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Workshop 15 – Simple Nomenclature of Inorganic Compounds

I. Ionic Compounds (Compounds composed of a metal and a nonmetal or a metal and a polyatomic ion.)

A. Monatomic cations (positive ions formed from one atom) from Groups IA, IIA, IIIA and hydrogen take the name of the element from which they were derived.

H^{+}	hydrogen	K^{+}	potassium
Mg^{+2}	magnesium	Al^{+3}	aluminum

B. When a metal forms more than one ion (if it has variable ionic charge), it is necessary to distinguish between the possible ions. We will use the Stock method which gives the charge of the ion as a Roman number in parentheses immediately after the name of the metal. This will occur with most of the transition metals and the metals of groups IVA and VA.

Fe^{+2}	iron(II)	Ni^{+}	nickel(I)	Pb^{+2}	lead(II)
Fe^{+3}	iron(III)	Ni^{+2}	nickel(II)	Pb^{+4}	lead(IV)

C. Monatomic anions (negative ions formed from one atom) are named by adding the suffix **–ide** to the stem of the name of the nonmetal from which they are derived. These names should be memorized.

F^{-}	fluoride	O^{-}	oxide	N^{-3}	nitride
Cl^{-}	chloride	S^{-2}	sulfide	H^{-}	hydride
Br^{-}	bromide	Se^{-2}	selenide	I^{-}	iodide

D. The names and formulas of these polyatomic ions must be memorized. The charge is an essential part of the formula.

$C_2H_3O_2^{-}$	acetate	ClO^{-}	hypochlorite
CO_3^{-2}	carbonate	ClO_2^{-}	chlorite
HCO_3^{-}	bicarbonate (hydrogen carbonate)	ClO_3^{-}	chlorate
OH^{-}	hydroxide	ClO_4^{-}	perchlorate
NO_3^{-}	nitrate	MnO_4^{-}	permanganate
NO_2^{-}	nitrite	SO_4^{-2}	sulfate
CrO_4^{-2}	chromate	SO_3^{-2}	sulfite
$Cr_2O_7^{-2}$	dichromate	HSO_3^{-}	bisulfite (hydrogen sulfite)
PO_4^{-3}	phosphate	HSO_4^{-}	bisulfate (hydrogen sulfate)
HPO_4^{-2}	hydrogen phosphate	O_2^{-2}	peroxide
NH_4^{+}	ammonium	CN^{-}	cyanide

E. An ionic compound is a combination of one or more cations, and one or more anions. To name the compound, name the cation, then name the anion.

K_2S	potassium sulfide	NH_4Cl	ammonium chloride
$AlCl_3$	aluminum chloride	NH_4NO_3	ammonium nitrate

F. If the cation is a metal with variable ionic charge, you must determine the charge on the metal so that you know what number to put in the parentheses. To do this, look at the anion(s). The charge on the anion(s) multiplied by the number of anions gives the total negative charge. Since the number of positive charges and negative charges in a compound must equal, the total positive charge must be the absolute value of the total negative charge. The total positive charge should be divided by the number of metal ions in the formula to give the charge on an individual ion. This is the number which goes in the parentheses.

CuBr	copper(I) bromide	$Pb(C_2H_3O_2)_4$	lead(IV) acetate
$CuBr_2$	copper(II) bromide	$PbSO_4$	lead(II) sulfate
CuS	copper(II) sulfide	$NiCl_2$	nickel(II) chloride
$Fe(OH)_3$	iron(III) hydroxide	Cu_2SO_3	copper(I) sulfite

G. The formula of an ionic compound must contain equal numbers of positive charges and negative charges. When you are given a name and you need to write a formula, you may need to use several cations and/or anions for the number of charges to be equal. Often, you can use the charge on the **cation** as the number of **anions** and the **absolute value** of the charge on the **anion** as the number of **cations**. However, sometimes when you try to do this you will get a formula where the number of cations and the number of anions have a common factor. In this case you must divide both numbers by that common factor to give you the correct empirical formula.

aluminum iodide	AlI_3	sodium sulfide	Na_2S
tin(IV) chloride	$SnCl_4$	iron(III) oxide	Fe_2O_3
chromium(VI) oxide	CrO_3	magnesium oxide	MgO

II. Binary Compounds of Two Nonmetals (Covalent Compounds)

A. A compound composed of two nonmetals is a covalent compound. The compound's name is written by taking the less electronegative element first, writing the name of that element, then taking the more electronegative element and adding the **–ide** suffix to the stem of the name of the element. If more than one atom of an element is in the formula, prefixes are used to indicate the numbers. These prefixes are:

2	di–	5	penta–	8	octa–
3	tri–	6	hexa–	9	nona–
4	tetra–	7	hepta–	10	deca–

The prefix for one is mono–, but it no longer has to be used.

P_4O_{10}	tetraphosphorus decoxide	NF_3	nitrogen trifluoride
CCl_4	carbon tetrachloride	SiO_2	silicon dioxide
CS_2	carbon disulfide	NO	nitrogen oxide
Cl_2O	dichlorine oxide	N_2O_3	dinitrogen trioxide

B. There are several binary compounds that have common names.

H_2O	water	NH_3	ammonia	CH_4	methane*

*For organic hydrocarbons (carbon and hydrogen), a different method is employed for naming.

III. Acids

A. Acids are compounds that contain hydrogen and which, under certain conditions, ionize to form hydrogen ions and a negative nonmetal ion or a negative polyatomic ion. You can always recognize the formula of an acid because in acids, but not in other compounds, the H is written first. (Water is a very weak acid.)

B. Binary acids: Binary acids contain hydrogen and one other element. They are formed from hydrogen ions and a monatomic nonmetal ion. They are given two different names depending on whether or not they are dissolved in water. If they are dissolved in water their names are formed by taking the name of the anion, dropping the –**ide** suffix, and then adding both the **hydro–** prefix and the **–ic acid** suffix. If binary acids are not dissolved in water, they are named as ionic compounds.

HCl(aq)	hydrochloric acid	HCl(g)	hydrogen chloride
HF(aq)	hydrofluoric acid	HF(g)	hydrogen fluoride
H_2S(aq)	hydrosulfuric acid	H_2S(g)	hydrogen sulfide

C. Oxyacids: Oxyacids are acids that contain oxygen in addition to hydrogen and another element. They can be formed by combining hydrogen ions and polyatomic anions. For Chem 12, you only need to worry about the acids of polyatomic ions that end in **–ate**. For these acids, the acid is named by taking the name of the polyatomic ion and changing the **–ate** ending to **–ic acid**. Note that the "hydro–" prefix is only used for binary acids, not for oxyacids.

The names of oxyacids are the same whether or not they are dissolved in water.

HNO_3	nitric acid	$HC_2H_3O_2$	acetic acid
$HClO_3$	chloric acid	H_2CO_3	carbonic acid

There are several acids whose names are not quite what you would expect. Memorize these names.

H_2SO_4	sulfuric acid (not sulfic acid)
H_3PO_4	phosphoric acid (not phosphic acid)

D. To write the formula of an acid when given the acid's name, determine the name of the anion that corresponds to the acid by using the rules in section B and C in reverse. For each negative charge on the formula of the anion, add one H^+ in order to give a neutral formula.

hydroselenic acid	H_2Se(aq)
perchloric acid	$HClO_4$

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Write the formulas and the names of the compounds formed by combining these ions.

	SO_4^{-2}	NO_3^-	ClO_3^-	CO_3^{2-}	PO_4^{3-}	HSO_4^-	S*	OH^-	I*
NH_4^+									
Na*									
Mg*									
Al*									
Cu^{+2}									
Fe^{+3}									

* Predict the oxidation number and write it on the symbol.