

Module 2: What is a “Chemical Species”?

Introduction to Chemical Nomenclature

Fundamentals of Chemistry Open Course

1. State and apply the laws of chemical combination.
2. State and apply the tenets of the modern atomic theory.
3. Visualize the subatomic particles that constitute the atom using a simple planetary model; count subatomic particles using atomic number (Z) and mass number (M).
4. Represent an atom or ion using an atomic symbol.
5. Represent the number ratios of atoms in a compound using a chemical formula.
6. Visualize and distinguish between submicroscopic models of molecular and ionic compounds.
7. Use the periodic table to efficiently find information about a chemical element.
8. Recognize key collections of elements on the periodic table.
9. Determine the name of a binary ionic compound from the chemical formula and *vice versa*.
10. Determine the name of a simple molecular compound from the chemical formula and *vice versa*.

- **Chemical nomenclature** refers to a system for assigning names to chemical substances.
- A robust nomenclature system enables the “conversion” of a chemical formula into a name and *vice versa*.



- Nomenclature reflects the way we think about chemical structure. The rules and conventions of nomenclature systems are not exactly arbitrary...
- For example, many chemical names are structured to list metallic components first and nonmetallic components second. This convention allows us to infer the distribution of charge in the structure:

“metal(lic) nonmetal(lic)”

- Here, we will cover naming conventions for simple ionic and molecular compounds.
- **Binary ionic compounds** consist of one type of cation and one type of anion.
 - The ions may be monatomic or polyatomic; the cation is listed first and the anion second.
 - Examples: NaCl, Ca(OH)₂, NH₄Cl, Pd(NO₃)₂
- **Binary molecular (covalent) compounds** consist of two nonmetallic elements.
 - The “more metallic” element, further down and to the left on the periodic table, is generally listed first.
 - Examples: NO₂, CS₂, P₄O₁₀, NF₃
- For both classes of compounds, the elements may not be present in a 1:1 number ratio.

- Polyatomic ions** contain more than one type of atom; bonds *within* a polyatomic ion are covalent and the net charge may be positive (lack of electrons) or negative (excess of electrons).

Name	Formula	Name	Formula
acetate	$\text{C}_2\text{H}_3\text{O}_2^-$	hypochlorite	ClO^-
ammonium	NH_4^+	chlorite	ClO_2^-
carbonate	CO_3^{2-}	chlorate	ClO_3^-
cyanide	CN^-	perchlorate	ClO_4^-
hydrogen carbonate	HCO_3^-	chromate	CrO_4^{2-}
hydrogen phosphate	HPO_4^{2-}	dichromate	$\text{Cr}_2\text{O}_7^{2-}$
hydrogen sulfate	HSO_4^-	permanganate	MnO_4^-
hydroxide	OH^-		
nitrite nitrate	NO_2^- NO_3^-		
peroxide	O_2^{2-}		
phosphite phosphate	PO_3^{3-} PO_4^{3-}		
sulfite sulfate	SO_3^{2-} SO_4^{2-}		

Naming Binary Ionic Compounds

- Because ionic compounds are electrically neutral and ion names include information about charge, prefixes are *omitted* in names of binary ionic compounds.
- Ions with variable charge require a Roman numeral in parentheses after the name of the ion.

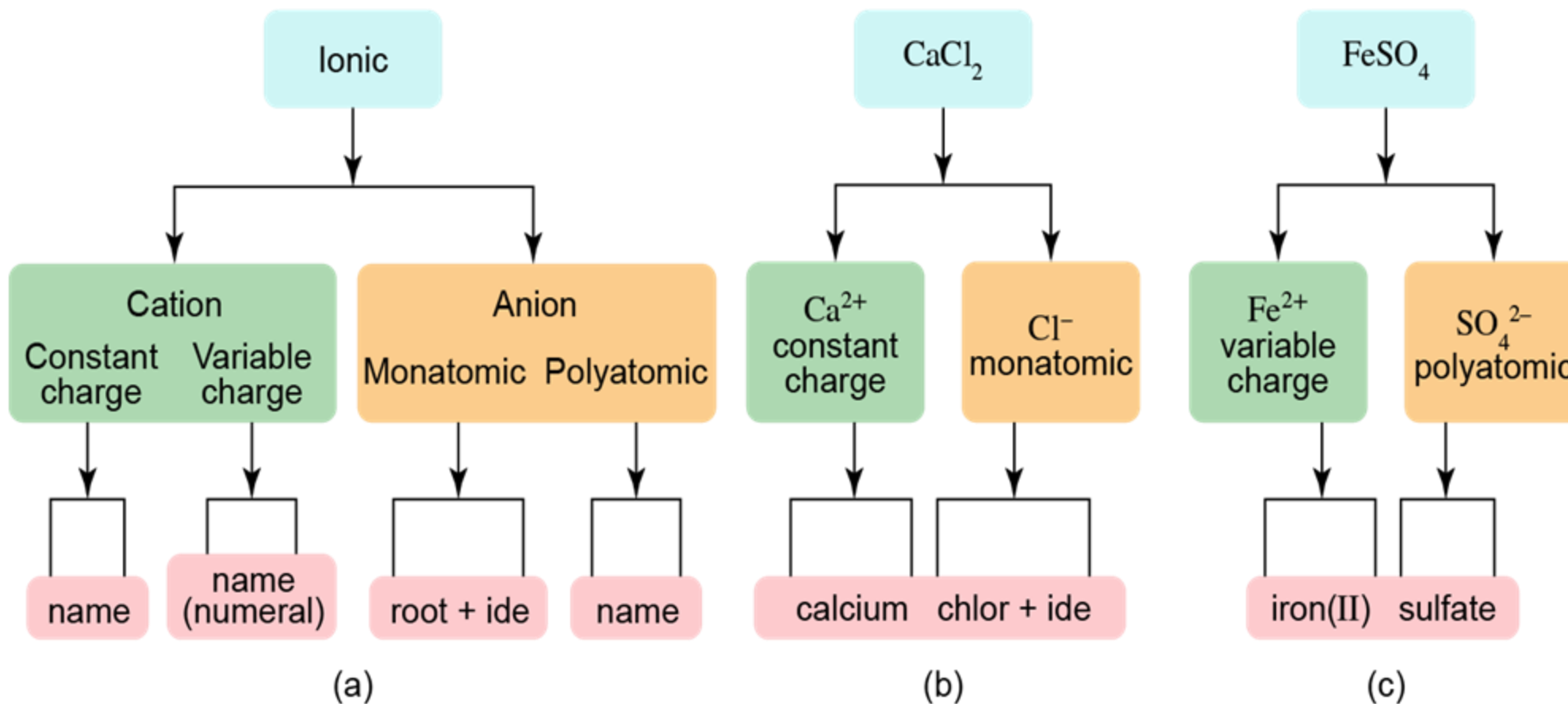


Figure. (a) A general scheme for naming binary ionic compounds and (b, c) two examples.

Naming Binary Molecular Compounds

- Molecular (covalent) compounds are composed of two or more *nonmetals*; **binary** covalent compounds contain only two elements.
- List the first nonmetal with a prefix indicating the number of atoms of that type in the molecule.
 - After a space, list the second nonmetal with a similar prefix, replacing the ending of the element name with *-ide*.

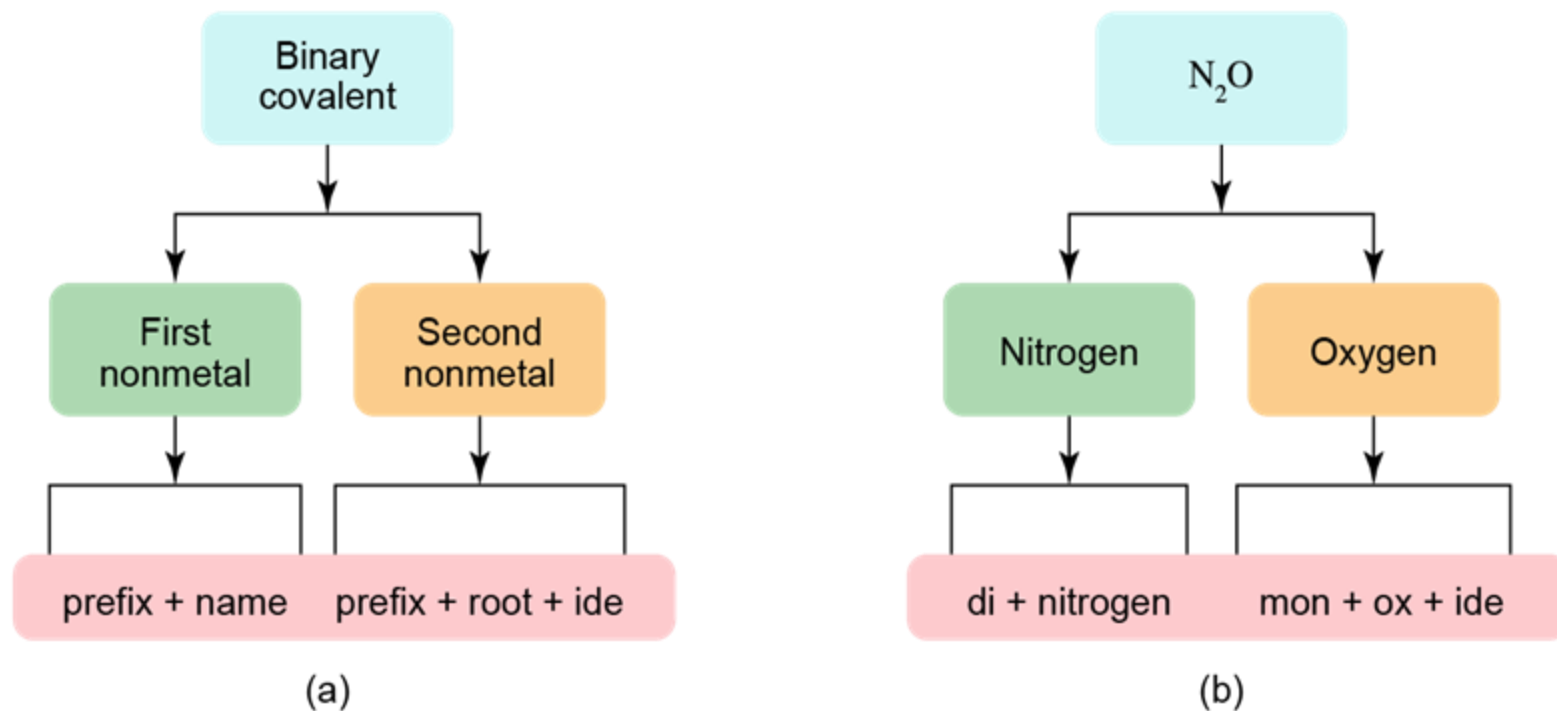
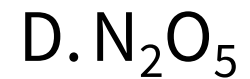
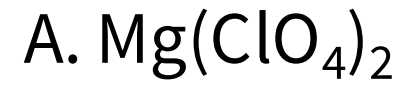


Figure. (a) A general scheme for naming binary covalent compounds and (b) an example.

Prefix	Number of Atoms per Molecule
mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6
hepta	7
octa	8
nona	9
deca	10

Example. Determine the names of each of the following compounds.



Example. Determine chemical formula for each of the following compounds.

A. Calcium cyanide

B. Ruthenium(IV) oxide

C. Silicon dioxide

D. Diphosphorus trisulfide

- How do we name compounds with more complex structures? What kinds of naming conventions are needed?