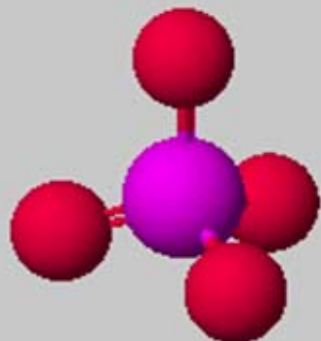


Chemistry 1: Chapter 9

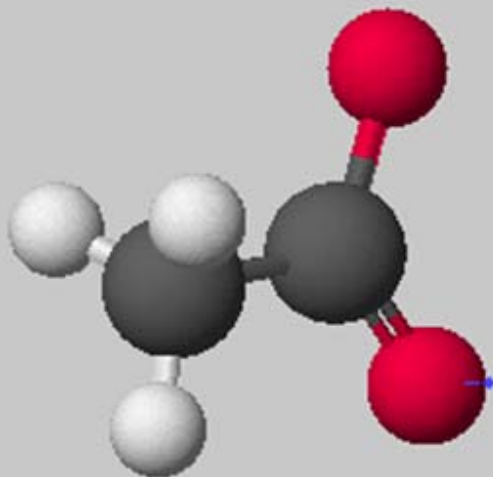
Chemistry 1 Honors: Chapter 4

ICP: Chapter 20

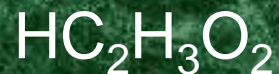


PO_4^{3-}
phosphate ion

Nomenclature



$\text{C}_2\text{H}_3\text{O}_2^-$
acetate ion



Acetic Acid

SAVE PAPER AND INK!!! When you print out the notes on PowerPoint, print "Handouts" instead of "Slides" in the print setup. Also, turn off the backgrounds (Tools>Options>Print>UNcheck "Background Printing")!

Forms of Chemical Bonds



Most bonds are somewhere in between ionic and covalent.

- There are 3 forms bonding atoms:
- **Ionic**—complete *transfer* of 1 or more electrons from one atom to another (one loses, the other gains)
- **Covalent**—some valence electrons *shared* between atoms
- — holds atoms of a metal together

Common Names

- A lot of chemicals have common names as well as the proper IUPAC name.
- Chemicals that should always be named by common name and never named by the IUPAC method are:
 - H_2O water, not dihydrogen monoxide
 - NH_3 ammonia, not nitrogen trihydride

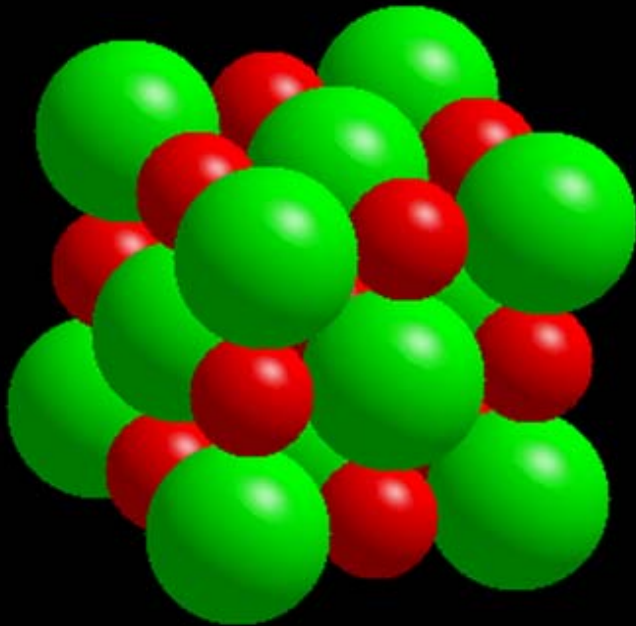


COMPOUNDS FORMED FROM IONS

CATION +
ANION \rightarrow
COMPOUND



**A neutral compound
requires
equal number of +
and - charges.**



Predicting Charges on Monatomic Ions KNOW THESE !!!!

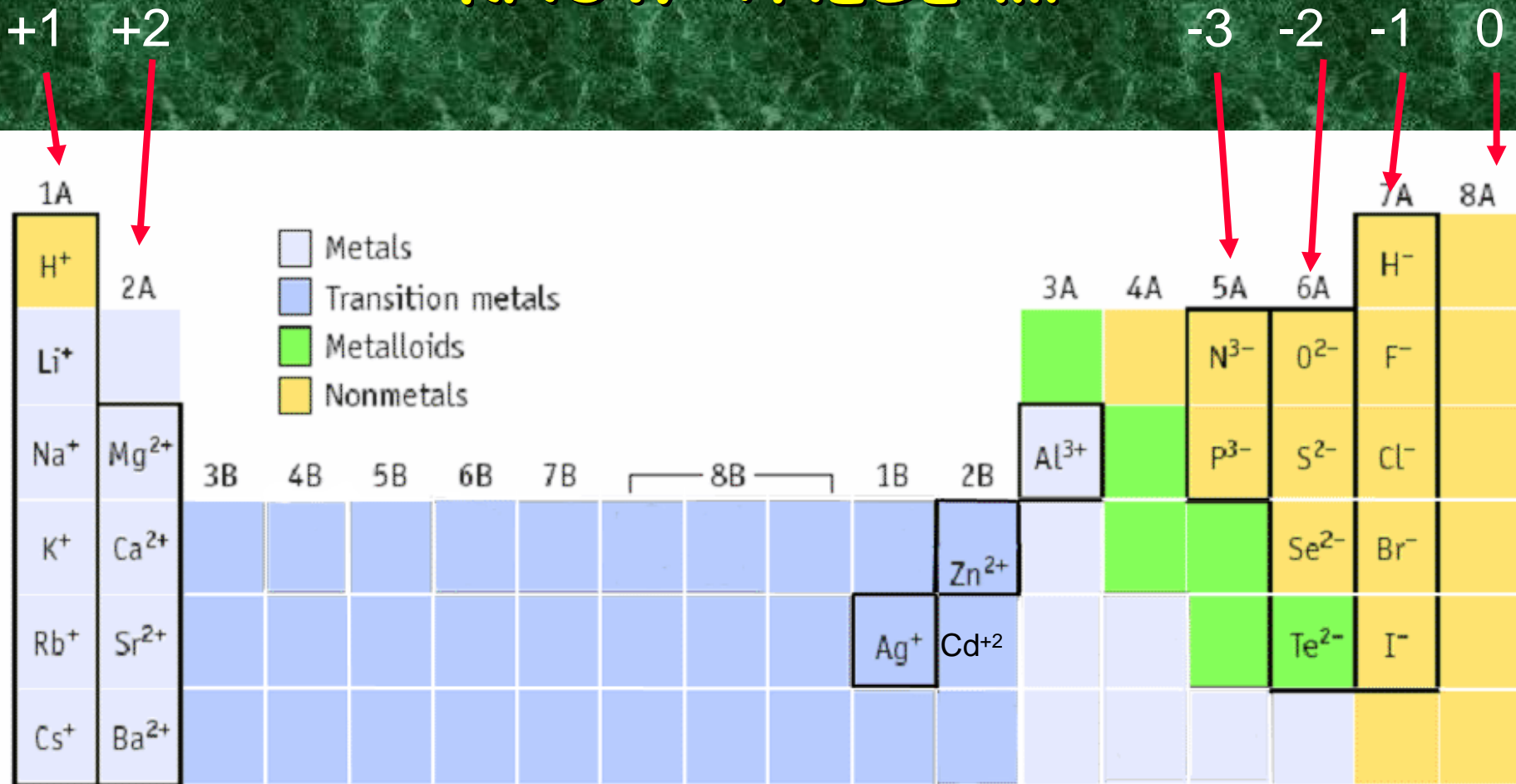
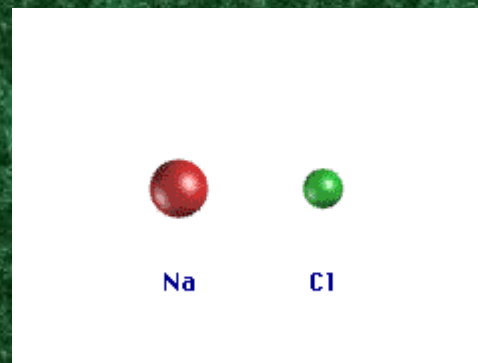


Figure 1. Charges on some common monatomic cations and anions. Metals usually form cations and nonmetals usually form anions.

Properties of Ionic Compounds

Forming NaCl from Na and Cl₂

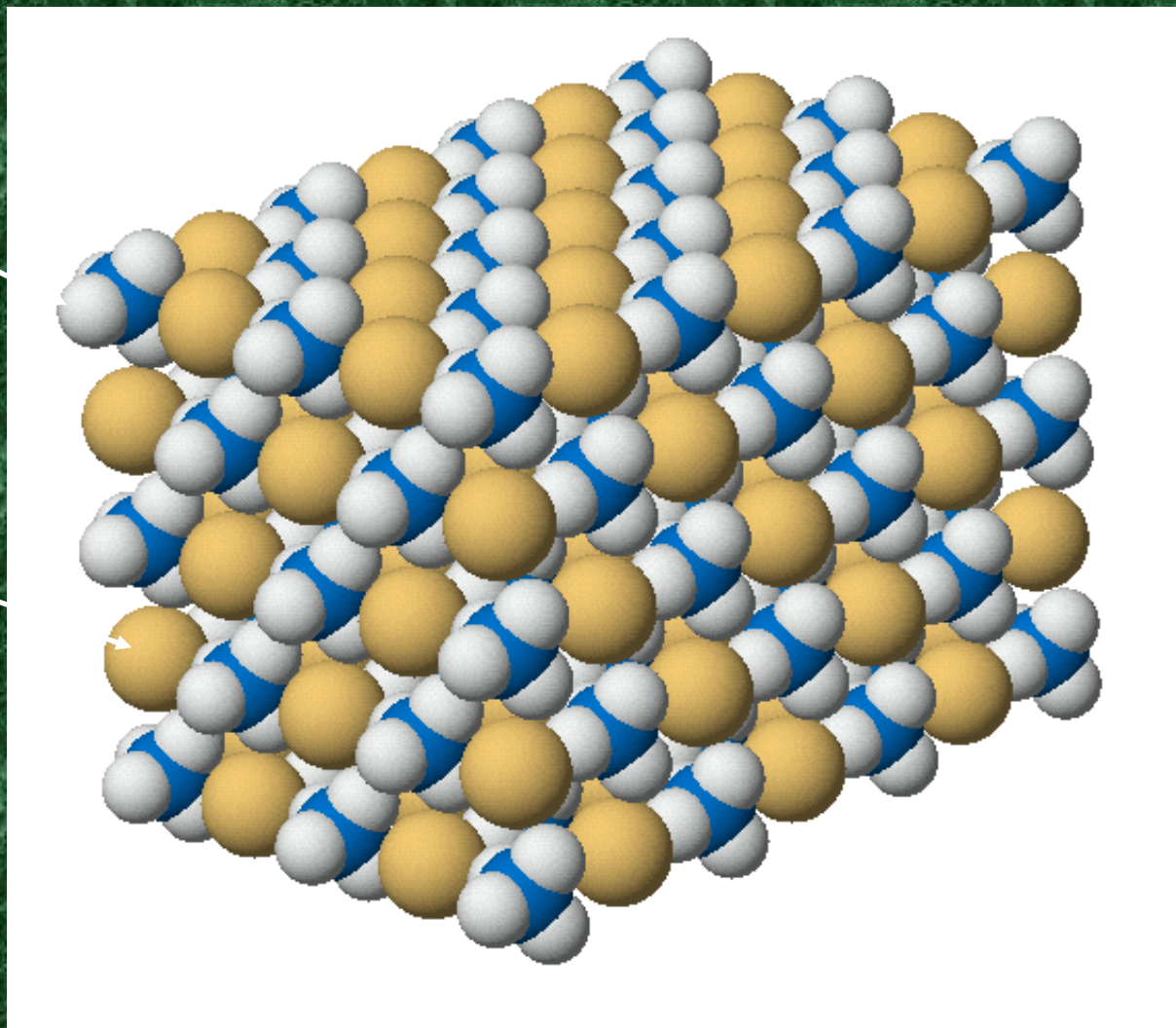
- A metal atom can transfer an electron to a nonmetal.
- The resulting cation and anion are attracted to each other by **electrostatic forces**.



IONIC COMPOUNDS

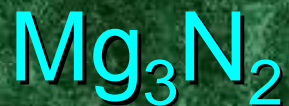
NH_4^+

Cl^-



ammonium chloride, NH_4Cl

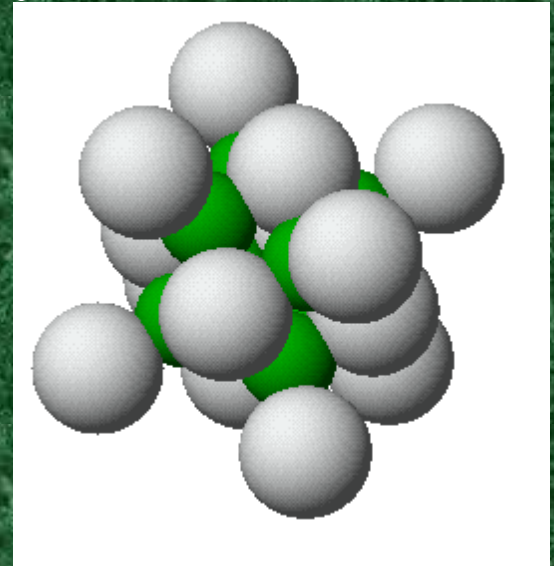
Some Ionic Compounds



magnesium nitride



Tin (IV) oxide



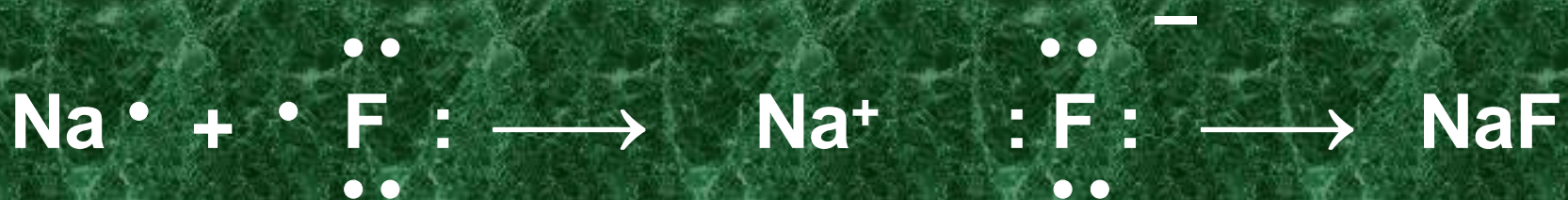
calcium fluoride

Formulas of Ionic Compounds

Formulas of ionic compounds are determined from the charges on the ions

atoms

ions



sodium + fluorine \longrightarrow sodium fluoride formula

Charge balance: 1+ 1- = 0

Monatomic Ions

TABLE 4.1

Common Simple Cations and Anions

Cation	Name	Anion	Name*
H ⁺	hydrogen	H ⁻	hydride
Li ⁺	lithium	F ⁻	fluoride
Na ⁺	sodium	Cl ⁻	chloride
K ⁺	potassium	Br ⁻	bromide
Cs ⁺	cesium	I ⁻	iodide
Be ²⁺	beryllium	O ²⁻	oxide
Mg ²⁺	magnesium	S ²⁻	sulfide
Ca ²⁺	calcium		
Ba ²⁺	barium		
Al ³⁺	aluminum		
Ag ⁺	silver		

*The root is given in color.

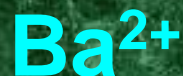
Writing a Formula

Write the formula for the ionic compound that will form between Ba^{2+} and Cl^- .

Solution:

1. Balance charge with + and – ions
2. Write the positive ion of metal first, and the

negative ion



3. Write the number of ions needed as
subscripts



Learning Check

Write the correct formula for the compounds containing the following ions:

1. Na^+ , S^{2-}

a) NaS

b) Na_2S

c) NaS_2

2. Al^{3+} , Cl^-

a) AlCl_3

b) AlCl

c) Al_3Cl

3. Mg^{2+} , N^{3-}

a) MgN

b) Mg_2N_3

c) Mg_3N_2

Solution

1. Na^+ , S^{2-}

b) Na_2S

2. Al^{3+} , Cl^-

a) AlCl_3

3. Mg^{2+} , N^{3-}

c) Mg_3N_2

Naming Compounds

Binary Ionic Compounds:

- 1. Cation first, then anion
- 2. Monatomic cation = name of the element
 - Ca^{2+} = calcium ion
- 3. Monatomic anion = root + -ide
 - Cl^- = chloride
 - CaCl_2 = calcium chloride

Naming Binary Ionic Compounds

- **Examples:**



sodium chloride



zinc iodide



aluminum oxide

Learning Check

Complete the names of the following binary compounds:

Na_3N sodium _____

KBr potassium _____

Al_2O_3 aluminum _____

MgS _____

Transition Metals

Elements that can have more than one possible charge **MUST** have a Roman Numeral to indicate the charge on the individual ion.

1+ or 2+

2+ or 3+

Cu^+ , Cu^{2+}

Fe^{2+} , Fe^{3+}

copper(I) ion

iron(II) ion

copper (II) ion

iron(III) ion

Names of Variable Ions

These elements REQUIRE Roman Numerals because they can have more than one possible charge:

anything except Group 1A, 2A, Ag, Zn, Cd, and Al

(You should already know the charges on these!)

Or another way to say it is: Transition metals and the **metals** in groups 4A and 5A (except Ag, Zn, Cd, and Al) require a Roman Numeral.

FeCl_3	(Fe^{3+})	iron (III) chloride
CuCl	(Cu^+)	copper (I) chloride
SnF_4	(Sn^{4+})	tin (IV) fluoride
PbCl_2	(Pb^{2+})	lead (II) chloride
Fe_2S_3	(Fe^{3+})	iron (III) sulfide

Examples of Older Names of Cations formed from Transition Metals

(you do not have to memorize these)

TABLE 4.2

Common Type II Cations

Ion	Systematic Name	Older Name
Fe^{3+}	iron(III)	ferric
Fe^{2+}	iron(II)	ferrous
Cu^{2+}	copper(II)	cupric
Cu^{+}	copper(I)	cuprous
Co^{3+}	cobalt(III)	cobaltic
Co^{2+}	cobalt(II)	cobaltous
Sn^{4+}	tin(IV)	stannic
Sn^{2+}	tin(II)	stannous
Pb^{4+}	lead(IV)	plumbic
Pb^{2+}	lead(II)	plumbous
Hg^{2+}	mercury(II)	mercuric
Hg_2^{2+*}	mercury(I)	mercurous

*Mercury(I) ions always occur bound together in pairs to form Hg_2^{2+} .

Learning Check

Complete the names of the following binary compounds with variable metal ions:

FeBr_2 iron (_____) bromide

CuCl copper (_____) chloride

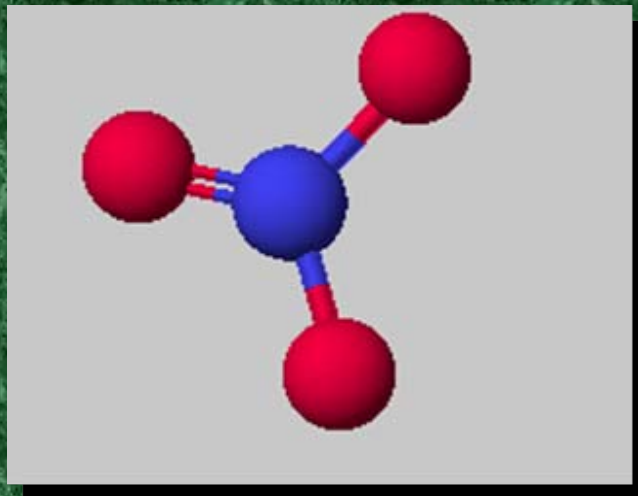
SnO_2 _____ (_____) _____

Fe_2O_3 _____

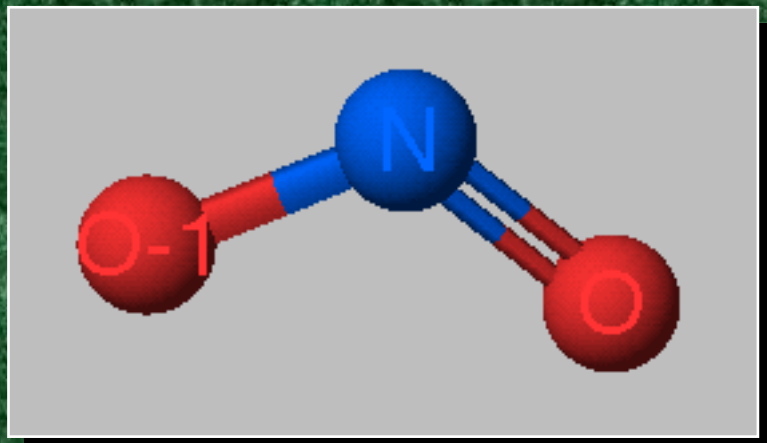
Hg_2S _____

Polyatomic Ions

NO_3^-
nitrate ion



NO_2^-
nitrite ion



Polyatomic Ions

You can make additional polyatomic ions by adding a H^+ to the ion!

CO_3^{-2} is carbonate

HCO_3^- is hydrogen carbonate

$H_2PO_4^-$ is dihydrogen phosphate

HSO_4^- is hydrogen sulfate

Ternary Ionic Nomenclature

Writing Formulas

- Write each ion, cation first. Don't show charges in the final formula.
- Overall charge must equal **zero**.
 - If charges cancel, just write symbols.
 - If not, use subscripts to balance charges.
- Use parentheses to show more than one of a particular **polyatomic ion**.
- Use **Roman numerals** indicate the ion's **charge** when needed (stock system)

Ternary Ionic Nomenclature

Sodium Sulfate

Na^+ and SO_4^{-2}



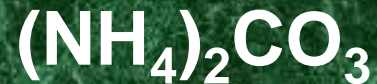
Iron (III) hydroxide

Fe^{+3} and OH^-



Ammonium carbonate

NH_4^+ and CO_3^{-2}



Learning Check

1. aluminum nitrate



2. copper(II) nitrate



3. Iron (III) hydroxide



4. Tin(IV) hydroxide



Naming Ternary Compounds

- Contains at least 3 elements
- There **MUST** be at least one **polyatomic ion**
(it helps to circle the ions)

- **Examples:**



Sodium **nitrate**



Potassium **sulfate**



Aluminum **bicarbonate**

or

Aluminum **hydrogen carbonate**

Learning Check

Match each set with the correct name:



a) magnesium sulfite

b) magnesium sulfate

c) sodium carbonate



a) calcium carbonate

b) calcium phosphate

c) calcium bicarbonate

Mixed Practice!

Name the following:

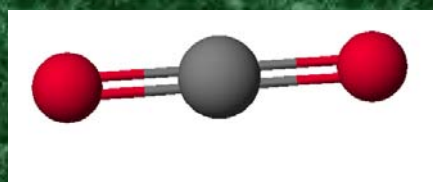
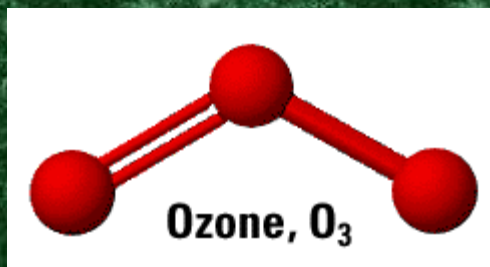


Mixed Up... The Other Way

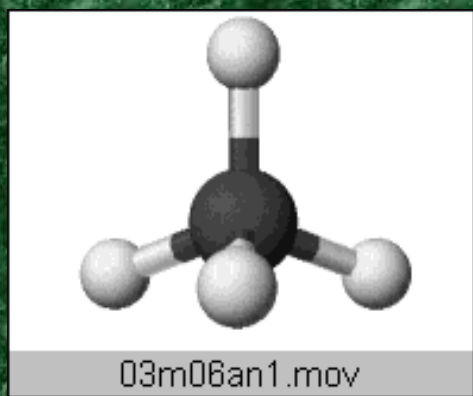
Write the formula:

1. Copper (II) chlorate
2. Calcium nitride
3. Aluminum carbonate
4. Potassium bromide
5. Barium fluoride
6. Cesium hydroxide

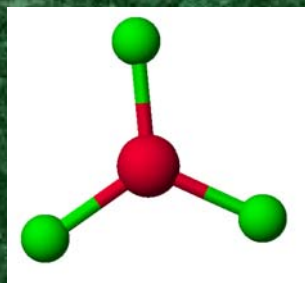
Naming Molecular Compounds



All are formed from two or more nonmetals.



CH_4 methane



Ionic compounds generally involve a metal and nonmetal (NaCl)

Molecular (Covalent) Nomenclature for two **nonmetals**

- **Prefix System** (binary compounds)

1. **Less electronegative** atom comes first.

2. Add **prefixes** to indicate # of atoms. Omit **mono-** prefix on the **FIRST** element. **Mono-** is **OPTIONAL** on the **SECOND** element (in this class, it's **NOT** optional!).

3. Change the ending of the second element to **-ide**.

The image shows a periodic table of elements. A blue arrow points from the right side of the table towards the left side, indicating that electronegativity increases in this direction. A red arrow points from the top of the table towards the bottom, indicating that electronegativity also increases in this direction. The table is color-coded by groups, with nonmetals in shades of blue and green, and metals in shades of red, orange, and yellow.

Molecular Nomenclature Prefixes

PREFIX	NUMBER
--------	--------

mono-	1
-------	---

di-	2
-----	---

tri-	3
------	---

tetra-	4
--------	---

penta-	5
--------	---

hexa-	6
-------	---

hepta-	7
--------	---

octa-	8
-------	---

nona-	9
-------	---

deca-	10
-------	----

Molecular Nomenclature: Examples

- **CCl_4**
 - carbon tetrachloride
- **N_2O**
 - dinitrogen monoxide
- **SF_6**
 - sulfur hexafluoride

More Molecular Examples

- **arsenic trichloride**
 - AsCl_3
- **dinitrogen pentoxide**
 - N_2O_5
- **tetraphosphorus decoxide**
 - P_4O_{10}

Learning Check

Fill in the blanks to complete the following names of covalent compounds.

CO carbon _____ oxide

CO₂ carbon _____

PCl₃ phosphorus _____ chloride

CCl₄ carbon _____ chloride

N₂O _____ nitrogen _____ oxide

Learning Check



- a) phosphorus oxide
- b) phosphorus pentoxide
- c) diphosphorus pentoxide

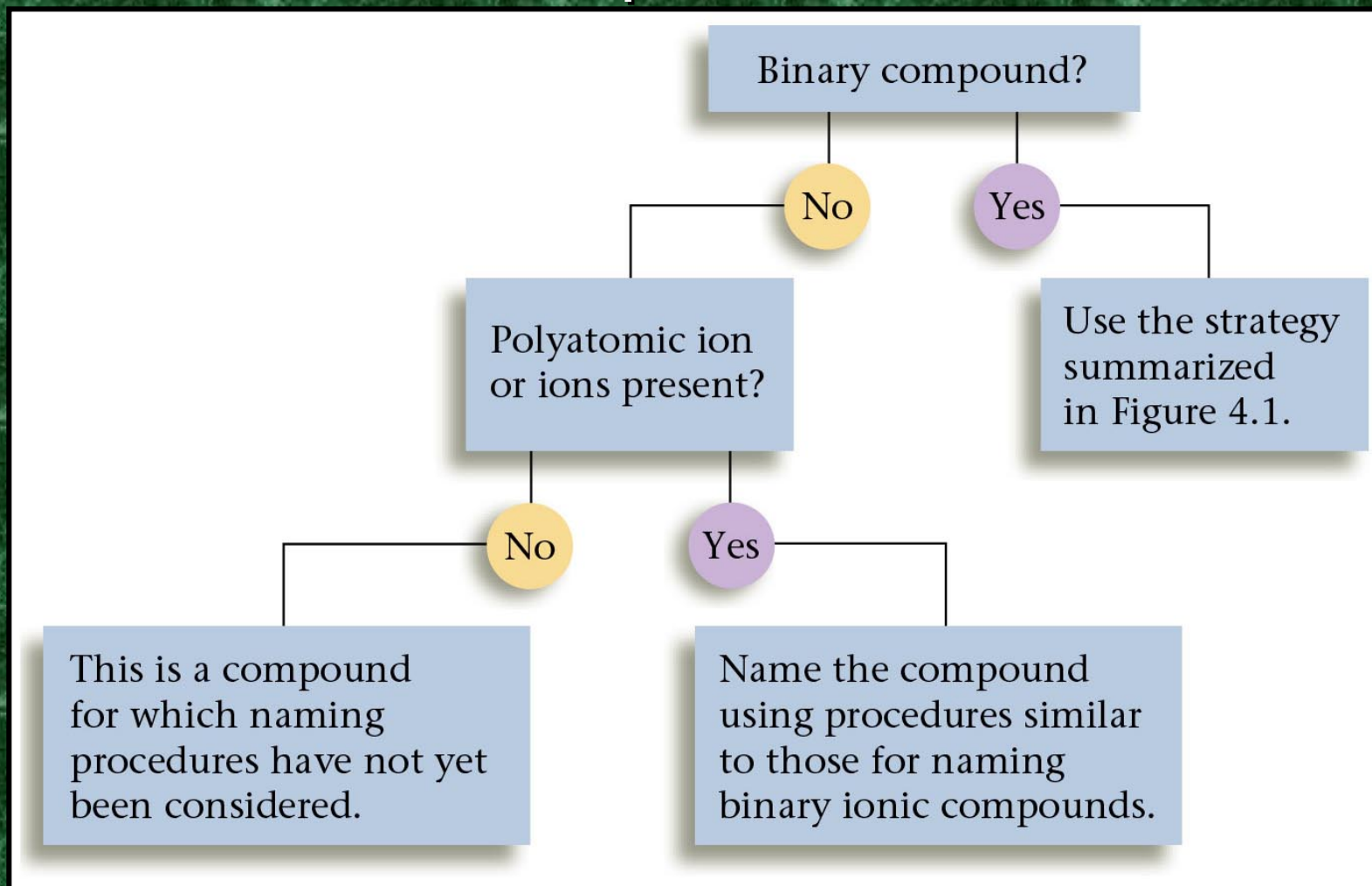


- a) dichlorine heptoxide
- b) dichlorine oxide
- c) chlorine heptoxide

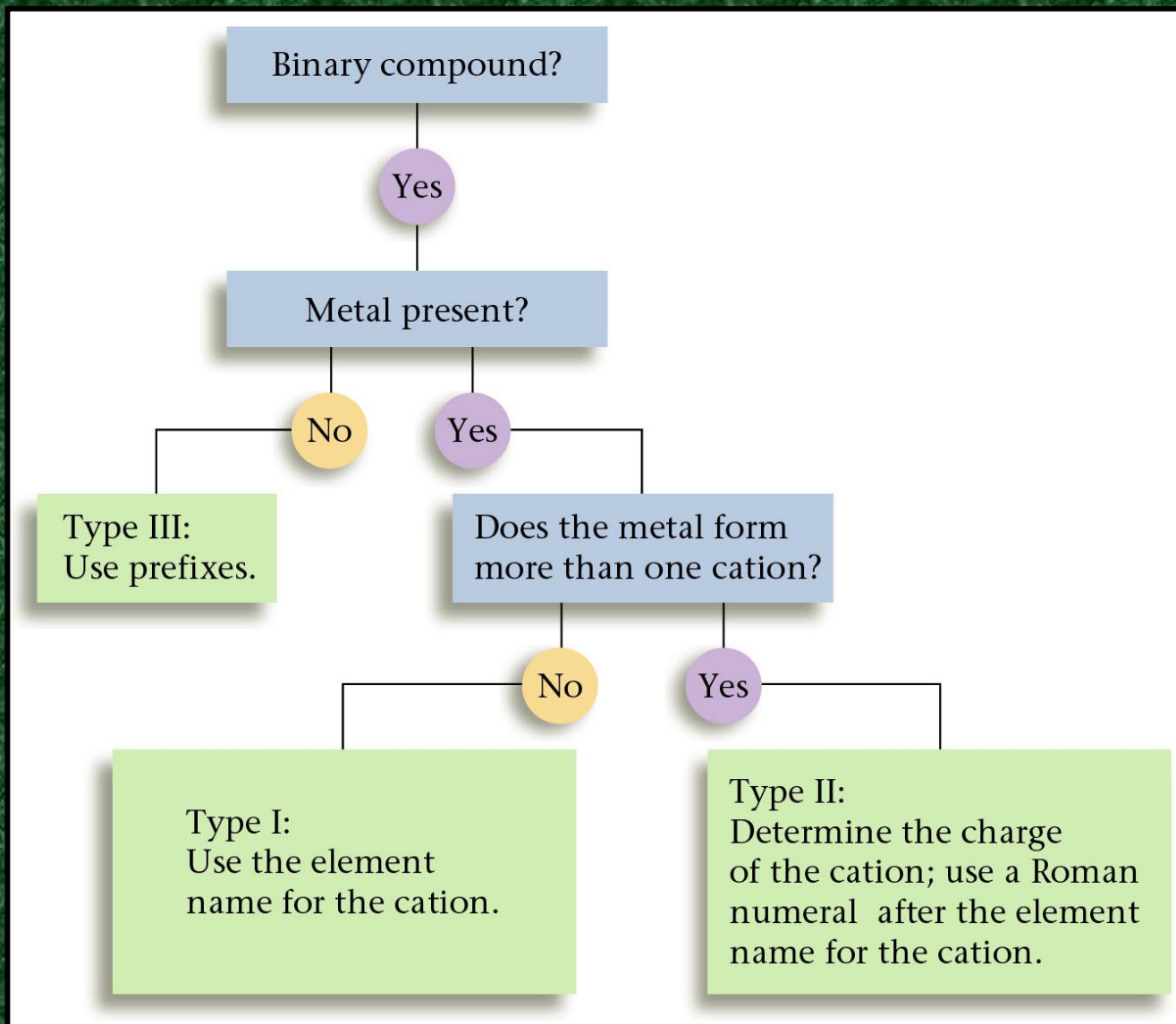


- a) chlorine
- b) dichlorine
- c) dichloride

Overall strategy for naming chemical compounds.



A flow chart for naming binary compounds.



Mixed Review

Name the following compounds:

1. CaO

- a) calcium oxide
- c) calcium (II) oxide

b) calcium(I) oxide

2. SnCl_4

- a) tin tetrachloride
- c) tin(IV) chloride

b) tin(II) chloride

3. N_2O_3

- a) nitrogen oxide
- c) nitrogen trioxide

b) dinitrogen trioxide

Solution

Name the following compounds:

1. CaO a) calcium oxide
2. SnCl_4 c) tin(IV) chloride
3. N_2O_3 b) Dinitrogen trioxide

Mixed Practice

1. Dinitrogen monoxide
2. Potassium sulfide
3. Copper (II) nitrate
4. Dichlorine heptoxide
5. Chromium (III) sulfate
6. Iron (III) sulfite
7. Calcium oxide
8. Barium carbonate
9. Iodine monochloride

Mixed Practice

1. BaI_2
2. P_4S_3
3. $\text{Ca}(\text{OH})_2$
4. FeCO_3
5. $\text{Na}_2\text{Cr}_2\text{O}_7$
6. I_2O_5
7. $\text{Cu}(\text{ClO}_4)_2$
8. CS_2
9. B_2Cl_4

Acid Nomenclature

- **Acids**
 - Compounds that form H^+ in water.
 - Formulas usually begin with 'H'.
 - In order to be an acid instead of a gas, binary acids must be aqueous (dissolved in water)
 - Ternary acids are ALL aqueous
- **Examples:**
 - $\text{HCl}_{(\text{aq})}$ – hydrochloric acid
 - HNO_3 – nitric acid
 - H_2SO_4 – sulfuric acid

Acid Nomenclature

Anion Ending	Acid Name
--------------	-----------

Binary →	<i>-ide</i>	<i>hydro-(stem)-ic acid</i>
----------	-------------	-----------------------------

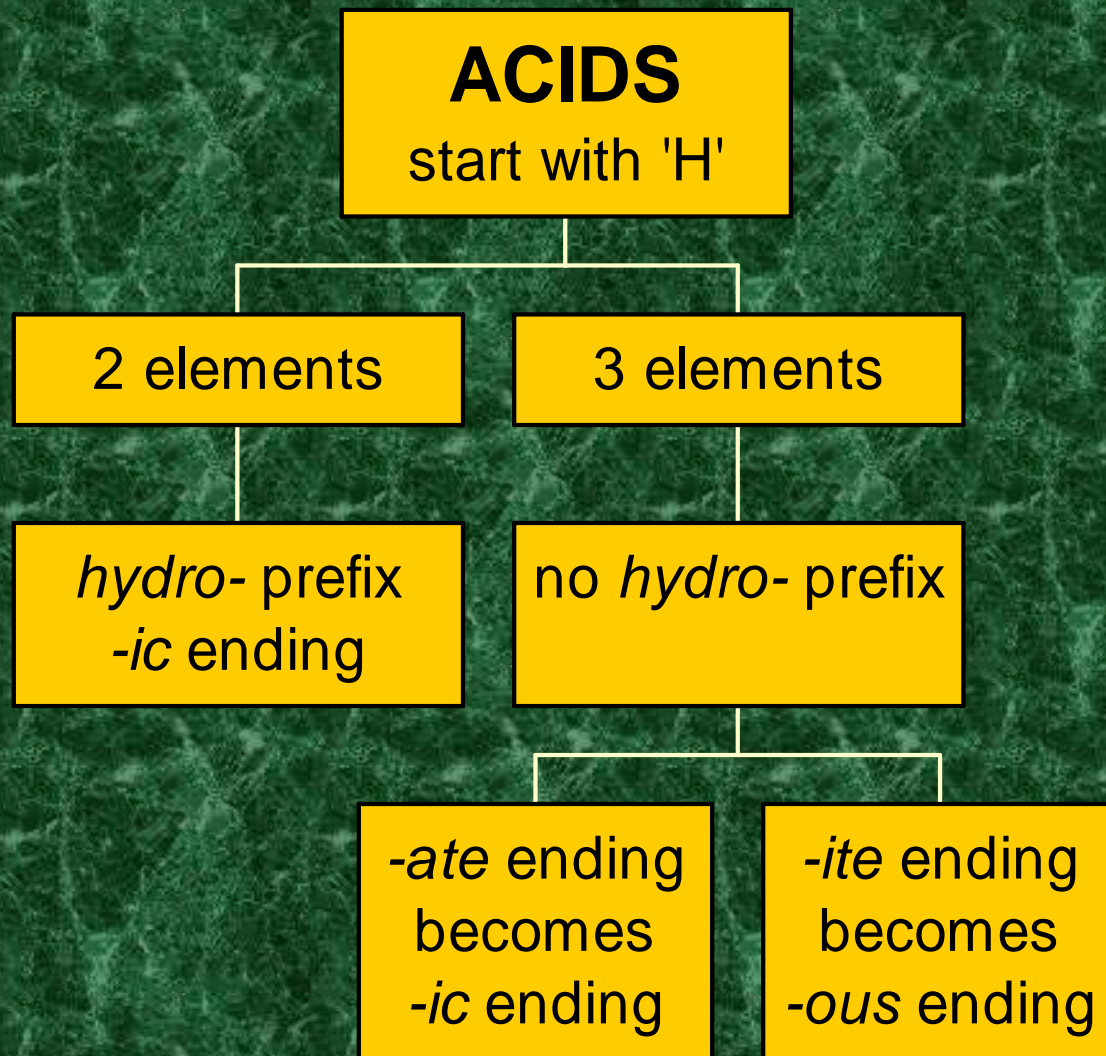
Ternary	↗	<i>-ate</i>	<i>(stem)-ic acid</i>
---------	---	-------------	-----------------------

	↘	<i>-ite</i>	<i>(stem)-ous acid</i>
--	---	-------------	------------------------

An easy way to remember which goes with which...

*“In the cafeteria, you **ATE** something **ICky**”*

Acid Nomenclature Flowchart



Acid Nomenclature

- **HBr** (aq)
 - 2 elements, *-ide* \Rightarrow **hydrobromic acid**
- **H₂CO₃**
 - 3 elements, *-ate* \Rightarrow **carbonic acid**
- **H₂SO₃**
 - 3 elements, *-ite* \Rightarrow **sulfurous acid**

Acid Nomenclature

- **hydrofluoric acid**

- 2 elements



- **sulfuric acid**

- 3 elements, *-ic*



- **nitrous acid**

- 3 elements, *-ous*



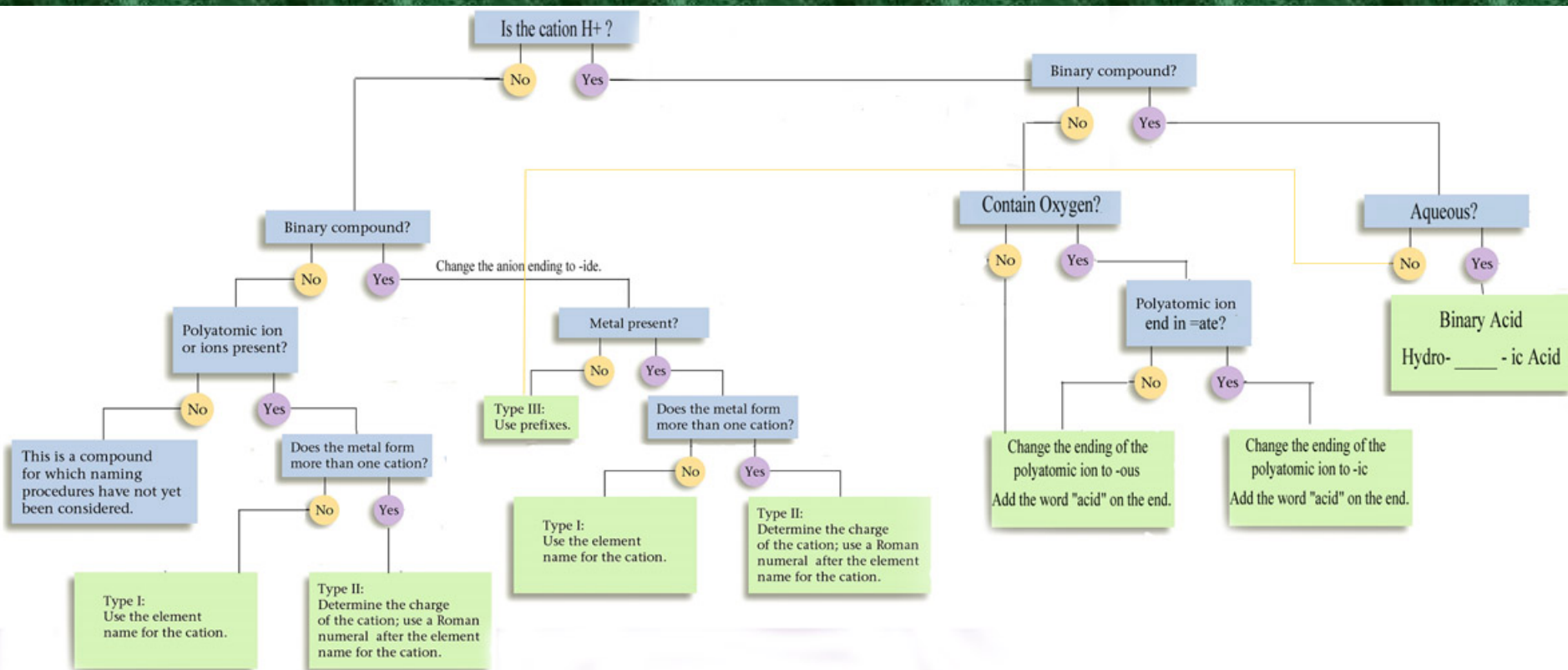
Name 'Em!

- $\text{HI}_{(aq)}$
- HCl
- H_2SO_3
- HNO_3
- HIO_4

Write the Formula!

- Hydrobromic acid
- Nitrous acid
- Carbonic acid
- Phosphoric acid
- Hydrotelluric acid

Nomenclature Summary Flowchart



Now it's Study Time

DONE



Rainbow Matrix Game

- Link on Chemistry Geek.com on Chemistry I page
- <http://chemistrygeek.com/rainbow>

Use [] to represent subscripts since you can't enter subscripts into the computer

So H₂O would be H[2]O

And Al₂(SO₄)₃ would be Al[2](SO[4])[3]

Additional Polyatomic Ions (you do not have to memorize these, but they are in the game!)

Borate = BO₃⁻³ ; Silicate = SiO₄⁻⁴ ;

Manganate = MnO₄⁻² (permanganate is -1)