Formula Writing

Parts of a Chemical Formula

- Chemical Formula- symbolic way to represent compounds

- Chemical Symbol
  - Letters
  - Represents the elements that are in a compound
  - Each new capital letter represents a new element

- Subscripts
  - Small numbers on the lower right of the chemical symbol
  - Represents how many atoms of the preceding element are in the compound
  - No subscript means there is only one atom of the compound

Parts of a Chemical Formula

- Parentheses
  - When present, subscript on the outside multiples by all the subscripts on the inside to determine number of atoms

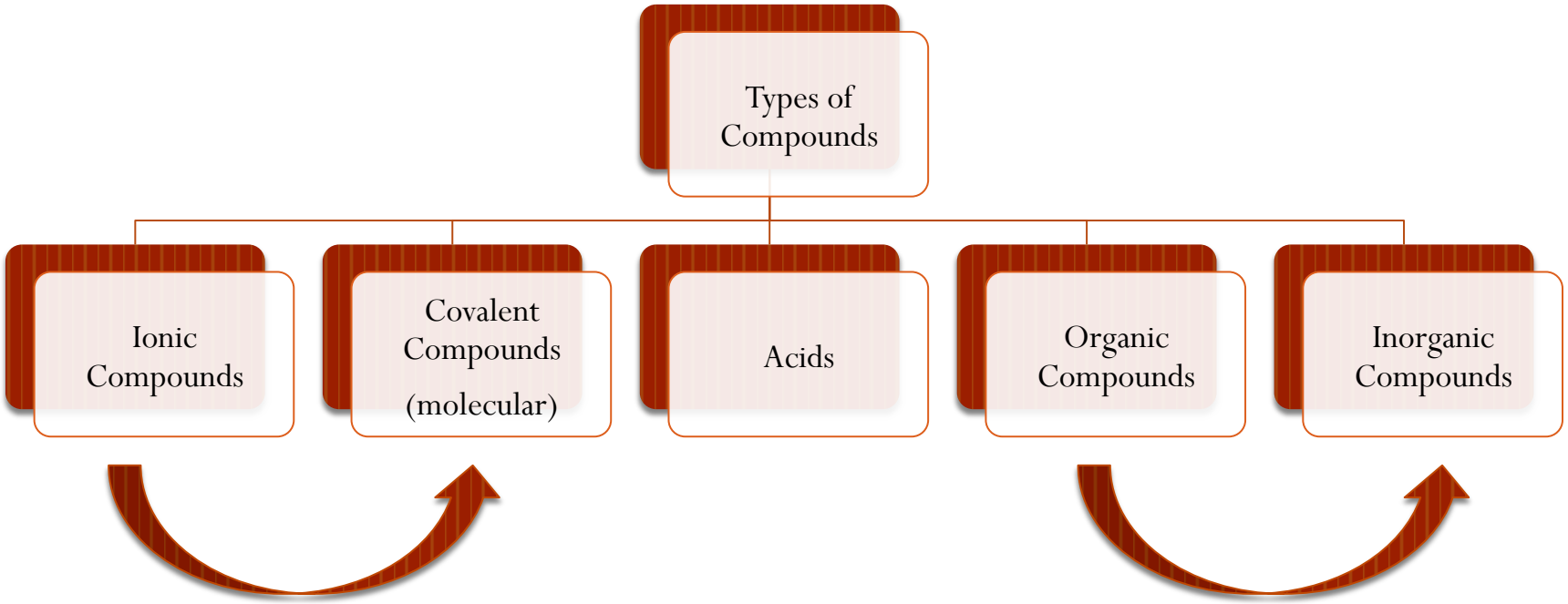
Parts of a Chemical Formula

- Examples:
  - H_2SO_4
    - What elements are present in the compound?
    - How many atoms of each element are present in the compound?
    - What is the ratio of atoms of elements in the compound?

Parts of a Chemical Formula

- Examples:
  - $Mg(OH)_2$
    - What elements are present in the compound?
    - How many atoms of each element are present in the compound?
    - What is the ratio of atoms of elements in the compound?

Types of Compounds



Ionic Compounds

Ions

- Ions are atoms of elements with positive or negative charges
  - Cation- positive charge
    - Always a metal or ammonium NH_4^{+1}
  - Anion- negative charge

- Oxidation Number= the positive or negative charge on an ion

- Polyatomic Ions- ions that include more than one atom

Properties of Ionic Compounds

- Contain Ionic Bonds
  - Result from a <u>transfer</u> of electrons
  - Bonds between a positive cation and a negative ion anion
- Composed of a metal and a nonmetal (or metal + multiple nonmetals)
  - Exception: compounds containing ammonium (NH_4^{+1}) do not contain metals but are ionic
- Names do NOT use numeric prefixes
- All soluble in water

Properties of Ionic Compounds

- Conduct Electricity when dissolved in water
- Solid at room temperature
- Crystalline structure
- Very high melting and boiling points

Covalent Compounds

Properties of Covalent Compounds

- Also called MOLECULAR compounds
- Contain covalent bonds
  - Result from a sharing of electrons
- Contain ONLY nonmetals
- Names use numeric prefixes
- Two kinds:
  - Nonpolar- NOT soluble in water
  - Polar- soluble in water (very few)

Properties of Covalent Compounds

- Do NOT conduct electricity
- Most are liquids or gasses at room temperature
- If solid, the structure is “softer” than an ionic compound
- Low melting and boiling points
- Often flammable

Acids

Properties of Acids

- All contain Hydrogen as the first element
- React with metals to form hydrogen gas
- Corrosive- react with and destroy other substances
- Taste sour
- Usually liquid at room temperature
- Can be strong or weak
- pH value less than 7

Writing Formulas for Ionic Compounds

Types of Ionic Compounds

- Binary Ionic
- Binary Ionic with Transition Metal
- Ionic with Polyatomic Ion
- Ionic with a Transition Metal and a Polyatomic Ion

Common Ion Sheet
Honors Chemistry Reference

Name: _____

Transition Metals (can have more than one charge)

Ion Name	Formula and Charge
Antimony (III)	Sb^{3+}
Antimony (V)	Sb^{5+}
Arsenic (III)	As^{3+}
Arsenic (V)	As^{5+}
Chromium (II)	Cr^{2+}
Chromium (III)	Cr^{3+}
Cobalt (II)	Co^{2+}
Cobalt (III)	Co^{3+}
Copper (I) "cuprous"	Cu^{1+}
Copper (II) "cupric"	Cu^{2+}
Gold (I) "aurous"	Au^{1+}
Gold (III) "auric"	Au^{3+}
Iron (II) "ferrous"	Fe^{2+}
Iron (III) "ferric"	Fe^{3+}
Lead (II) "plumbous"	Pb^{2+}
Lead (IV) "plumbic"	Pb^{4+}
Manganese (II)	Mn^{2+}
Manganese (III)	Mn^{3+}
Mercury (I) "mercurous"	Hg_2^{1+}
Mercury (II) "mercuric"	Hg^{2+}
Nickel (II)	Ni^{2+}
Nickel (III)	Ni^{3+}
Platinum (II)	Pt^{2+}
Platinum (IV)	Pt^{4+}
Silver	Ag^{1+}
Tin (II) "stannous"	Sn^{2+}
Tin (IV) "stannic"	Sn^{4+}
Zinc	Zn^{1+}

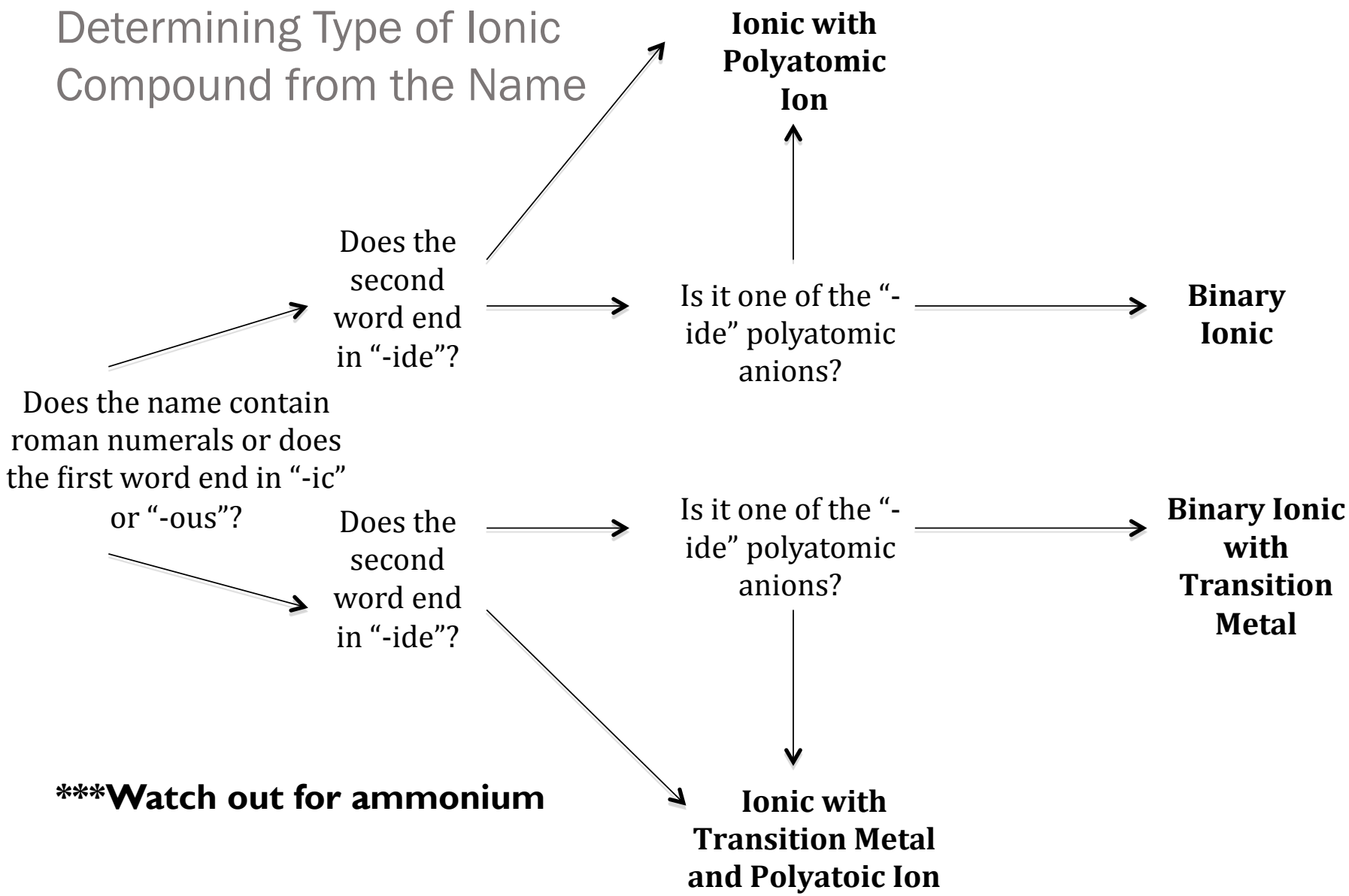
Polyatomic Cation (positive charge)

Ion Name	Formula and Charge
Ammonium	NH_4^{1+}

Polyatomic Anions (negative charge)

Ion Name	Formula and Charge
Acetate	$C_2H_3O_2^{1-}$ or CH_3COO^{1-}
Bicarbonate "hydrogen carbonate"	HCO_3^{1-}
Bisulfite	HSO_3^{1-}
Bisulfate	HSO_4^{1-}
Bromate	BrO_3^{1-}
Bromite	BrO_2^{3-}
Carbonate	CO_3^{2-}
Chlorite	ClO_2^{1-}
Chlorate	ClO_3^{1-}
Chromate	CrO_4^{2-}
Cyanide	CN^{1-}
Dichromate	$Cr_2O_7^{2-}$
Hydride	H^{1-}
Hydroxide	OH^{1-}
Hypochlorite	ClO^{1-}
Iodate	IO_3^{1-}
Manganate	MnO_4^{2-}
Nitrite	NO_2^{1-}
Nitrate	NO_3^{1-}
Oxalate	$C_2O_4^{2-}$
Perchlorate	ClO_4^{1-}
Peroxide	O_2^{2-}
Permanganate	MnO_4^{1-}
Phosphate	PO_4^{3-}
Phosphite	PO_3^{3-}
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}
Thiosulfate	$S_2O_3^{2-}$
Thiocyanate	SCN^{1-}

Determining Type of Ionic Compound from the Name



*****Watch out for ammonium**

Identify the Type of Ionic Compound

1. Potassium Carbonate _____
2. Sodium Chloride _____
3. Iron (III) Oxide _____
4. Manganese (III) Carbonate _____
5. Cupric Chloride _____
6. Magnesium Phosphate _____
7. Ferric Sulfate _____
8. Sodium Oxide _____

Binary Ionic

- Definition- ionic compound that contains one metal and one nonmetal, both from the periodic table

Binary Ionic

- Writing Formula
  - Write both symbols
  - Write oxidation numbers
    - Determine from periodic table
  - Crisscross oxidation numbers to find subscripts
    - Reduce if possible
    - Don’t write if subscript is one

Binary Ionic

- Examples
  - Sodium Chloride
  - Sodium Oxide

Binary Ionic with Transition Metal

- Definition- ionic compound that contains one transition metal and one nonmetal, both from the periodic table

Binary Ionic with Transition Metal

- Writing Formula
  - Write both symbols
  - Write oxidation numbers
    - Oxidation number of transition metal is the same as the roman numeral
    - If old school name, use common ion chart
  - Crisscross oxidation numbers to find subscripts
    - Reduce if possible
    - Don’t write if subscript is one

Binary Ionic with Transition Metal

- Examples:
  - Iron (III) Oxide
  - Cupric Chloride

Ionic with a Polyatomic Ion

- Definition- ionic compound that contains one metal and one polyatomic ion from the common ion sheet

Ionic with a Polyatomic Ion

- Writing Formula
  - Write both symbols
  - Write oxidation numbers
    - Determine metal from periodic table
    - Determine polyatomic ion from common ion sheet
  - Crisscross oxidation numbers to find subscripts
    - If the subscript for the polyatomic ion is more than one, put the whole ion in parentheses and place the subscript on the outside
    - Reduce if possible
    - Don't write if subscript is one

Ionic with a Polyatomic Ion

- Examples
  - Potassium Carbonate
  - Magnesium Phosphate

Ionic with Transition Metal and Polyatomic Ion

- Definition- Ionic compound that contains one transition metal and one polyatomic ion from the common ion sheet

Ionic with Transition Metal and Polyatomic Ion

- Writing Formula
  - Write both symbols
  - Write oxidation numbers
    - Oxidation number of transition metal is the same as the roman numeral (if old school, use common ion sheet)
    - Determine polyatomic ion from common ion sheet
  - Crisscross oxidation numbers to find subscripts
    - If the subscript for the polyatomic ion is more than one, put the whole ion in parentheses and place the subscript on the outside
    - Reduce if possible
    - Don't write if subscript is one

Ionic with Transition Metal and Polyatomic Ion

- Examples:
  - Manganese (III) Carbonate
  - Ferric Sulfate

Ammonium Exception

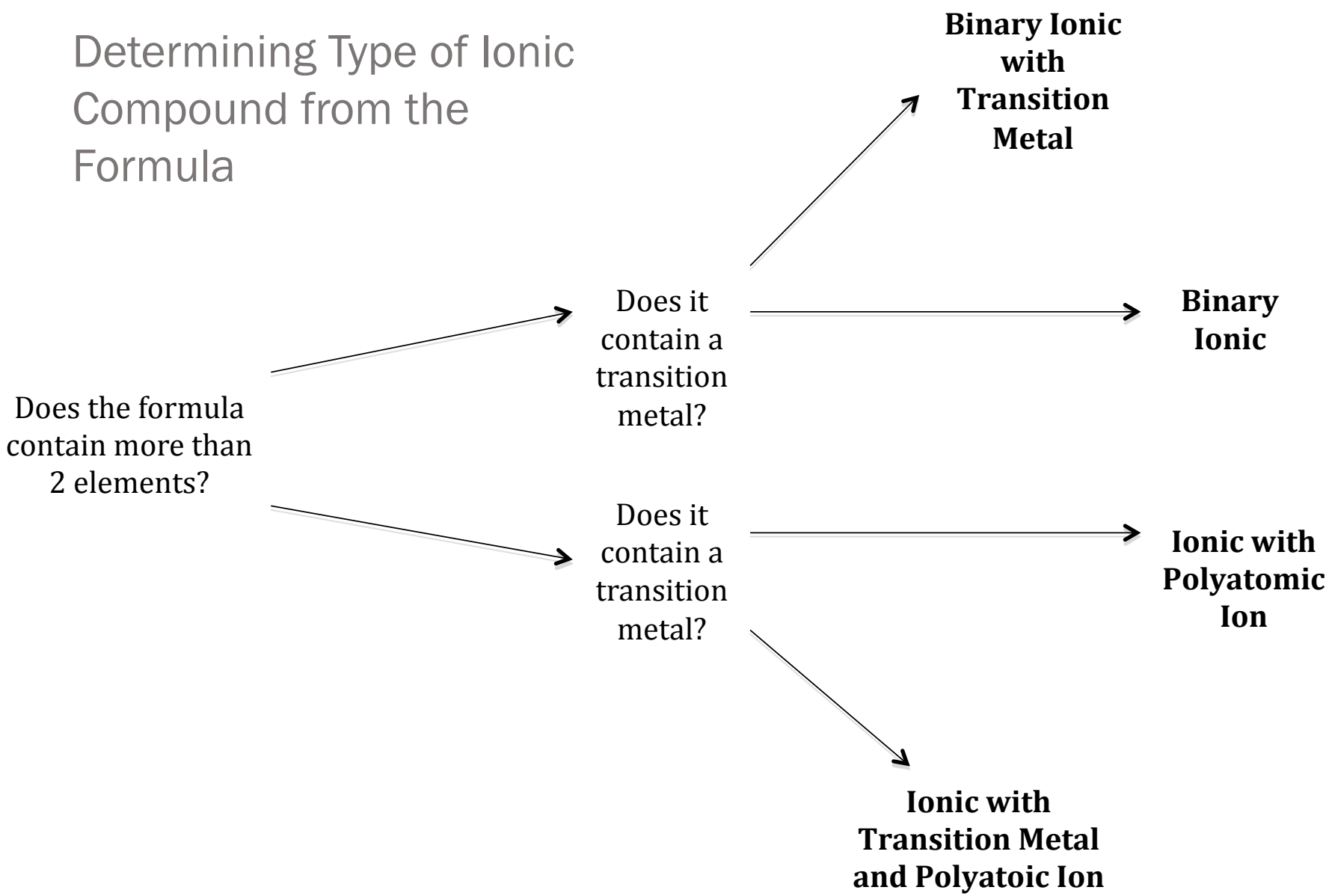
- If ammonium is in the compound
  - Ammonium is the cation
  - Just like other cations, write the name for ammonium
  - Follow the chart to find what category the anion is in
  - Examples:
    - Ammonium Chloride
    - Ammonium Carbonate

Naming Ionic Compounds

Types of Ionic Compounds

- Binary Ionic
- Binary Ionic with Transition Metal
- Ionic with Polyatomic Ion
- Ionic with a Transition Metal and a Polyatomic Ion

Determining Type of Ionic Compound from the Formula



Identify the Type of Ionic Compound

1. $Mg(OH)_2$ _____
2. Li_2O _____
3. $FeCl_3$ _____
4. $Pb(NO_3)_2$ _____
5. NaF _____
6. $Sr(NO_3)_2$ _____
7. Cu_2SO_4 _____
8. $CuCl_2$ _____

Binary Ionic

- Naming
  - Write the name of the metal
  - Write the name of the nonmetal but change the ending to "-ide"

- Examples:

  - Li_2O

  - NaF

Binary Ionic with Transition Metal

- Naming
  - Determine the oxidation number on the transition metal (reverse crisscross)
  - Write the name of the transition metal
  - Write the oxidation number in roman numerals, in parentheses
  - Write the name of the nonmetal but change the ending to "-ide"
  -
- Examples
  - $FeCl_3$
  - $CuCl_2$

Ionic with a Polyatomic Ion

- Naming
  - Write the name of the metal
  - Write the name of the polyatomic ion
  - DO NOT CHANGE THE ENDING

- Examples:
  - $Mg(OH)_2$

  - $Sr(NO_3)_2$

Ionic with Transition Metal and Polyatomic Ion

- Naming
  - Determine the oxidation number on the transition metal (reverse crisscross)
  - Write the name of the transition metal
  - Write the oxidation number in roman numerals, in parentheses
  - Write the name of the polyatomic ion
  - DO NOT CHANGE THE ENDING

- Examples:
  - Cu_2SO_4
  - $Pb(NO_3)_2$

Ammonium Exception

- Ammonium NH_4, will be the first thing in the compound
- Write "ammonium"

- For the anion:
  - If it is a nonmetal, change the ending to "-ide"
  - If it is a polyatomic ion, leave it alone and just write it

  - Examples:
    - NH_4Cl

    - NH_4OH

Acids

- Binary Acids: contain hydrogen and a nonmetal
- Oxyacids: contain hydrogen and a polyatomic ion

Naming Binary Acids

- Add the prefix "hydro"
- Change ending to –"ic"
- Add the word acid

- Examples:
  - HF
  - H_2S

Naming Oxyacids

Catch Phrase:

If you **ATE** something –**IC**ky….

You need to b-**ITE** something delici**OUS**

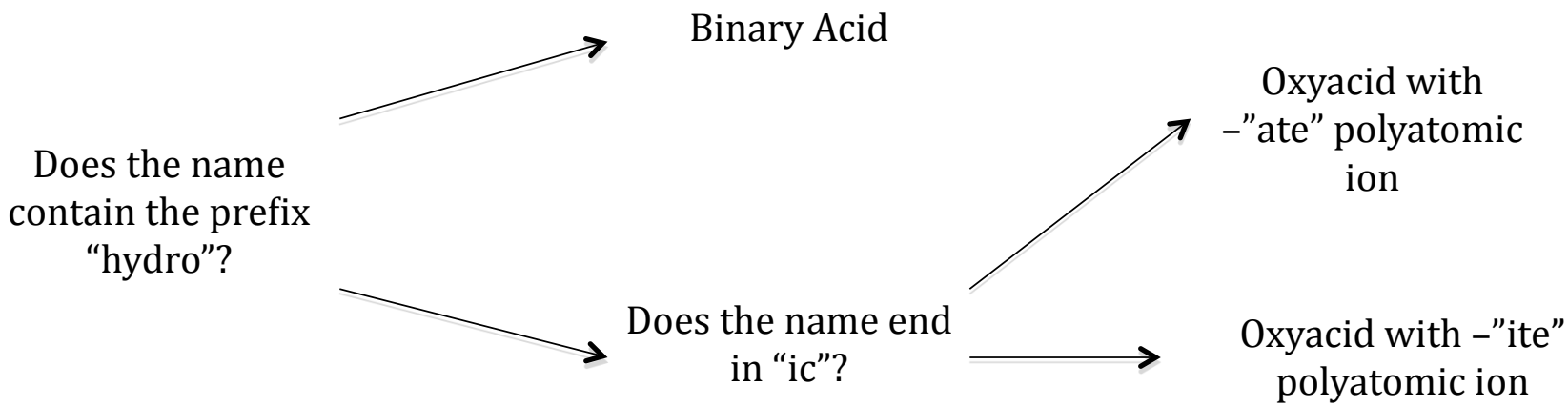
- If the acid contains an "-ate" polyatomic ion
  - Change the "-ate" to "-ic"
  - Add the word acid
- If the acid contains an "-ite" polyatomic ion
  - Change the "-ite" to "-ous"
  - Add the word acid

Naming Oxyacids

- Examples:
  - HNO_3
  - HNO_2

Writing Formulas for Acids

- Determine kind of acid



- Write symbols
- Write oxidation numbers
- Use crisscross method as you would for an ionic compound

Writing Formulas for Acids

- Examples:
- Hydrochloric acid
- Phosphorous Acid
- Phosphoric Acid

Naming Covalent Compounds

- First element
  - Prefix that corresponds to subscript
  - (never use mono on the first element)
  - Name of element
- Second element
  - Prefix that corresponds to subscript
  - Name of element
  - Change ending to "-ide"

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

Naming Covalent Compounds

- Examples:
  - H_2O
  - N_2O_3
  - SO_3
  - CCl_4

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

Writing Formulas for Covalent Compounds

- First element
  - Prefix that corresponds to the subscript
  - Name of the element

- Second element
  - Prefix that corresponds to the subscript
  - Name of the element, but change the ending to “-ide”

Organic Compounds

- All contain carbon- defines them as organic
  - There are few compounds that contain carbon that are not organic (carbon oxides, carbides and carbonates)
- All also contain large quantities of hydrogen atoms
- Other elements often found in organic compounds= Oxygen, Nitrogen, Phosphorous, and Sulfur (though in much smaller quantities
- All organic compounds are covalent (molecular) compounds

Inorganic Compounds

- Do not contain carbon
  - There are few compounds that contain carbon that are inorganic (carbon oxides, carbides and carbonates)
- Can contain atoms of various elements
- Include all ionic compounds, and covalent compounds that are not organic

Organic vs. Inorganic Compounds Lab

- Flammability demonstration
  - http://www.youtube.com/watch?v=NOTWg3Krww0&NR=1
  - Sodium Chloride demonstration

Properties of Organic and Inorganic Compounds

	ORGANIC	INORGANIC
FLAMMABILITY		
SOLUBILITY IN H_2O		
MELTING POINTS		
CONDUCTIVITY		

Properties of Organic and Inorganic Compounds

	ORGANIC	INORGANIC
FLAMMABILITY	Most are very flammable	Most are not flammable
SOLUBILITY IN H_2O	Generally insoluble in water	Generally soluble in water
MELTING POINTS	Generally low melting points	Generally have higher melting points than organic compounds
CONDUCTIVITY	Stay together when in water, therefore do not conduct electricity	Compounds break apart in water to produce ions that can conduct electricity

Hydrocarbons

- Organic compounds that contain only carbon and hydrogen
- Alkanes- contain only single carbon-carbon bonds
- General formula C_nH_{2n+2}
- You need to be able to name the first 10 alkanes

Alkanes

Alkane Nomenclature	
CH_4	methane
C_2H_6	ethane
C_3H_8	propane
C_4H_{10}	butane
C_5H_{12}	pentane
C_6H_{14}	hexane
C_7H_{16}	heptane
C_8H_{18}	octane
C_9H_{20}	nonane
$C_{10}H_{22}$	decane

- From five down, the prefixes are based on the number of carbons
- To remember the first four: "Mice Eat Peanut Butter"