NAMING IONIC COMPOUNDS

$(NH_4)_2S$

ammonium sulfide

$FeCO_3$

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

+2 −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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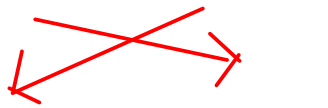
Examples:

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

$Na^+ \quad SO_4^{2-}$

Na^+

Na_2SO_4

strontium oxide

$Sr^{2+} \quad O^{2-}$

SrO

tin(II) phosphate

$Sn^{2+} \quad PO_4^{3-}$

$Sn^{2+} \quad PO_4^{3-}$

Sn^{2+}

$Sn_3(PO_4)_2$

chromium(III) nitrate

$Cr^{3+} \quad NO_3^-$

NO_3^-

NO_3^-

$Cr(NO_3)_3$

barium hydroxide

$Ba^{2+} \quad OH^-$

OH^-

$Ba(OH)_2$

~~$BaOH_2$~~

titanium(IV) chloride

$Ti^{4+} \quad Cl^-$

$TiCl_4$

Note: Be careful when adding a subscript to HYDROXIDE, HYPOCHLORITE, or CYANIDE ions. You need to put ANY polyatomic in parenthesis before adding an additional subscript!

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:

Usually from Group VIIA

1 BINARY ACIDS

- contain hydrogen and one other element

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	Cl_2O_7	CO	CO_2
boron trifluoride	dichlorine hept(a)oxide	carbon monoxide	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

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

sulfATE

H_2SO_4

sulfuric acid

phosphATE

H_3PO_4

phosphoric acid

sulfITE

H_2SO_3

sulfurous acid

nitrate

HNO_3

nitric acid

OXYACID EXAMPLES

based on acetate

acetic acid

$H^+ \quad C_2H_3O_2^-$

$HC_2H_3O_2$

based on nitrite

nitrous acid

$H^+ \quad NO_2^-$

HNO_2

based on carbonate

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