

Announcements for Thursday, 03OCT2024

- Office Hours are **cancelled** today
- Week 5 Homework Assignments available on eLearning
 - Graded and Timed Quiz 5 – “Periodic Trends” due **Tuesday, 08OCT2024, at 6:00 PM (EDT)**

ANY GENERAL QUESTIONS? Feel free to see me after class!

Ionic Compound Formulas

- **formula unit** = the basic unit of an ionic compound
 - the smallest, electrically neutral collection of ions
 - NaCl, K₂O, AgNO₃ ...etc.
- ionic compounds are NOT made of molecules

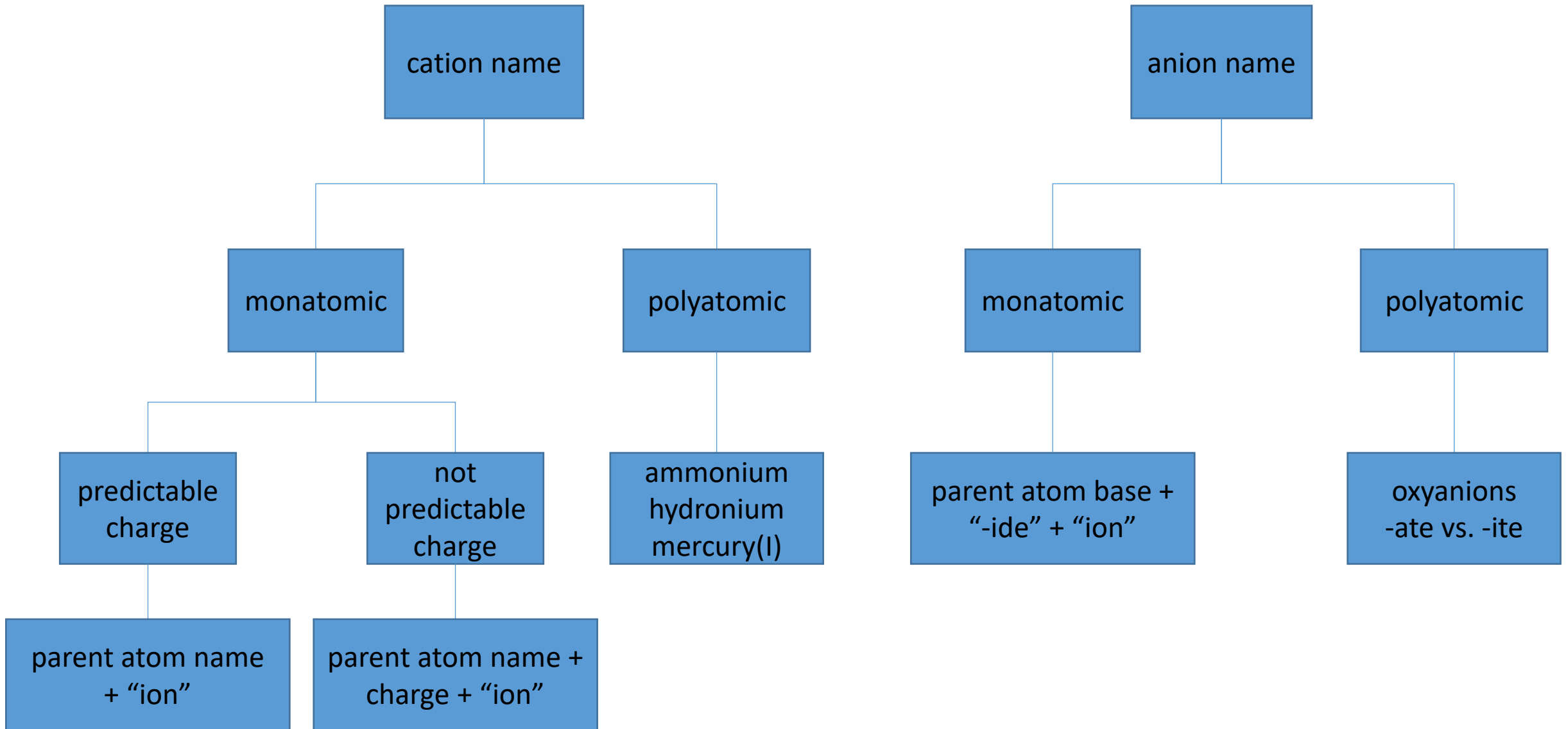
Writing Formulas for Ionic Compounds

- ionic compounds are electrically neutral
- **the sum of all the positive charge = the sum of all the negative charge**
- subscripts always expressed in *smallest whole-number ratios*

Ionic Compound Nomenclature

- most important step is being able to identify a compound as ionic (as opposed to molecular)
- *usually* consists of metal(s) + nonmetal(s)
 - beware of the polyatomic cation NH_4^+
- name the cation and then the anion
 - lots of little details to be familiar with

Naming Ionic Compounds



Naming Cations

monatomic cations

1. elements whose ion charges are predictable

- name of parent atom + “ion”
- no need to specify the charge of the cation in the name

Sr	Sr^{2+}	Strontium	2A
Ba	Ba^{2+}	Barium	2A
Al	Al^{3+}	Aluminum	3A
Zn	Zn^{2+}	Zinc	*
Sc	Sc^{3+}	Scandium	*
Ag**	Ag^{+}	Silver	*

*The charge of these metals cannot be inferred from their group number.

**Silver sometimes forms compounds with other charges, but these are rare.

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Metals Whose Charge Is Invariant from One Compound to Another

Metal	Ion	Name	Group Number
Li	Li^{+}	Lithium	1A
Na	Na^{+}	Sodium	1A
K	K^{+}	Potassium	1A
Rb	Rb^{+}	Rubidium	1A
Cs	Cs^{+}	Cesium	1A
Be	Be^{2+}	Beryllium	2A
Mg	Mg^{2+}	Magnesium	2A
Ca	Ca^{2+}	Calcium	2A

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Naming Cations (continued)

2. elements whose ion charges are **not predictable** from group number and can vary
- more than one charge possible
 - charge must be given in the name to distinguish it from other charges
 - name of parent atom + (charge in roman numerals) + “ion”

polyatomic cations

- “poly-” = many; two or more atoms bound together as unit where the unit carries an overall charge
 - NH_4^+ = ammonium ion
 - H_3O^+ = hydronium ion
 - Hg_2^{2+} = mercury(I) ion

TABLE 4.3 Some Metals That Form Cations with Different Charges

Metal	Ion	Name
Chromium	Cr^{2+}	Chromium(II)
	Cr^{3+}	Chromium(III)
Iron	Fe^{2+}	Iron(II)
	Fe^{3+}	Iron(III)
Cobalt	Co^{2+}	Cobalt(II)
	Co^{3+}	Cobalt(III)
Copper	Cu^+	Copper(I)
	Cu^{2+}	Copper(II)
Tin	Sn^{2+}	Tin(II)
	Sn^{4+}	Tin(IV)
Mercury	Hg_2^{2+}	Mercury(I)
	Hg^{2+}	Mercury(II)
Lead	Pb^{2+}	Lead(II)
	Pb^{4+}	Lead(IV)

Naming Monatomic Anions

- monatomic anions
 - main group elements whose ion charges are predictable
 - main groups 5A, 6A, and 7A
- name of parent atom base + “-ide” + “ion”

TABLE 4.2 Some Common Monoatomic Anions

Nonmetal	Symbol for Ion	Base Name	Anion Name
Fluorine	F ⁻	fluor	Fluoride
Chlorine	Cl ⁻	chlor	Chloride
Bromine	Br ⁻	brom	Bromide
Iodine	I ⁻	iod	Iodide
Oxygen	O ²⁻	ox	Oxide
Sulfur	S ²⁻	sulf	Sulfide
Nitrogen	N ³⁻	nitr	Nitride
Phosphorus	P ³⁻	phosph	Phosphide

Naming Polyatomic Ions

- mostly anions
 - bonding *within* the ion is **covalent**
- many names end in “-ate” or “-ite”
- oxyanions
 - polyatomic ions with oxygens bound to other elements
- look for patterns in naming
 - “-ite” form always has 1 less oxygen than “-ate” form, but same charge
 - oxyanions with more than 2 forms use prefixes “per-” and “hypo-”
 - adding H^+ changes the name and the charge of the oxyanion
- MEMORIZE ★★ ★

TABLE 4.4 Some Common Polyatomic Ions

Name	Formula	Name	Formula
★ Acetate	$\text{C}_2\text{H}_3\text{O}_2^-$	Hypochlorite	ClO^-
★ Carbonate	CO_3^{2-}	Chlorite	ClO_2^-
Hydrogen carbonate (or bicarbonate)	HCO_3^-	★ Chlorate	ClO_3^-
★ Hydroxide	OH^-	★ Perchlorate	ClO_4^-
Nitrite	NO_2^-	★ Permanganate	MnO_4^-
★ Nitrate	NO_3^-	Sulfite	SO_3^{2-}
Chromate	CrO_4^{2-}	Hydrogen sulfite (or bisulfite)	HSO_3^-
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$	★ Sulfate	SO_4^{2-}
★ Phosphate	PO_4^{3-}	Hydrogen sulfate (or bisulfate)	HSO_4^-
Hydrogen phosphate	HPO_4^{2-}	★ Cyanide	CN^-
Dihydrogen phosphate	H_2PO_4^-	Peroxide	O_2^{2-}
★ Ammonium	NH_4^+		

Naming Ionic Compounds

bring it all together:

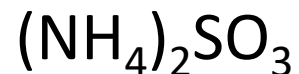
- name the cation and name the anion without using the words “ion”



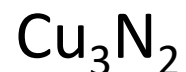
- magnesium ion + fluoride ion = “magnesium fluoride”



- **chromium(III)** ion + phosphate ion = “chromium(III) phosphate”



- ammonium ion + sulfite ion = “ammonium sulfite”



- **copper(II)** ion + nitride ion = “copper(II) nitride”

Give the formula for **lead(IV)** sulfide

- lead(IV) ion = Pb^{4+} + sulfide ion = S^{2-} so PbS_2

Give the formula for **iron(II)** hydrogen phosphate

- iron(II) ion = Fe^{2+} + hydrogen phosphate ion = HPO_4^{2-} so FeHPO_4

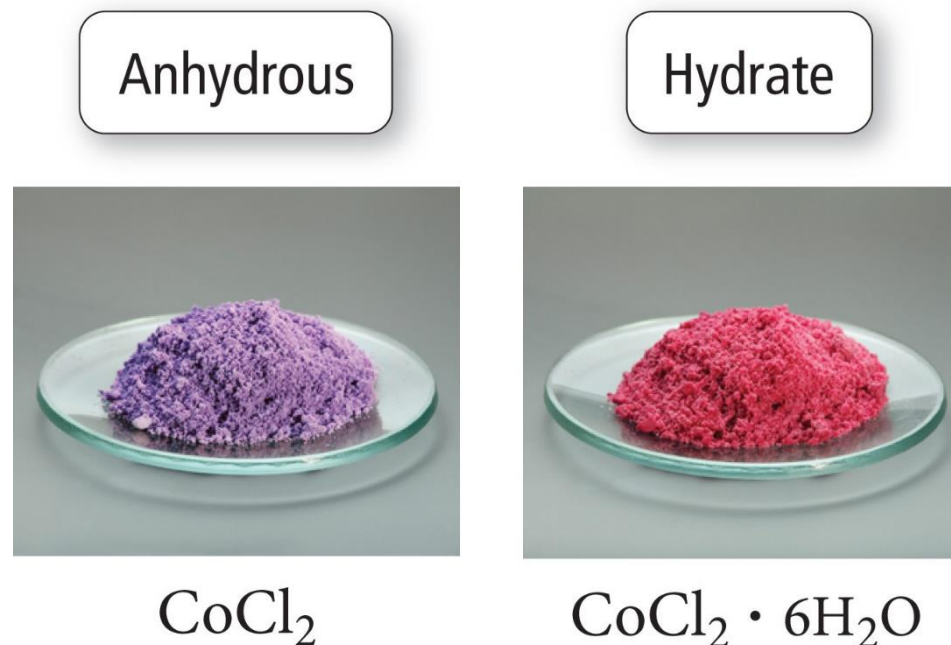
Naming Hydrates

- **hydrates** = ionic compounds in which the formula unit has a certain number of water molecules associated with it
- numbers of water molecules designated by prefixes
- ionic compound name • prefix + “hydrate”

$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
magnesium sulfate
heptahydrate

$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$
cobalt(II) chloride hexahydrate

$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
copper(II) sulfate pentahydrate



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prefix	number
hemi-	$\frac{1}{2}$
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

Binary Molecular Compounds: Formulas and Names

- **binary** = two elements
- unlike ionic compounds, the formula of a molecular compound cannot always be determined from its elements

Naming Molecular Compounds

1. name the first nonmetal and use the proper prefix to designate number if it's 2 or more
 - never use “mono-” for the first element
2. name the second nonmetal and use the proper prefix to designate number
 - when a prefix ends in “a” or “o” and the element's name begins with “o”, drop the “a” or “o” from the prefix
3. binary molecular compounds end in “-ide”

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

Try These On Your Own

Give the formula or the name of the following:

- iodine heptachloride
- dihydrogen monoxide
- nitrogen trihydride
- xenon tetrafluoride
- As_4O_{10}
- N_2O_5
- P_2I_4
- NH_4NO_3