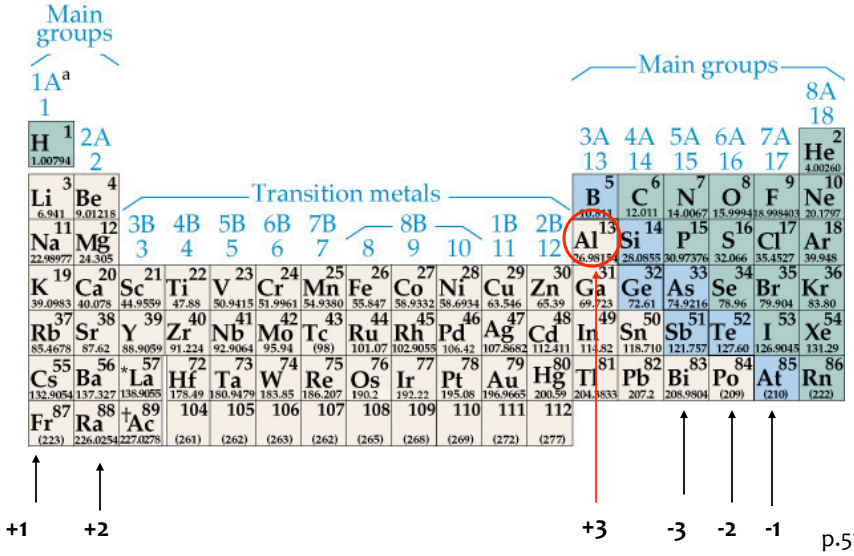
CHE1031 Lab Exercise:
Naming Chemical Compounds

Predicting Ionic Charge:

Use group numbers to predict ionic charge as shown below.
Transition metals have varying charges & cannot be predicted this way.



p.57-58

Naming Chemical Compounds:

p.60-67

There are three distinct naming systems, so your first task is determining what type of compound you're dealing with:

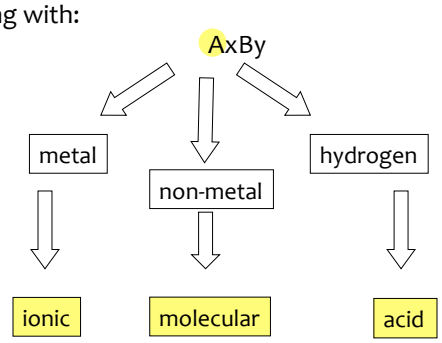
Ionic - metal + non-metal

Acid - H is always the first element

Molecular - only non-metals

So all you have to do is identify the first element in the compound as a metal, hydrogen or a non-metal.

Metals are on the West Coast.
Non-metals are on the East Coast.



Think learning three different systems is tough? Try memorizing each of the 1500 commonly used chemical, or all 5 MILLION.

Naming tutorial on the web @ www.towson.edu/~yau/NomenclatureTutorial.htm

Are these examples ionic, acid or molecular?

$Fe(OH)_2$	ionic	$HBrO_3$	acid
XeO_3	molecular	$Fe_2(CO_3)_3$	ionic
$Cu(NO_3)_2$	ionic	SO_3	molecular
H_3PO_4	acid	CO_2	molecular
SF_6	molecular	$Cd(II)(ClO_4)_2$	ionic
$CaHCO_3$	ionic	N_2O_4	molecular
$Sn(II)F_2$	ionic	HBr	acid
P_4S_6	molecular	IF_5	molecular
HF	acid	$HClO_3$	acid
HCN	acid	$(NH_4)_2SO_4$	ionic

Naming Cations:

Cations are positively charged ions - most often **metals**.
With one exception, cations are monoatomic.

Cations are named for the element they are derived from.
Transition metals (the Midwest) must include charge as (Roman numerals).

Na^{+1}	sodium ion
Mg^{+2}	magnesium ion
Fe^{+2}	iron (II) ion
Al^{+3}	aluminum ion
Cu^{+1}	copper (I) ion
Sr^{+2}	strontium ion
Mn^{+2}	manganese (II) ion
Cs^{+1}	cesium ion
Ca^{+2}	calcium ion
Sn^{+2}	tin (II) ion
Cr^{+3}	chromium (III) ion
NH_4^{+1}	ammonium ion

Element names can be found in the table below the periodic table on the front cover of your text.

Naming MONOATOMIC Anions:

Anions are negatively charged ions formed from non-metals. (a negative ion)
Anions can be either mono- or polyatomic.

Monoatomic anions consist of a single element (can have multiple copies).
Anions get the root name of their element + -ide suffix.

_____-ide

F^{-1}	fluoride ion
P^{-3}	phosphide ion
O^{-2}	oxide ion
Cl^{-1}	chloride ion
N^{-3}	nitride ion
I^{-1}	iodide ion
Br^{-1}	bromide ion
S^{-2}	sulfide ion

Element names can be found in the table below the periodic table on the front cover of your text.

Naming POLYATOMIC Anions:

Polyatomic anions are combinations of a more than one non-metal atom.
Generally, a non-metal & one or more **oxygen** atom(s).

Naming? Root name of the non-oxygen atom with a suffix:

- **hypo ____-ite** — less than fewer
- **-ite** — fewer oxygen atoms
- **-ate** — more oxygen atoms
- **per _____-ate** — even more oxygen atoms

NO_2^{-1} nitrite ion
NO_3^{-1} nitrate ion

ClO_1^{-1} hypochlorite ion
ClO_2^{-1} chlorite ion
ClO_3^{-1} chlorate ion
ClO_4^{-1} perchlorite ion

Unfortunately, there is no fixed pattern for polyatomic naming.

Just distinct groups or families.

HCO_3 hydrogen carbonate

Get to Know POLYATOMIC Families:

NH_4^+ ammonium

AsO_4^{-3} arsenate

Cr ? chromium (x)
CrO_4^{-2} chromate
$Cr_2O_7^{-2}$ dichromate

Memorize these!

MnO_4^{-1} permanganate

$C_2H_3O_2^{-1}$ acetate
CN^{-1} cyanide
SCN^{-1} thiocyanate
CO_3^{-2} cabonate
HCO_3^{-1} hydrogen carbonate

NO_2^{-1} nitrite
NO_3^{-1} nitrate

O_2^{-2} peroxide
OH^{-1} hydroxide

S^{-2} sulfide
SO_3^{-2} sulfite
SO_4^{-2} sulfate
HSO_3^{-1} hydrogen sulfite
SCN^{-1} thiocyanate

Cl^{-1} chloride
ClO^{-1} hypochlorite
ClO_2^{-1} chlorite
ClO_3^{-1} chlorate
ClO_4^{-1} perchlorate

PO_4^{-3} phosphate
HPO_4^{-2} hydrogen phosphate
$H_2PO_4^{-1}$ dihydrogen phosphate

What about formulas of ionic compounds?

All molecules (ionic, molecular, or acid) have a net charge of **zero**.
So total positive and negative charges must be equal - must cancel out.

How do you ensure a net zero charge?
Use subscripts to balance positive & negative charges.

CatxAny → zero

Mg Cl	1, 2	Sr SO_4	1, 1
Na O	2, 1	Cr ClO_3	1, 3
N F	1, 3	Li PO_4	3, 1
Ba Br	1, 2	Ca NO_3	1, 2
Fe S	1 (II), 1	Cs BrO_3	1, 1 ??
Ni N	3, 2	Fe CO_3	1 (II), 1

Three steps:
1. Assign ionic charges
2. Cross charges down to the other ion
3. Use these as subscripts for that ion

Ionic formulas are always empirical formulas.

If you are given a cation and anion and are asked to give the formula, you can write ONLY the empirical formula (i.e. ratio of elements).

How?

Ionic compounds have ONLY empirical formulas !!

- The net sum of compounds must be zero.
- Each ion has a given charge.
- **You** must determine what # of each ion the compound must have for a net charge of zero.

Al and Cl ions	1 & 3	Na and PO_4 ions	3 & 1
Al and O ions	2 & 3	Zn and SO_4 ions	1 (I) & 1
Mg and NO_3 ions	1 & 2	Fe and CO_3 ions	1 (II) & 1

So… back to naming ionic compounds.

Naming ionic compounds is fairly straightforward.

Name the cation first, and the anion second
- together they make up the name

NEVER include the **subscript numbers** in the name.

Mg Cl	magnesium chloride	Sr SO_4	strontium sulfate
Na O	sodium oxide	Cr ClO_3	chromium chlorate
N F	nitrogen fluoride	Li PO_4	lithium phosphate
Ba Br	barium bromide	Ca NO_3	calcium nitrate
Fe S	iron (II) sulfide	Cs BrO_3	cesium bromate
Ni N	nickel (III) nitride	Fe CO_3	iron (II) carbonate

Naming MOLECULAR compounds is much easier.

Remember that a molecular compound is: a combination of two non-metals.

Elements are named from left to right (as found in the peroidic table):
- Left-hand element gets the element name.
- Right-hand element is named for its root + **-ide** suffix.

Molecular compounds use Greek prefixes to 'name' subscript numbers.

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

Both elements get prefixes
EXCEPT when there is only
a single atom of the first element.

Naming MOLECULAR compounds is much easier.

Elements are named from left to right (as found in the peroidic table):
- Left-hand element gets the element name.
- Right-hand element is named for its root + **-ide** suffix.

Molecular compounds use Greek prefixes to **'include'** subscript numbers.

(Net charge of molecular compounds is still zero.)

C_2O_2	dicarbon dioxide
CO_2	carbon dioxide
CO	monocarbon monoxide

NOTE: It's difficult to predict the formula of molecular compounds.

P_4S_{10}	tetraphosphorous decasulfide	SO_2	sulfur dioxide
Cl_2O	dichloride monoxide	PCl_5	phosphorous pentachloride
N_2O_4	dinitrogen tetroxide	S_2Cl_2	disulfur dichloride
NF_3	nitrogen trifluoride	$SiBr_4$	silicon tetrabromide

Names of ACIDS are based on anion names.

Remember that acids are compounds that can donate protons (H^+).
Acid formulas always **begin with H**: HCl, HBr, H_2SO_4

Since all acids have protons, names are based on the **anion name**.

MONOatomic acids: **hydro** root **-ic acid**

HCl	hydrochloric acid
HBr	hydrobromic acid
H_2S	hydrosulfuric acid
HF	hydrofluoric acid

POLYatomic acids: change the suffix & add the word acid (no hydro-)
- -ate --> **-ic acid**
- -ite --> **-ous acid**

H_2SO_3	sulfurous acid	HClO	hypochlorous acid
H_2SO_4	sulfuric acid	$HClO_2$	chlorous acid
		$HClO_3$	chloric acid
		$HClO_4$	perchloric acid