CHE 1031: General Chemistry I

2. Atoms, molecules & ions

2.1: Early ideas about atomic theory

2.2: Evolution of atomic theory

2.3: Atomic structure & symbolism

2.4: Chemical formulas

2.5: The periodic table

2.6: Molecular & ionic compounds

2.7: Naming chemical compounds → *covered in lab*

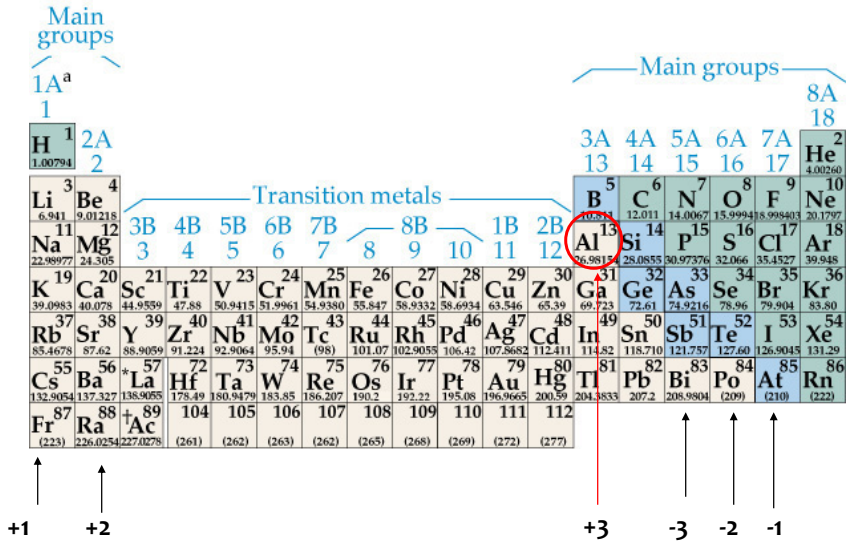
2. Atoms, molecules & ions

2.7: Naming chemical compounds

- Identifying a molecule's type
- Naming ionic compounds
  - Cations
  - Anions: mono- and polyatomic
  - Ionic compounds
- Naming molecular compounds
- Naming acids and bases

Predicting ionic charge

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



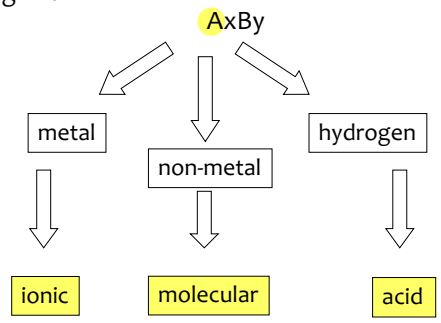
Which type of molecule is this?

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

Ionic

Acid

Molecular



Are these examples ionic, acid or molecul

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

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}
Mg^{+2}
Fe^{+2}
Al^{+3}
Cu^{+1}
Sr^{+2}
Mn^{+2}
Cs^{+1}
Ca^{+2}
Sn^{+2}
Cr^{+3}

NH_4^{+1}

Naming monoatomic anions

Anions are negatively charged ions formed from non-metals.

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}
P^{-3}
O^{-2}
Cl^{-1}
N^{-3}
I^{-1}
Br^{-1}
S^{-2}

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**
- **-ite**
- **-ate**
- **per _____-ate**

NO_2^{-1}
NO_3^{-1}

ClO_1^{-1}
ClO_2^{-1}
ClO_3^{-1}
ClO_4^{-1}

HCO_3

Families of polyatomic anions

NH_4^+	ammonium	Cr ?	chromium (x)		
		CrO_4^{-2}	chromate		
AsO_4^{-3}	arsenate	$Cr_2O_7^{-2}$	dichromate		
		MnO_4^{-1}	permanganate		
$C_2H_3O_2^{-1}$	acetate	NO_2^{-1}	nitrite	S^{-2}	sulfide
CN^{-1}	cyanide	NO_3^{-1}	nitrate	SO_3^{-2}	sulfite
SCN^{-1}	thiocyanate			SO_4^{-2}	sulfate
CO_3^{-2}	carbonate	O_2^{-2}	peroxide	HSO_3^{-1}	hydrogen sulfite
HCO_3^{-1}	hydrogen carbonate	OH^{-1}	hydroxide	SCN^{-1}	thiocyanate
Cl^{-1}	chloride	PO_4^{-3}	phosphate		
ClO^{-1}	hypochlorite	HPO_4^{-2}	hydrogen phosphate		
ClO_2^{-1}	chlorite	$H_2PO_4^{-1}$	dihydrogen phosphate		
ClO_3^{-1}	chlorate				
ClO_4^{-1}	perchlorate				

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?

CatxAny

Mg Cl	Sr SO_4
Na O	Cr ClO_3
Na F	Li PO_4
Ba Br	Ca NO_3
Fe S	Cs BrO_3
Ni N	Fe CO_3

Ionic formulas are 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?

Al and Cl ions

Al and O ions

Mg and NO_3 ions

Na and PO_4 ions

Zn and SO_4 ions

Fe and CO_3 ions

Practice naming ionic compounds

Naming ionic compounds is fairly straightforward.

Name the cation first, and the anion second

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

Mg Cl

Na O

Na F

Ba Br

Fe S

Ni N

Sr SO_4

Cr ClO_3

Li PO_4

Ca NO_3

Cs BrO_3

Fe CO_3

Molecular names use prefixes

Remember that a molecular compound is:

Elements are named from left to right (as found in the peroidic table):

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

mono
di
tri
tetra
penta
hexa
hepta
octa
nona
deca

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

Naming molecular compounds

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
CO_2
CO

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

P_4S_{10} SO_2

Cl_2O PCl_5

N_2O_4 S_2Cl_2

NF_3 $SiBr_4$

Naming acids (a bit like ionics)

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
HBr
H_2S
HF

POLYatomic acids: change the suffix & add the word acid (no hydro-)

- -ate --> **-ic acid**
- -ite --> **-ous acid**

H_2SO_3
H_2SO_4

HClO
$HClO_2$
$HClO_3$
$HClO_4$