first element in the formula is named first, and the full element name is used

2) The second element is named as if it were an anion

3) Prefixes are used to denote the number of atoms present

mono	1	penta	5
di	2	hexa	6
tri	3	hepta	7
tetra	4	octa	8

4) The prefix " mono " is never used for naming the first element

CO carbon monoxide

Naming Binary Compounds that Contain Only Nonmetal Atoms - Type III Compounds (cont)

Examples:	IF_5	**Iodine pentafluoride**
	BF_3	**boron trifluoride**
	N_2O_5	**dinitrogen pentoxide**
	CCl_4	**carbon tetrachloride**
	NO_2	**nitrogen dioxide**

continue….

Naming Compounds that Contain Polyatomic Ions

Polyatomic Ions: " Ions that are composed of several atom bound together "

- Polyatomic ions are assigned special names.
  Find these on the back or your periodic table

Example:

Ammonium Nitrate NH_4NO_3

Made up of two ions:

NH_4^+ Ammonium

NO_3^- Nitrate

continue….

Naming Compounds that Contain Polyatomic Ions (cont)

The Common Polyatomic Ions

NH_4^+	ammonium
NO_3^-	nitrate
SO_4^{2-}	sulfate
OH^-	hydroxide
CN^-	cyanide
PO_4^{3-}	phosphate
CO_3^{2-}	carbonate
ClO_3^-	chlorate
$C_2H_3O_2^-$	acetate

continue….

Naming Polyatomic Ions (cont)

Some elements form polyatomic anions with different numbers of oxygen atoms

Oxyanions: " polyatomic anions of an element with different numbers of oxygen atoms "

Example: SO_4^{2-} **sulfate**

SO_3^{2-} **sulfite**

When there are two oxyanions:

- **The one with the larger number of oxygen atoms ends in "** ***ate*** **"**
- **The one with the smaller number of oxygen atoms ends in "** ***ite*** **"**

Example: NO_3^- **nitrate**

NO_2^- **nitrite**

Naming Polyatomic Ions (cont)

When there are more than two oxyanions in the series:

- **" *per* " (more than) is used to name the oxyanion with the most oxygen atoms**
- **" *hypo* " (less than) is used to name the oxyanion with the fewest oxygen atoms**

Example:

ClO_4^-	perchlorate
ClO_3^-	chlorate
ClO_2^-	chlorite
ClO^-	hypochlorite

continue….

Naming Polyatomic Ions (cont)

Naming ionic compounds that contain polyatomic ions is very similar to naming binary ionic compounds

Examples:

NaCN	**sodium cyanide**
KOH	**potassium hydroxide**
$RbClO_2$	**rubidium chlorite**
$Ca_3(PO_4)_2$	**calcium phosphate**

- **To name these you must learn to recognize the polyatomic ions**

continue….

Practice naming & formulas

$Ti(C_2H_3O_2)_2$	Titanium (II) Acetate
$NaMnO_4$	Sodium Permanganate
$Pb(SO_4)_2$	Lead (IV) Sulfate
$FeCl_3$	Iron (III) chloride

Strontium Chromate	$SrCrO_4$
Potassium Nitrate	KNO_3
Vanadium (V) Phosphate	$V_3(PO_4)_5$
Ammonium Carbonate	$(NH_4)_2CO_3$

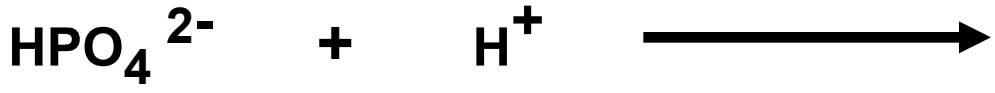
Practice naming & formulas

Na_2S	Sodium sulfide
PCl_3	Phosphorus trichloride
CO	Carbon monoxide
$Cu(NO_3)_2$	Copper(II) nitrate
Dinitrogen tetraoxide	N_2O_4
Lead(IV) carbonate	$Pb(CO_3)_2$
Calcium phosphide	Ca_3P_2

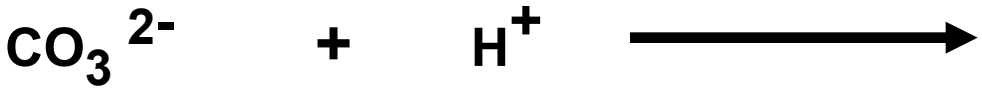
Adding a Proton (H^+) to Polyatomic Ions

- Follow the rules for naming Type III compounds

Phosphate hydrogen phosphate



hydrogen phosphate dihydrogen phosphate



carbonate hydrogen carbonate

continue….

Naming Acids

Acid: " A compound that produces H^+ ions (protons) when dissolved in water "

- An acid is a molecule (or compound) in which one or more H^+ ions (protons) are attached to an anion

Rules for Naming Acids:

1) If the anion *does not contain oxygen*, the acid is named with the prefix " *hydro* " and the suffix " *ic* " is attached to the root name for the element or compound.

HCl dissolved in water:	hydrochloric acid
HF dissolved in water:	hydrofluoric acid
HBr dissolved in water:	hydrobromic acid
HCN dissolved in water:	hydrocyanic acid

continue….

Naming Acids (cont)

2) When the *anion contains oxygen*, the acid name is formed from the root name of the central element of the anion, or the anion name, with a suffix of " ic " or " ous "

- **When the anion name ends in " *ate* ", the suffix " *ic* " is used**

Acid	Anion	Name
H_2SO_4	SO_4^{2-} (sulfate)	sulfuric acid
H_3PO_4	PO_4^{3-} (phosphate)	phosphoric acid
$HC_2H_3O_2$	$C_2H_3O_2^-$ (acetate)	acetic acid

continue….

Naming Acids (cont)

- When the anion name ends in " ite ", the suffix " ous " is used

Acid	Anion		Name
H_2SO_3	SO_3^{2-}	(sulfite)	sulfurous acid
HNO_2	NO_2^-	(nitrite)	nitrous acid

Naming the oxy acids of chlorine:

Acid	Anion		Name
$HClO_4$	ClO_4^-	(perchlorate)	perchloric acid
$HClO_3$	ClO_3^-	(chlorate)	chloric acid
$HClO_2$	ClO_2^-	(chlorite)	chlorous acid
$HClO$	ClO^-	(hypochlorite)	hypochlorous acid

end….