Name _____ Date _____ Grade _____

Work Session 2B: Formulas, Names, and Masses

Use the information in your textbook for this work session, as well as the information on pages 4 and 5.

Part 1: Binary Ionic Compounds

Give the formula and name for the ionic compound formed between each of these metals with each of these nonmetals: Metals:

sodium, magnesium, aluminum
Nonmetals: chlorine, oxygen, nitrogen

Formula	Name	Formula	Name

Part 2: General Ionic Compounds

Give the formula and name for the ionic compound formed between each of these cations with each of these anions: Cations:

ammonium, sodium, magnesium, aluminum, iron(II), iron(III)
Anions: chloride, hydroxide, nitrate, sulfate, phosphate

Formula	Name	Formula	Name

Part 3: Acids

Give the formula and name for the acids formed from each of the following anions:
chloride, acetate, hypochlorite, chlorate, nitrite, nitrate, carbonate, phosphate, sulfite, sulfate

Formula	Name	Formula	Name

Part 4: Binary Covalent Compounds

Give the name from the formula, or the formula from the name, for each of the following binary covalent compounds

Formula	Name	Formula	Name
P_4O_{10}		_____	dinitrogen tetraoxide
S_2Cl_2		_____	xenon trioxide
CO		_____	iodine pentafluoride
SF_6		_____	oxygen difluoride
P_2S_5		_____	phosphorous triiodide

Part 5: Ionic versus Binary Covalent Names

For each of the following formulas, name the compound using the appropriate naming system. State which system you are using and why.

Formula	Name	System	Reason
Al_2O_3	_____		
$NaHCO_3$	_____		
NCl_3	_____		
MnO_2	_____		
SiO_2	_____		

Name_____ Grade_____ Date_____

Part 6: Molecular Masses

Give the formula, the molecular mass, and the % by weight of each of the elements in the following substances. For the hydrate, give the percent of water in the compound along with the percent of each of the other atoms in the compound. Use the space after the compound to show your calculations.

Name	Formula	Molecular Mass	% Composition
barium sulfate dihydrate			
perchloric acid			
ammonium dichromate			
diarsenic pentasulfide			

Part 7: Errors

Each of the following names has something wrong with it. Tell what is wrong, and rewrite the name correctly.

Name	Error	Correct name
disodium sulfide		
magnesium(II) chloride		
calcium monocarbon trioxide		
nitrogen fluoride (NF_3)		
chromium nitrate		

Inorganic Nomenclature. Gerhard Lind, J. Chem. Ed. 1992, 69, pp. 613.
Figure 1. Scheme for naming cations (name plus the word "ion").

Positive Ions (Cations)

Monatomic

Forms Only One Common Ion

Name of Element.

Examples:

Na^{+}	sodium ion
Mg^{2+}	magnesium ion
H^{+}	hydrogen ion

Comment:
The number of positive charges is not indicated in the name because it is not necessary

Forms More Than One Common Ion

(a) Newer rule: Name of element with positive charges indicated by a Roman numeral

Examples:

Fe^{2+}	iron(II) ion
Fe^{3+}	iron(III) ion
Cu^{+}	copper(I) ion
Cu^{2+}	copper (II) ion

(b) Old rule (but still used): Latin stem for the element + "ous" for the lesser charge and "ic" for the greater charge.

Examples:

Fe^{2+}	ferrous ion
Fe^{3+}	ferric ion
Cu^{+}	cuprous ion
Cu^{2+}	cupric ion
Sn^{2+}	stannous ion
Sn^{4+}	stannic ion

Polyatomic

Special Cases

Examples:

NH_4^{+}	ammonium ion
H_3O^{+}	hydronium ion or oxonium ion
Hg_2^{2+}	mercury(I) ion or mercurous ion

Comment:
Hg_2^{2+} is two Hg^{+} ions bonded together. Hg^{+} does not exist by itself; therefore, mercury(I) ion is Hg_{2}^{2+}. The mercury(II) ion (Hg^{2+}) is a monatomic ion.

Figure 2. Scheme for naming anions (name plus the word "ion").

Negative Ions (Anions)

Monatomic

Stem of the element name + "ide."

Examples:

H^{-}	hydride ion
F^{-}	fluoride ion
O^{2-}	oxide ion

Oxyanions (Containing Oxygen)

least oxygen: hypo__ite ion
less oxygen: __ite ion
less oxygen: __ite ion
more oxygen: __ate ion

N^{3-} nitride ion C^{4-} carbide ion

Others and Exceptions

These items are special cases;
cases;
they must be memorized.
most oxygen: per __ate ion
most oxygen: per __ate ion

Examples:

Oxyanions Containing Hydrogen

H + oxyanion: "hydrogen"
+ name of oxyanion
+ name of oxyanion
or "bi" + name of oxyanion

ClO^{-}	hypochlorite ion
ClO_2^{-}	chlorite ion ClO_3^{-}
	chlorate ion ClO_4^{-}
	perchlorate SO_3^{2-}

sulfite ion SO_4^{2-} sulfate ion

Comment: When only two of the four ions exist, they are the -ite and the -ate ions. Halogens (except F) form all four ions.

Examples:

OH^- hydroxide ion
CN^- cyanide ion SCN^- thiocyanate ion
OCN^- cyanate ion
O_2^{2-} peroxide ion
O_2^- superoxide ion
$C_2H_3O_2^-$ acetate ion
$Cr_2O_7^{2-}$ dichromate ion
$C_2O_4^{2-}$ oxalate ion
MnO_4^- manganate ion
MnO_4 permanganate ion

H_2 + oxyanion: "dihydrogen" + name of oxyanion

Examples:

HCO_3^- hydrogen carbonate ion or bicarbonate ion
HSO_4^- hydrogen sulfate ion or bisulfate ion
HPO_4^{2-} hydrogen phosphate or biphosphate ion
$H_2PO_4^-$ dihydrogen phosphate ion

Comment: The rule applies to ions only. For example H_2CO_3 (carbonic acid) does not follow the rule. It is a compound, not an ion.

Figure 3. Scheme for naming compounds.

Compounds

Ionic (Cation-Anion)

Compounds Containing Hydrogen

Covalent (Nonmetal-Nonmetal)

H-Metal

Name of cation + name of anion.

Examples:
NaCl sodium chloride
$MgCl_2$ magnesium chloride
Fe_3N_2 iron(II) nitride
Na_2CO_3 sodium carbonate
NH_4OH ammonium hydroxide
NaH sodium hydride
CaH_2 calcium hydride

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

H-Nonmetal

a) In the absence of H_2O, name
hydrogen __ide.

Examples:
HCl hydrogen chloride
HF hydrogen fluoride
H_2S hydrogen sulfide

Comment:
These H-containing compounds are named as if they were ionic compounds.

b) When dissolved in H_2O, name hydro __ic acid

Examples:
HCl(aq) hydrochloric acid
HF(aq) hydrofluoric acid
H_2S(aq) hydrosulfuric acid.

Comment:
The (aq) in the formulas of the acids is often omitted if it is clear from the context they are acids.

H-Oxyanion

a) In the absence of H_2O, name like ionic compounds: cation + anion

a) In the absence of H_2O, name like ionic compounds: cation + anion
Hydrogen hypo__ite
Hydrogen __ite
Hydrogen__ate
Hydrogen per__ate

Comment:
These H-containing compounds are named as if they were ionic compounds.

b) When dissolved in H_2O, name
hypo__ous acid
__ous acid
__ic acid
per__ic acid

Examples:
HClO(aq) Hypochlorous acid
$HClO_2$(aq) chlorous acid
$HClO_3$(aq) chloric acid
$HClO_4$(aq) perchloric acid
HNO_2(aq) nitrous acid
HNO_3(aq) nitric acid
H_2SO_3(aq) sulfurous acid
H_2SO_4(aq) sulfuric acid

H_3PO_4(aq) phosphoric acid

Comment:
The (aq) in the formulas is often omitted if it is clear from the context, they are acids.

a) Less electronegative element first (exception: when one of the elements is hydrogen).
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b) Number of atoms of each kind specified by Greek prefixes.
c) The prefix "mono" at the 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_2O_4 dinitrogen tetroxide
CO carbon monoxide CO_2 carbon dioxide
NO_2 nitrogen dioxide
N_2O dinitrogen monoxide

Comment: Tetraoxide becomes tetroxide, monooxide becomes monoxide etc., so that the name sounds better.

H-containing compounds do not follow a rule concerning the order in which the elements are written and should be memorized (H_2O, NH_3, etc.)