Lab Session 5, Experiment 4 Chemical Nomenclature

Objective:
To learn how to read and write formulas of compounds

Background:
Many of the substances you will encounter in this laboratory are ionic compounds. They are made up of ions which have an unequal number of protons and electrons. Ion is a charged species. If an element loses an electron, is it called at cation resulting in a positive charge. If an element gains an electron, is it called an anion resulting in a negative charge. Atoms of metals usually lose electrons. Atoms of nonmetals typically gain electrons. A polyatomic ion is a group of atoms that are bonded together and have an unequal number of protons and electrons.

Ionic compound names are read by stating the name of the cation, followed by the name of the anion. The formulas are written as:

$(cation)^{x+}$ $(anion)^{y-}$

$(cation)_y(anion)_x$

The subscripts (x and y) are the smallest possible whole numbers that would make the total charge equal to zero. If a subscript is 1, it is omitted. If the ion is a polyatomic ion and the subscript is not one, then parentheses are placed around the polyatomic ion's formula before writing the subscript. The charges of the ions are not included in the formula of the compound. The charge of the ion is only written when the formula of the ion is written by itself.
There are two situations of naming inorganic compounds.

- Group A metal and a nonmetal: group A metals are simple ions
  1. Just name the cation as its elemental name.
  2. Just name the anion, changing the ending to –ide.

$AlCl_3$ → aluminum chloride
Li_2S → lithium sulfide
Ca_3P_2 → calcium phosphide
K_2O → potassium oxide

- Group B metal and a nonmetal: group B metals have changing charges
  1. Determine charge on the cation
  2. Name the cation
  3. Place roman numeral after the cation to indicate its charge

+1 = I
+2 = II
+3 = III
+4 = IV
+5 = V
+6 = VI
+7 = VII
+8 = VIII
+9 = IX
+10 = X

4. Name the anion with an –ide ending.

$FeCl_2$ → iron (II) chloride
$FeCl_3$ → iron (III) chloride
SnO_2 → tin (IV) oxide
SnO → tin (II) oxide

- With a polyatomic:
  1. With a group A metal: name the cation ion, and then name the polyatomic
  2. With a group B metal: determine the charge, name the cation, use a roman numeral, and then name the polyatomic
  3. With a polyatomic cation: name the cation, name the nonmetal anion with –ide ending
  4. With two polyatomics: just name each of them in order

Example: Ions: Ca^{2+} and Cl^{1-}
Formula: $CaCl_2$
Name: Calcium chloride

Example: Ions: NH_4^{+} and SO_4^{2-}
Formula: $(NH_4)_2SO_4$
Name: Ammonium sulfate

Compounds composed of two nonmetals usually are not ionic, but covalent. Therefore, there are no ions, only atoms bonding together. Formulas of compounds such as these are written so that the subscripts (x and y) are whole numbers. If not specified, a subscript of 1 is implied. Use the following rules for naming binary compounds:

1. If MORE than one atom of the first element is present in the formula, state the prefix corresponding to that number. Do not use a prefix if there is only one atom present.
2. State the name of the first element.
3. Always state the prefix corresponding to the subscript of the second element (mono for one).
4. State the name of the root of the second element followed by the suffix –ide.
5. The following list includes the prefixes corresponding to the number of an element's atoms present in the formula.

mono = 1	hexa = 6	tetra = 4	nona = 9
di = 2	hepta = 7	penta = 5	deca = 10
tri = 3	octa = 8		

Example: Formula: OF_2
Name: Oxygen difluoride
Example: Formula: P_2O_5
Name: diphoshorous pentoxide
Example: Formula: CO
Name: carbon monoxide

List of polyatomic ions:

OH^-	Hydroxide
NH_4^+	Ammonium
NO_3^-	Nitrate
NO_2^-	Nitrite
ClO_4^-	Perchlorate
ClO_3^-	Chlorate
ClO_2^-	Chlorite
ClO^-	Hypochlorite
CO_3^{-2}	Carbonate
HCO_3^-	Hydrogen carbonate (or bicarbonate)
CN^-	Cyanide
$C_2H_3O_2^-$ (or CH_3COO^-)	Acetate
SO_4^{-2}	Sulfate

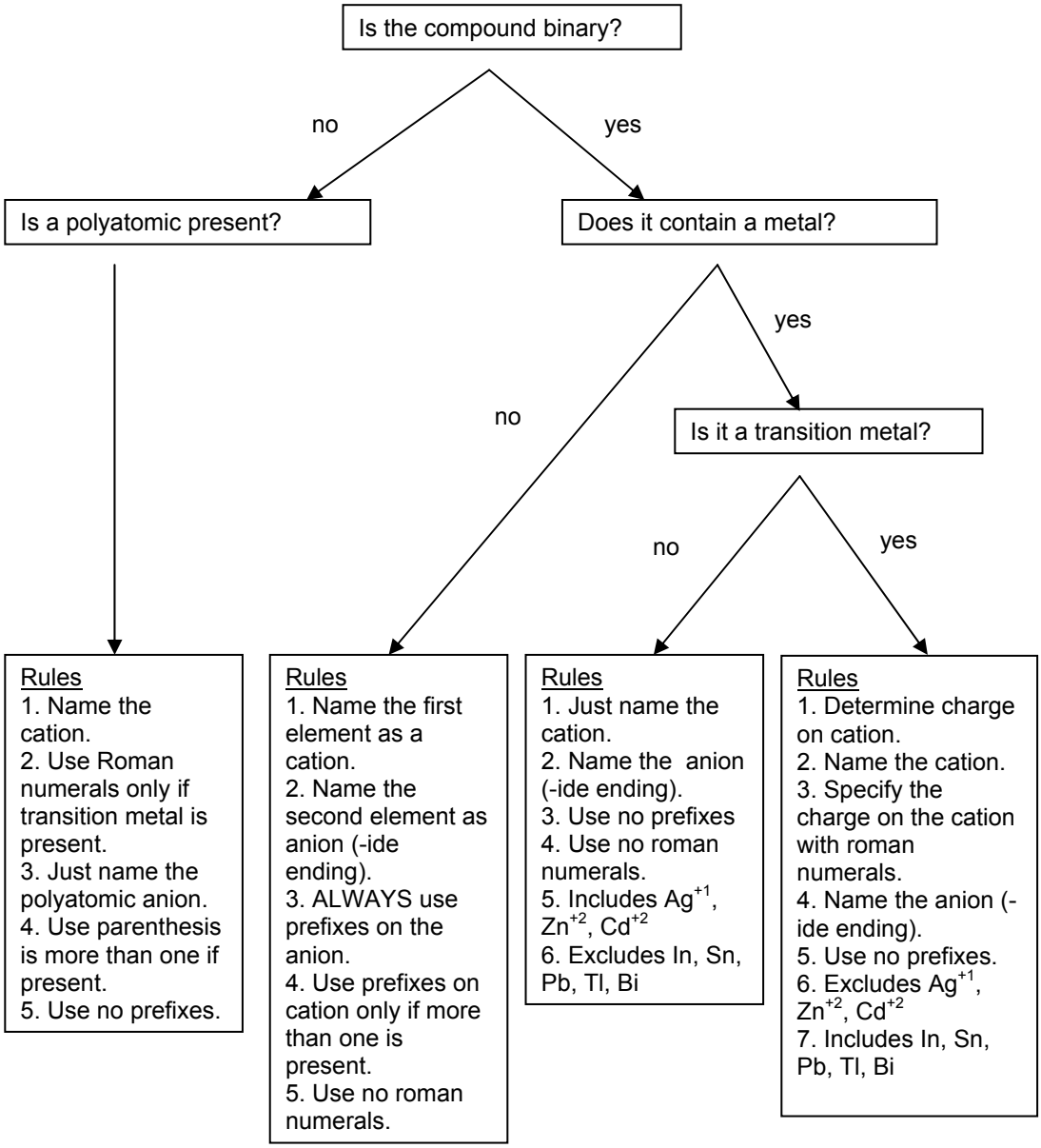
SO_3^{-2}	Sulfite
HSO_4^-	Hydrogen sulfate (or bisulfate)
HSO_3^-	Hydrogen sulfite (or bisulfite)
PO_4^{-3}	Phosphate
HPO_4^{-2}	Hydrogen phosphate
$H_2PO_4^-$	Dihydrogen phosphate
PO_3^{-3}	Phosphite
MnO_4^-	Permanganate
CrO_4^{-2}	Chromate
$C_2O_4^{-2}$	Oxalate
$Cr_2O_7^{-2}$	Dichromate
Hg_2^{+2}	Mercury (I)

Experimental procedure:

1. Group 1A metal atoms tend to lose 1 electron and become a cation with a charge of 1+. Typically, so does silver (Ag). Write the formulas of the ions provided on the data summary sheet.
2. Group 2A metal atoms tend to lose 2 electrons and become a cation with a charge of 2+. Typically, so does zinc (Zn) and cadmium (Cd). Write the formulas of the ions provided on the data summary sheet.
3. Group 3A metal atoms tend to lose 3 electrons and become a cation with a charge of 3+. Write the formulas of the ions provided on the data summary sheet.
4. Transition metal atoms may lose a variable number of electrons, depending on the reaction condition. Also some of the larger representative metals can form more than one cation. If two or more charges are possible, it is necessary to specify the charge by using a roman numeral in parenthesis after stating the name of the cation. Write the formulas of the ions provided on the data summary sheet.
5. Atoms of the nonmetals in Group 7A (the halogens) tend to gain one electron and become anions with a charge of 1-. The name of an anion is composed of the root of the nonmetal's name and the suffix –ide. Write the formulas of the ions provided on the data summary sheet.
6. Atoms of nonmetals in Group 6A tend to gain two electrons and become anions with a charge of 2-. The name of the anions is composed of the root of the nonmetal's name and the end with a suffix of –ide. Write the formulas of the ions provided on the data summary sheet.

7. On the answer sheet write the correct formula for the ionic compounds.
8. On the answer sheet write the name of the ionic compounds. For the compounds containing metals that can form more than one cation, be sure to include roman numerals.
9. On the answer sheet name the binary compounds composed of nonmetals.
10. On the answer sheet write down the correct formula for the binary compounds composed of nonmetals.

Naming Compounds Flow Chart



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Lab Session 5, Experiment 4 Chemical Nomenclature

Name: _____

Date: _____

Instructor: _____

DATA SUMMARY SHEET
CHEMICAL NOMENCLATURE

Cations:

a) Sodium ion _____
b) Lithium ion _____
c) Potassium ion _____
d) Cesium ion _____
e) Rubidium ion _____
f) Silver ion _____
g) Magnesium ion _____
h) Barium ion _____
i) Beryllium ion _____
j) Zinc ion _____
k) Calcium ion _____
l) Strontium ion _____
m) Cadmium ion _____
n) Aluminum ion _____
o) Iron (II) ion _____
p) Iron (III) ion _____
q) Tin (II) ion _____
r) Tin (IV) ion _____
s) Copper (I) ion _____
t) Copper (II) ion _____
u) Lead (II) ion _____
v) Lead (IV) ion _____

Anions:

a) Fluoride ion _____
b) Bromide ion _____
c) Chloride ion _____
d) Iodide ion _____
e) Oxide ion _____
f) Selenide ion _____
g) Sulfide ion _____
h) Telluride ion _____

Write the correct formula for the ionic compounds.

a) Silver Selenide _____

b) Tin (IV) hydroxide _____

c) Potassium sulfate _____

d) Lithium sulfate _____

e) Ammonium sulfate _____

f) Barium carbonate _____

g) Magnesium carbonate _____

h) Cobalt (II) bromide _____

i) Sodium oxide _____

j) Barium bromide _____

k) Aluminum iodide _____

l) Zinc chloride _____

m) Silver phosphate _____

n) Ammonium phosphate _____

o) Cadmium fluoride _____

p) Magnesium hydroxide _____

q) Rubidium sulfate _____

r) Lithium hydroxide _____

s) Mercury (II) oxide _____

t) Aluminum permanganate _____

u) Zinc sulfate _____

v) Lead (II) acetate _____

a) Sodium chloride _____

b) Magnesium chloride _____

c) Mercury (II) nitrate _____

d) Zinc nitrate _____

e) Tin (IV) oxide _____

f) Cobalt (II) hydroxide _____

g) Ammonium sulfide _____

h) Sodium bicarbonate _____

i) Tin (II) phosphate _____

j) Iron (II) sulfide _____

k) Aluminum dichromate _____

Write the name of the ionic compounds. For the compounds containing metals that can form more than one cation, be sure to include roman numerals.

a) K_2S _____

b) $CaCl_2$ _____

c) Na_2CO_3 _____

d) $Fe(NO_2)_3$ _____

e) $Fe(NO_3)_2$ _____

f) $Zn_3(PO_4)_2$ _____

g) $BaBr_2$ _____

h) $AgCl$ _____

i) $CaSO_4$ _____

j) $MgSO_3$ _____

k) $Sn_3(PO_4)_4$ _____

l) NaBr _____

m) Na_2SO_4 _____

n) K_3PO_3 _____

o) $Cu(NO_3)_2$ _____

Name the covalent compounds composed of nonmetals.

a) CF_4 _____

b) P_4O_{10} _____

c) SF_6 _____

d) S_2F_2 _____

e) SO_3 _____

f) PCl_3 _____

g) NO _____

Write down the correct formula for the covalent compounds composed of nonmetals.

a) Phosphorous pentachloride _____

b) Carbon tetrachloride _____

c) Carbon dioxide _____

d) Dinitrogen trioxide _____

e) Dihydrogen monoxide _____

f) Another name for dihydrogen monoxide is: _____