NAMING IONIC COMPOUNDS

- The name of the compound is based on the name of the ions in the compound
- Cation first, anion second

Examples:

$Mg(OH)_2$

magnesium hydroxide

Na_2S

sodium sulfide

$BeBr_2$

beryllium bromide

Fe_2O_3

Fe^{3+} O^{2-}
Fe^{3+} O^{2-}
O^{2-}
+6 −6

iron(III) oxide

CuO

Cu^{2+} O^{2-}
+2 −2

copper(II) oxide

Cu_2O

Cu^{+} O^{2-}
Cu^{+}
+2 −2

copper(I) oxide

* Remember to include the Roman numeral for CHARGE when you're writing transition metal compound names!

Page 63 (9th edition): Chart of polyatomic ions
Page 64 (10th edition)

NAMING IONIC COMPOUNDS

$(NH_4)_2S$

ammonium sulfide

$FeCO_3$

Fe^{2+} CO_3^{2-}

iron(II) carbonate

TiS_2

Ti^{4+} S^{2-}

S^{2-}

+4 −4

titanium(IV) sulfide

$Ba_3(PO_4)_2$

barium phosphate

Spelling matters!

Ba_3P_2

barium phosphide

DETERMINING THE FORMULA OF AN IONIC COMPOUND FROM THE NAME

- The name of an ionic compound is made of the names of the CATION and ANION in the compound.

- To get the FORMULA, you must figure out the SMALLEST RATIO of cation to anion that makes the charges balance out

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Examples:

iron(III) carbonate

Fe^{3+} CO_3^{2-}

$Fe_2(CO_3)_3$

potassium sulfide

K^+ S^{2-}

K^+

K_2S

calcium bromide

Ca^{2+} Br^-

Br^-

$CaBr_2$

DETERMINING IONIC FORMULAS

sodium sulfate

Na^{+} SO_4^{2-}

Na^{+}

Na_2SO_4

strontium oxide

Sr^{2+} O^{2-}

SrO

tin(II) phosphate

Sn^{2+} PO_4^{3-}

$Sn_3(PO_4)_2$

chromium(III) nitrate

Cr^{3+} NO_3^{-}

$Cr(NO_3)_3$

barium hydroxide

Ba^{2+} OH^{-}

OH^{-}

$Ba(OH)_2$ ~~$BaOH_2$~~

titanium(IV) chloride

Ti^{4+} Cl^{-}

$TiCl_4$

Don't forget parenthesis when you're indicating more than one HYDROXIDE, CYANIDE, or HYPOCHLORITE ion.

HYDRATES

- many ionic compounds are formed by crystallizing the compound from water. Sometimes, this causes water molecules to become part of the crystal structure.

- This water is present in a definite ratio to the ions in the compound. Can be removed by heating, but will NOT evaporate if the compound is left standing.

ex: $CuSO_4 \cdot 5H_2O$

\# water molecules per formula unit of compound

dot indicates that the water is weakly bound to the ionic compound

- many DESSICANTS are hydrates that have had their water molecules driven off. They will slowly reabsorb water from the air (and keep the environment in a dessicator at a low humidity)

- Hydrates are named using the name of the ionic compound, and a Greek prefix in front of the word "hydrate" to indicate how many water molecules are associated

Cu^{2+} SO_4^{2-}

copper (II) sulfate pentahydrate

Why "copper(II)"?

MOLECULAR COMPOUNDS

- There are several kinds of molecular compound. We will learn to name two simple but important classes

(1) BINARY MOLECULAR COMPOUNDS

- molecular compounds containing only two elements

(2) ACIDS

- molecular compounds that dissolve in water to release H^+ ions
- corrosive to metals (react with many to produce hydrogen gas)
- contact hazard: can cause chemical burns to eyes and skin
- sour taste
- turn litmus indicator RED
- two kinds of acids:

(1) BINARY ACIDS

- contain hydrogen and one other element

Usually from Group VIIA

(2) OXYACIDS

- contain hydrogen, OXYGEN, and another element

BINARY MOLECULAR COMPOUNDS

- Named based on the elements they contain, plus prefixes to indicate the number of atoms of each element in each molecule

(1) FIRST ELEMENT

- Add a GREEK PREFIX to the name of the element.
- Omit the "MONO-" (1) prefix if there is only one atom of the first element

(2) SECOND ELEMENT

- Add a GREEK PREFIX to the STEM NAME of the element
- Add the suffix "-ide" (as if you were naming an anion)
- DO NOT omit the "mono-" prefix if there is only one atom of the second element

SEE COURSE WEB SITE FOR A LIST OF GREEK PREFIXES!
THESE ARE THE SAME PREFIXES USED FOR THE HYDRATES!

BINARY MOLECULAR COMPOUNDS

Examples:

BF_3 boron trifluoride

Cl_2O_7 dichlorine heptaoxide

CO carbon monoxide

CO_2 carbon dioxide

*Note: metalloids like boron behave chemically like nonmetals do.

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carbon tetrachloride CCl_4

dihydrogen monoxide H_2O

dinitrogen tetrafluoride N_2F_4

$MgCl_2$: This one is MAGNESIUM CHLORIDE, not magensium dichloride. Why not? It's ionic. How do we tell?

Look at the first element. Compounds that start with a metal are almost always ionic!

ACIDS

(1) BINARY ACIDS

- named after the element (other than hydrogen) they contain
- common binary acids include a Group VIIA element
- named: "Hydro-" + STEM NAME OF ELEMENT+ "-ic acid"

Four common binary acids

HF : hydrofluoric acid * dissolves glass!

HCl : hydrochloric acid * most common binary acid!

HBr : hydrobromic acid

HI : hydroiodic acid

ACIDS

(2) OXYACIDS

- Easy to think about as HYDROGEN IONS combined with POLYATOMIC IONS

- These acids are not true ionic compounds, but they interact with water to PRODUCE ions!

- named based on the polyatomic ion they contain, with an ending change:

(1) - ions ending in -ATE form acids ending in -IC

(2) - ions ending in -ITE form acids ending in -OUS

H_2SO_4 (sulfATE) — sulfuric acid

H_3PO_4 (phosphATE) — phosphoric acid

H_2SO_3 (sulfITE) — sulfurous acid

HNO_3 (nitrate) — nitric acid

OXYACID EXAMPLES

acetic acid

$H^+ \quad C_2H_3O_2^-$

$HC_2H_3O_2$

nitrous acid

$H^+ \quad NO_2^-$

HNO_2

carbonic acid

$H^+ \quad CO_3^{2-}$

H^+

H_2CO_3

The number of hydrogen atoms at the beginning of the formula equals the charge of the anion the acid is based on!

SUMMING UP CHEMICAL NOMENCLATURE

- You need to be able to tell, by looking at a name OR a formula, what kind of compound you are working with!

DON'T GET THE NAMING SYSTEMS MIXED UP! EACH KIND OF COMPOUND IS NAMED WITH ITS OWN SYSTEM!

FROM A CHEMICAL NAME

- If the name has a Roman numeral, the name of a metal, or "ammonium", the compound is likely IONIC
- If the name has a Greek prefix AND the prefix is NOT in front of the word "hydrate", the compound is BINARY MOLECULAR
- If the name contains the word "acid":

... and starts with "hydro-", then the compound is a BINARY ACID

... and does not start with "hydro-", the compound is an OXYACID

FROM A CHEMICAL FORMULA

- if the formula contains a metal or the NH_4^+ ion, it is likely IONIC

H_2O H_2O_2

- If the formula starts with H and is not either water or hydrogen peroxide, the compound is likely an ACID. Which kind?

  - BINARY ACIDS contain only two elements

  - OXYACIDS contains oxygen

- If the formula contains only nonmetals (and is not an ammonium compound or an acid), the compound is likely MOLECULAR

Examples:

PCl_3: BINARY MOLECULAR
Name: phosphorus trichloride

NH_4Cl: IONIC (ammonium ion)
Name: ammonium chloride

H_3PO_4: OXYACID (hydrogen, phosphate)
Name: phosphoric acid

$Fe(OH)_2$: IONIC (starts with a metal)
Name: iron(II) hydroxide