Chapter 8 – Nomenclature

8.1 Names of Atoms

Simple neutral atoms with no charge are named as is: Na is sodium atom, Ne is neon atom

⇒ Know the names and symbols for elements #1-20
and Ba, Co, I, Cu, Fe, Pb, Hg, Ag, Au, Zn, Sn, Sr, Ni, Br, Cr, Mn, Cd

Ba barium	Cu copper	Hg mercury
Co cobalt	Fe iron	Ag silver
I iodine	Pb lead	Au gold
Zn zinc	Sn tin	Ni nickel
Br bromine	Cr chromium	Mn manganese
Cd cadmium	Sr strontium	

Definitions:

- **ionic compound**: *metal + nonmetal(s)* (eg. NaCl, $CaBr_2$, $KMnO_4$, $BaSO_4$)
- **covalent compound**: *2 or more nonmetals* (eg. NH_3, CCl_4)
- **monoatomic ion**: charged ion from a *single atom* (eg Na^+, Cl^-, O^{2-})
- **polyatomic ion**: charged ion containing *2 or more atoms* (eg. OH^-, SO_4^{2-})

Charges

- All elements **alone** have a charge of **zero** in their elemental state
- Atoms get a charge and become ions when they have lost or gained electrons

CATIONS - positively charged ion resulting from a neutral metal atom losing one or more e-'s.

Fixed Charge – The charge is always the same value – based on electron configuration.

- Typically group "A" representative metals.
  - Group IA metals always have a +1 charge when they become an ion.
    Example: Na^+ is sodium ion, K^+ is potassium ion
  - Group IIA metals always have a +2 charge when they become an ion.
    Example: Mg^{2+} is magnesium ion, Sr^{2+} is strontium ion
  - Group IIIA metals always have a +3 charge when they become an ion.
    Example: Al^{3+} is aluminum ion, Ga^{3+} is gallium ion
  - Exceptions: The transition metals Ag^{+1}, Zn^{2+}, and Cd^{2+} have fixed charges.

Ion Charge	Roman Numeral
+1	I
+2	II
+3	III
+4	IV
+5	V
+6	VI

Variable Charge – The charge can be a different value.

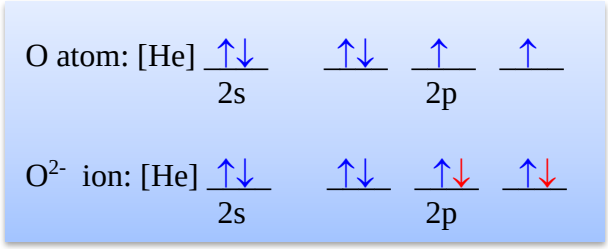
- Typically group "B" transition metals.
  - Use a Roman Numeral to indicate the charge of the cation if there is more than one possible charge.

Example: Fe can have two charges
Fe^{2+} is iron (II) ion
Fe^{3+} is iron (III) ion

- Exceptions: Group A metals Sn and Pb
  Sn^{2+} is tin (II) ion, Sn^{4+} is tin (IV) ion
  Pb^{2+} is lead (II) ion, Pb^{4+} is lead (IV) ion

ANIONS – negatively charged ion resulting from a neutral nonmetal atom gaining one or more e⁻'s.

- **Monatomic anions**: Name changes for these anions by adding ***–ide*** ending.
- ***Always*** a fixed charged - based on electron configuration
  - Group VA – gain 3 e⁻'s to make 3- ions.
    N^{3-} nitride ion
    P^{3-} phosphide ion
  - Group VIA – gain 2 e⁻'s to make 2- ions
    O^{2-} oxide ion
    S^{2-} sulfide ion
  - Group VIIA – gain 1 e⁻ to make 1- ions
    F^- fluoride ion
    Cl^- chloride ion
    Br^- bromide ion
    I^- iodide ion



Oxygen gains *only* two electrons.
The resulting oxide ion is then isoelectronic to the noble gas neon, Ne.

POLYATOMICS – two or more nonmetals covalently bonded with an overall charge.
Here is the complete list of Polyatomic Ions you are responsible for this semester:

Most Common Polyatomic Ions

NH_4^+ = ammonium
$C_2H_3O_2^-$ = acetate
OH^- = hydroxide
CN^- = cyanide
MnO_4^- = permanganate
CO_3^{2-} = carbonate
HCO_3^- = hydrogen carbonate or bicarbonate
NO_3^- = nitrate
NO_2^- = nitrite
SO_4^{2-} = sulfate
SO_3^{2-} = sulfite
PO_4^{3-} = phosphate
CrO_4^{2-} = chromate
$Cr_2O_7^{2-}$ = dichromate

*These are given to you on your CHM130 Periodic Table for quizzes and exams.

8.2 Ionic Formulas

Compounds are Neutral

They have no net charge so you must have enough cations and anions to equal zero.

Na^+ and Cl^- make NaCl since +1 and –1 = 0
Na^+ and CN^- make NaCN since +1and –1 = 0
Ba^{2+} and Cl^- make $BaCl_2$ since +2 and 2(-1) = 0

Al^{3+} and O^{2-} make Al_2O_3 since 2(+3) and 3(-2) = 0
Cu(II) and Br make $CuBr_2$ since +2 and 2(-1) = 0

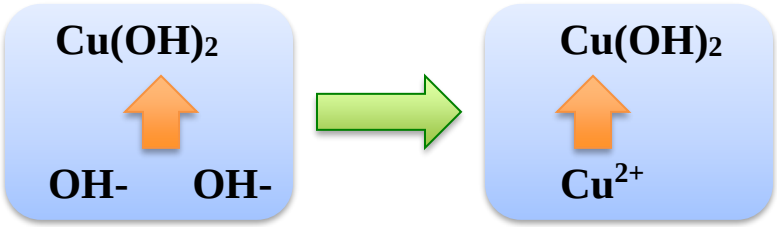
Polyatomic ions are just the same, remember to keep them together as a group
⇒ Express more than one polyatomic ion with subscripts and parentheses.

Sr^{2+} and NO_3^- make $Sr(NO_3)_2$ since +2 and 2(-1) = 0
Fe^{3+} and CO_3^{2-} make $Fe_2(CO_3)_3$ since 2(+3) and 3(-2) = 0

8.3 Ionic Names

- The name is always the cation (usually metal) first then the anion + -ide ending.
  Fixed Charge Metal: metal name + nonmetal name + "ide"
  Variable Charge Metal: metal name (charge of metal) + nonmetal name + "ide"
- *Don't* change the name for polyatomic ions to end in ide.
- For variable charge metals use a Roman Numeral to indicate the metal's charge.

  How do you figure out the charge on a variable charge metal? Well you look at the anion's charge.



The subscript of 2 indicates there are 2 OH^- ions in the formula.

The overall compound has zero charge, so the Cu ion must be 2+ to cancel the two -1 charges from the two hydroxide ions present.

- **Given the formula of a compound, predict the name:**

• What is the name for NaCl?	sodium chloride	(no Roman # since know Na is +1)
• What is the name for K_2SO_4?	potassium sulfate	(keep the polyatomic name as is)
• What is the name for CuCl?	copper (I) chloride	since Cl is –1 so Cu must be +1
• What is the name for $FePO_4$?	iron (III) phosphate	since PO_4 is –3 so Fe must be +3
• Name for $Ca(NO_3)_2$?	calcium nitrate	
• Name for Na_2O?	sodium oxide	

*Note: **Never** capitalize the names of compounds!*

- **Given the name of a compound, predict the formula:**

  ⇒ You must know charges on ions formed by Group A main elements.
  ⇒ Know *how to use* polyatomic ions given on your Periodic Table!

• lithium sulfide	Li_2S	since Li is +1 and S is –2 you need two Li's
• calcium oxide	CaO	since Ca is +2 and O is –2 you just need one of each
• iron (II) bromide	$FeBr_2$	since Fe is +2 and Br is –1 you need two Br's
• potassium acetate	$KC_2H_3O_2$	since K is +1 and acetate is –1, need one of each
• gold (II) nitrite	$Au(NO_2)_2$	since Au is +2 and NO_2 is –1, need two nitrites
• sodium iodide	NaI	since Na is +1 and I is –1, just need one of each

8.4 Covalent Names

Molecular Compounds: compounds consisting of 2 nonmetals.

These are **NOT ions**, so no charges.

You are not trying to add up to zero charge with these.

Number of atoms of element indicated by Greek prefix before element name

FIRST ELEMENT	SECOND ELEMENT
prefix *(except mono)* + nonmetal name	**prefix + 2nd nonmetal name + ide**

# of atoms	Greek prefix	# of atoms	Greek prefix
1	mono	6	hexa
2	di	7	hepta
3	tri	8	octa
4	tetra	9	nona
5	penta	10	deca

N_2O_4

2 nitrogen atoms = di

4 oxygen atoms = tetra

dinitrogen tetraoxide
or
dinitrogen tetroxide

Examples:

- CO_2 = carbon dioxide
- PCl_3 = phosphorus trichloride
- N_2S_5 = dinitrogen pentasulfide
- SF_6 = sulfur hexafluoride
- Cl_2O_7 = dichlorine heptaoxide

Prefixes are ONLY used with molecular compounds.
Roman numerals are ONLY used with variable charged metal ionic compounds.
Polyatomic ions never change their name.

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CHAPTER 8 PRACTICE PROBLEMS

Example 1: Circle all the examples below that are ionic compounds.

HCl K_2O $MgCl_2$ PF_5 $CuBr_2$ $CaSO_4$ CH_2O

Example 2: Circle all the examples below that are covalent compounds.

HCl K_2O $MgCl_2$ PF_5 $CuBr_2$ $CaSO_4$ CH_2O

Example 3: What ions are the following atoms most likely to make?

calcium =	_____	potassium =	_____
sulfur =	_____	aluminum =	_____
nitrogen =	_____	chlorine =	_____
silver =	_____	zinc =	_____

Example 4: What is the name for: $CuCl_2$, SrS, $NiCrO_4$, $Mg(NO_3)_2$, Na_3P, $ZnCO_3$, KOH, $Ca(CN)_2$

Example 5: What is the formula for sodium carbonate, copper(II) bromide, strontium fluoride, iron(III) nitride, silver sulfite, nickel(II) nitrate, cadmium phosphate, ammonium hydroxide, magnesium sulfate?

Example 6: What is the name for CF_4, CO, PO_5, N_2F_4? What is the formula for diphosphorus tetraiodide, tribromine octaoxide, tetraphosphorus decasulfide, carbonic acid?

Answers to Practice Problems

Example 1: Circle all the examples below that are ionic compounds. metal-nonmetal

HCl K_2O $MgCl_2$ PF_5 $CuBr_2$ $CaSO_4$ CH_2O

Example 2: Circle all the examples below that are molecular compounds. nonmetals

HCl K_2O $MgCl_2$ PF_5 $CuBr_2$ $CaSO_4$ CH_2O

Example 3:

calcium =	**Ca^{2+}**	potassium =	**K^+**
sulfur =	**S^{2-}**	aluminum =	**Al^{3+}**
nitrogen =	**N^{3-}**	chlorine =	**Cl^-**
silver =	**Ag^+**	zinc =	**Zn^{2+}**

Example 4:	name
$CuCl_2$	**copper(II) chloride**
SrS	**strontium sulfide**
$NiCrO_4$	**nickel(II) chromate**
$Mg(NO_3)_2$	**magnesium nitrate**
$ZnCO_3$	**zinc carbonate**
Na_3P	**sodium phosphide**
KOH	**potassium hydroxide**
$Ca(CN)_2$	**calcium cyanide**

Example 5:	formula
sodium carbonate	**Na_2CO_3**
copper(II) bromide	**$CuBr_2$**
strontium fluoride	**SrF_2**
iron(III) nitride	**FeN**
silver sulfite	**Ag_2SO_3**
nickel(II) nitrate	**$Ni(NO_3)_2$**
cadmium phosphate	**$Cd_3(PO_4)_2$**
ammonium hydroxide	**NH_4OH**
magnesium sulfate	**$MgSO_4$**

Example 6: **carbon tetrafluoride, carbon monoxide, phosphorus pentaoxide, dinitrogen tetrafluoride, P_2I_4, Br_3O_8, P_4S_{10}, H_2CO_3**