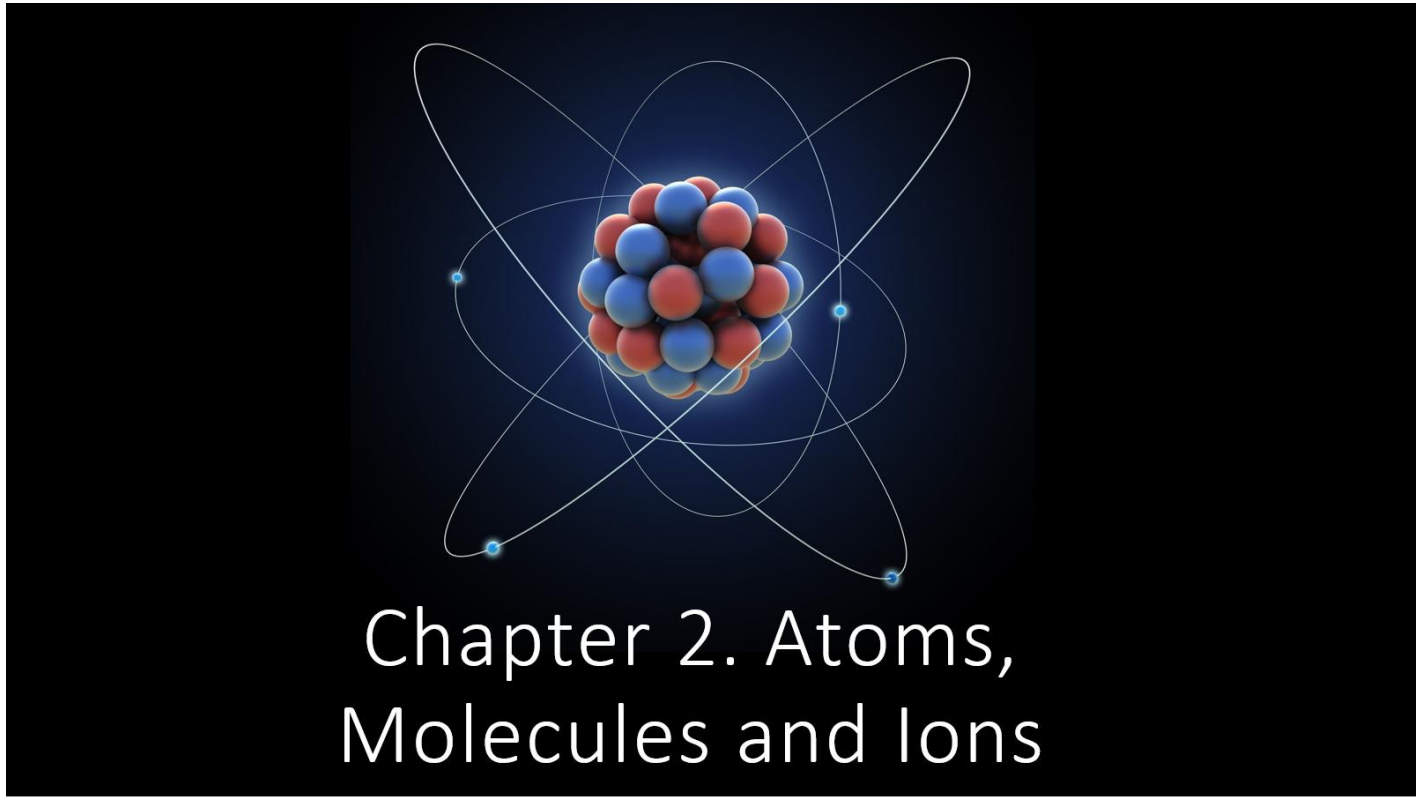


General Chemistry I, CHEM 103-002

Lecture 5: Ionic and Molecular Compounds, Chemical Nomenclature

September 11th 2026

Learning Objectives for Chapter Units 2.6 – 2.7

- Define binary ionic and molecular (covalent) compounds (including hydrates and compounds containing common polyatomic ions).
- Write formulas of binary covalent and ionic compounds (including hydrates and compounds containing common polyatomic ions) given names.
- Predict the type of compound formed from elements based on their location within the periodic table.
- Determine formulas for simple ionic compounds.
- Derive names for common types of inorganic compounds using a systematic approach.

Reading from book pages 89-101.

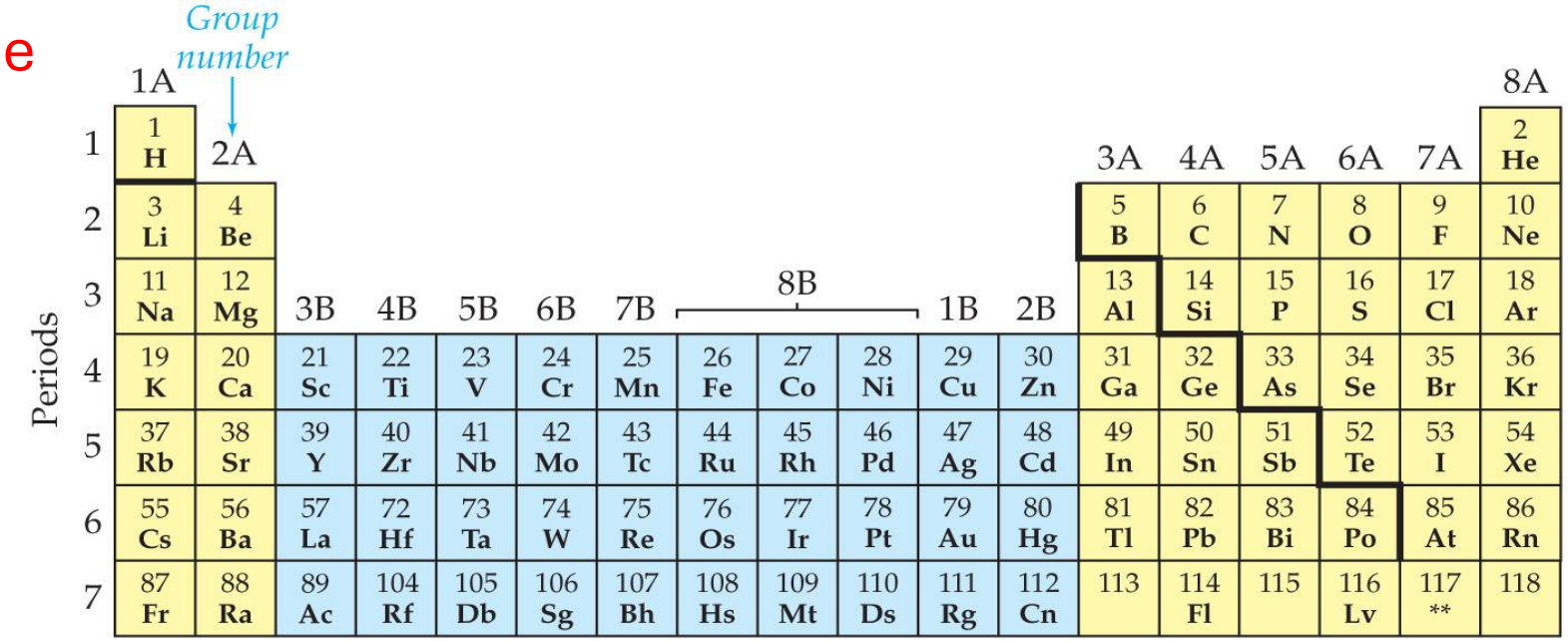
Chapter Unit 2.6

Ionic and Molecular Compounds

Ions & Periodic Table

Main group elements tend to form ions that have the same number of **valence electrons** as the nearest noble gas.

- Li tends to lose 1 electron (become Li^{+}) to become like He
- Be tends to lose 2 electrons (become Mg^{2+}) to become like He
- F tends to gain 1 electron (become F^{-}) to become like Ne
- O tends to gain 2 electrons (become O^{2-}) to become like Ne



Ions and the Periodic Table

This is a very important slide to study!!!

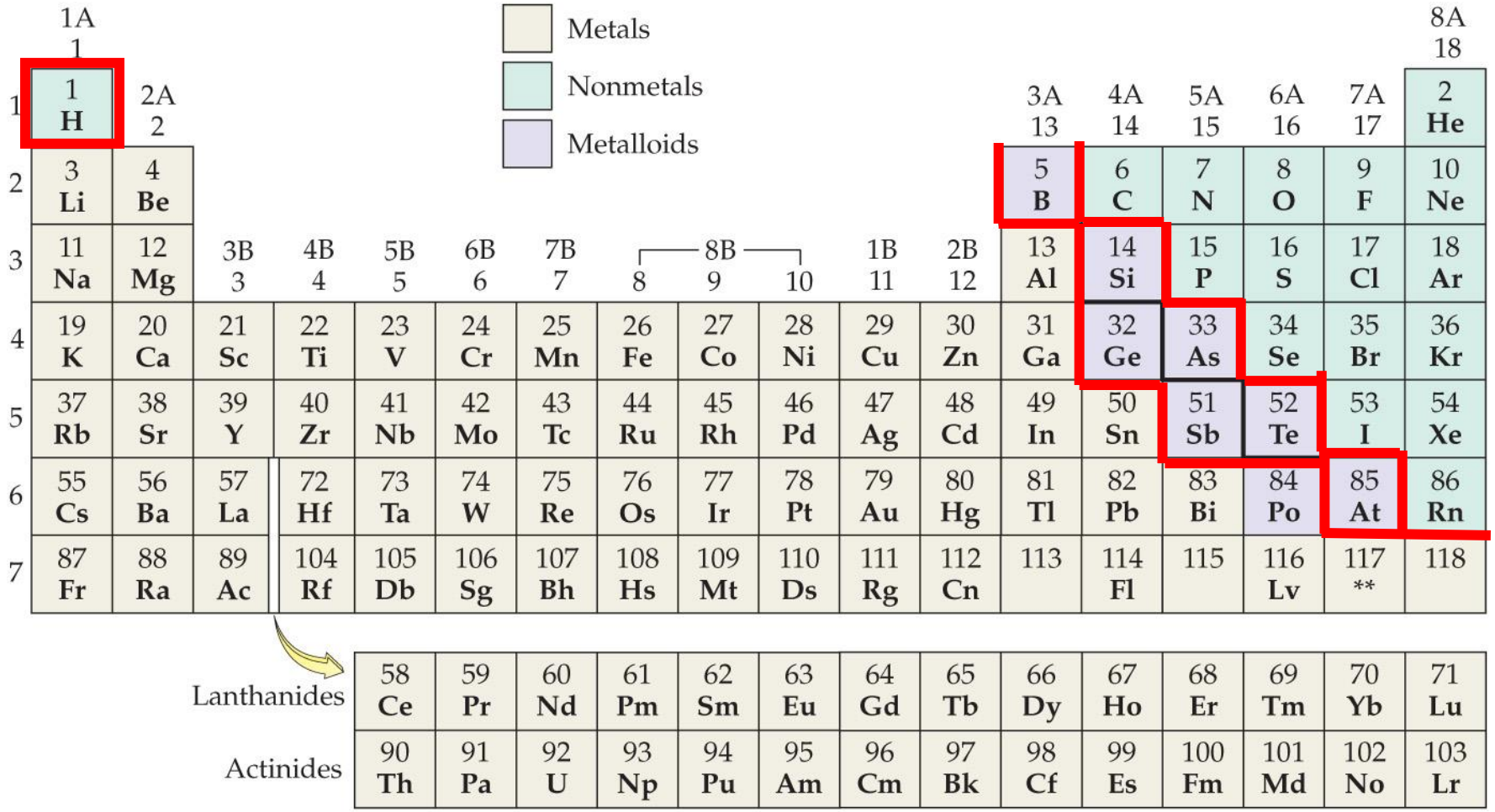
1A	2A									3A	4A	5A	6A	7A	8A
Li^+	Be^{2+}											N^{3-}	O^{2-}	F^-	
Na^+	Mg^{2+}									Al^{3+}			S^{2-}	Cl^-	
K^+	Ca^{2+}									Ga^{3+}			Se^{2-}	Br^-	
Rb^+	Sr^{2+}			Transition metals form cations with various charges						In^{3+}			Te^{2-}	I^-	
Cs^+	Ba^{2+}														

Molecules & Compounds

Molecule: two or more atoms held together by chemical bonds (ex: O_2, H_2O)

Compound: Pure substance consisting of two or more different elements combined in whole-number ratios (ex: H_2O)

Locating Metals, Nonmetals, Metalloids



Chemical Formulas of Compounds

- Metal elements are listed first (example NaCl, KBr)

- For nonmetals, list the most metallic element first (left-most in periodic table) (Example: CO_2, NO)

Example: Write a chemical formula for a compound containing two silver atoms for every sulfur atom.

Polyatomic Ions

Charged species (ion) made up of two or more atoms

Example: Nitrate ion = NO^-_3

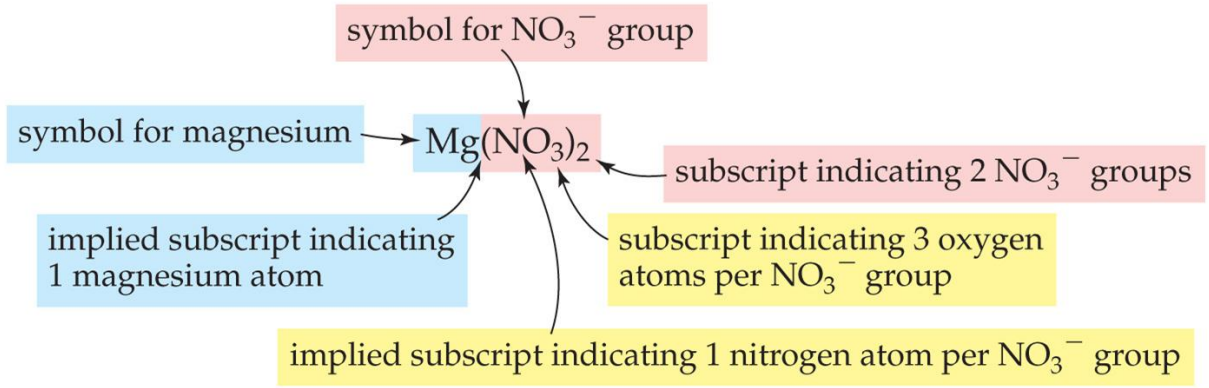
Magnesium Nitrate $Mg(NO_3)_2$

___ nitrate ions for every ___ magnesium

___ Mg and ___ NO^-_3

in total: __ Mg, __ N, ___ O

Polyatomic Ions



Memorize these names, formulas, and charges!

Flash cards!

Polyatomic Ion	Name	Polyatomic Ion	Name
NO_3^-	Nitrate	ClO_4^-	Perchlorate
NO_2^-	Nitrite	ClO_3^-	Chlorate
SO_4^{2-}	Sulfate	ClO_2^-	Chlorite
SO_3^{2-}	Sulfite	ClO^-	Hypochlorite
PO_4^{3-}	Phosphate	*Pattern above applies to other halogens as well (i.e. bromate, iodite)	
CO_3^{2-}	Carbonate	CN^-	Cyanide
HCO_3^-	Bicarbonate	OH^-	Hydroxide
$C_2H_3O_2^-$	Acetate	MnO_4^-	Permanganate
PO_4^{3-}	Phosphate	NH_4^+	Ammonium

Example:

Determine the number of each type of atom in $Al_2(SO_4)_3$

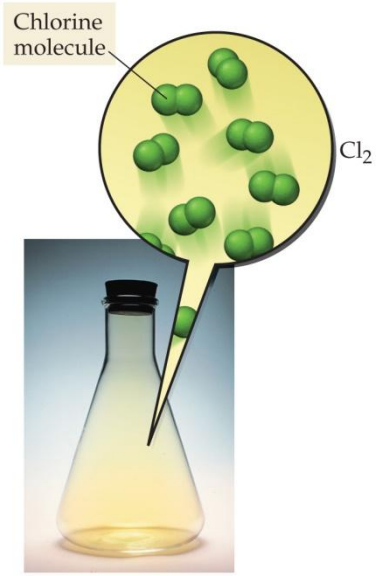
Elements and Compounds

Elements = cannot be simplified

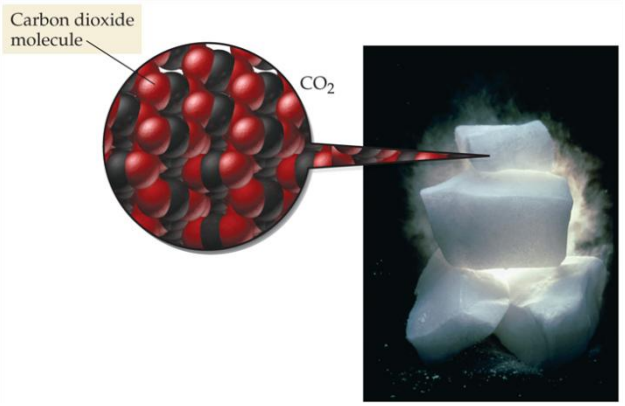
Compounds = composed of two or more elements

Atomic Elements: Exist as single atoms; Most elements; Example: Helium, Copper, Carbon

Molecular Elements ("Diatomic Elements"): Exist as two atoms bonded together; There are seven: H_2, O_2, N_2, Cl_2, F_2, I_2, Br_2



Covalent and Ionic Compounds

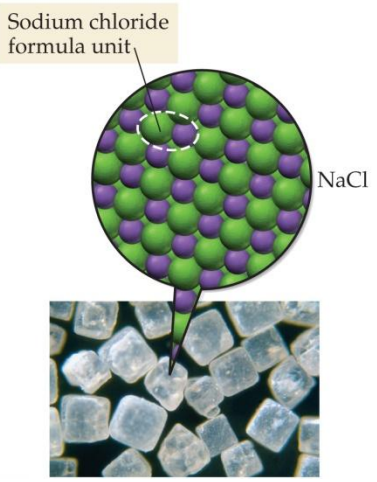


Covalent Compounds (also called molecular compounds): two or more nonmetals (example: H_2O, CO_2, many organic molecules are made of C H and O)

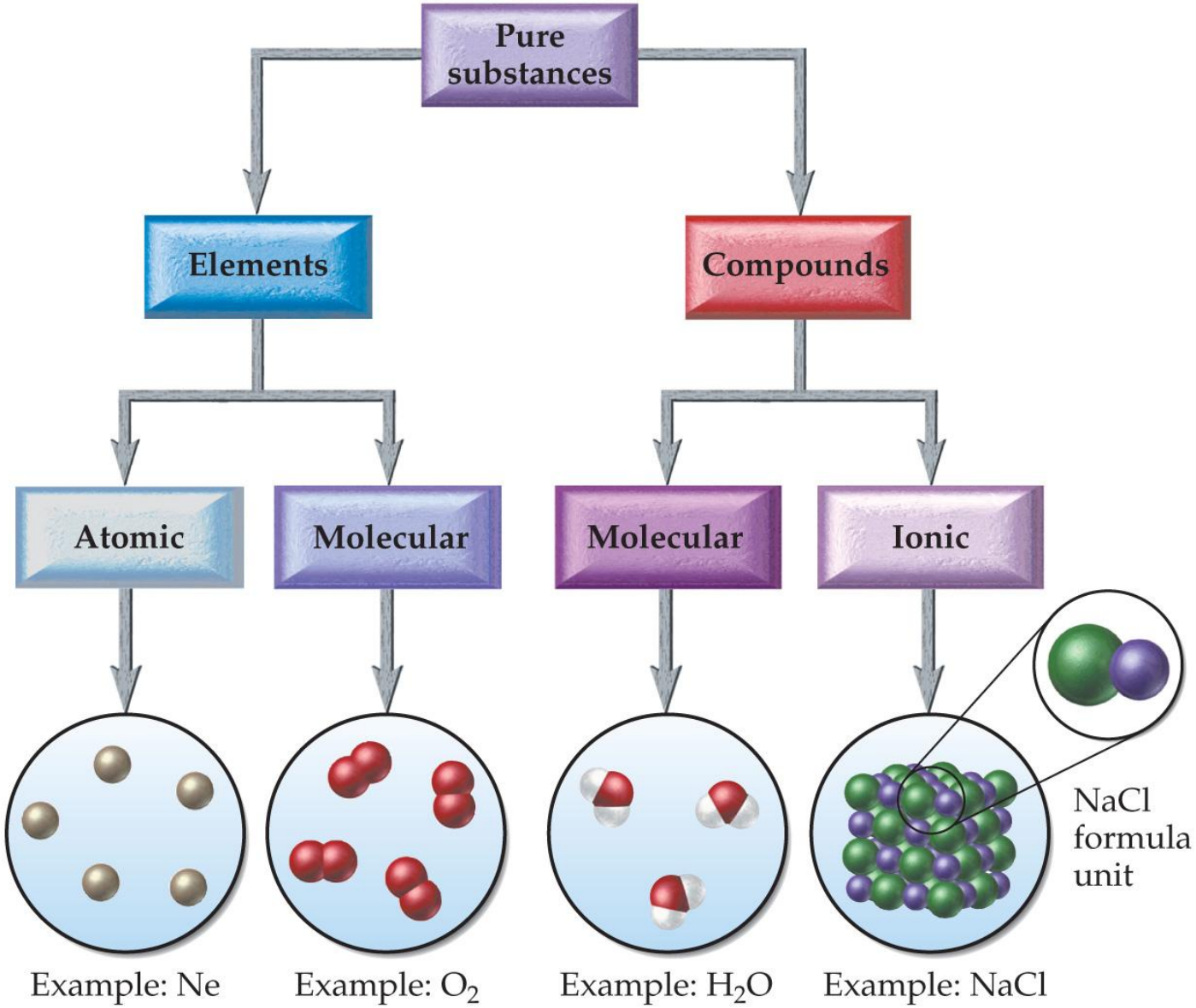
Ionic Compounds: formed from a metal and a nonmetal

Not a real "bond" between ions: just + and – attraction.

metals have positive charge (lose electrons),
nonmetals have negative charge (gain electrons)



Classification of Elements and Compounds



Practice Exercise: Classify each element (as atomic or diatomic/molecular) or compound (as covalent/molecular or ionic).

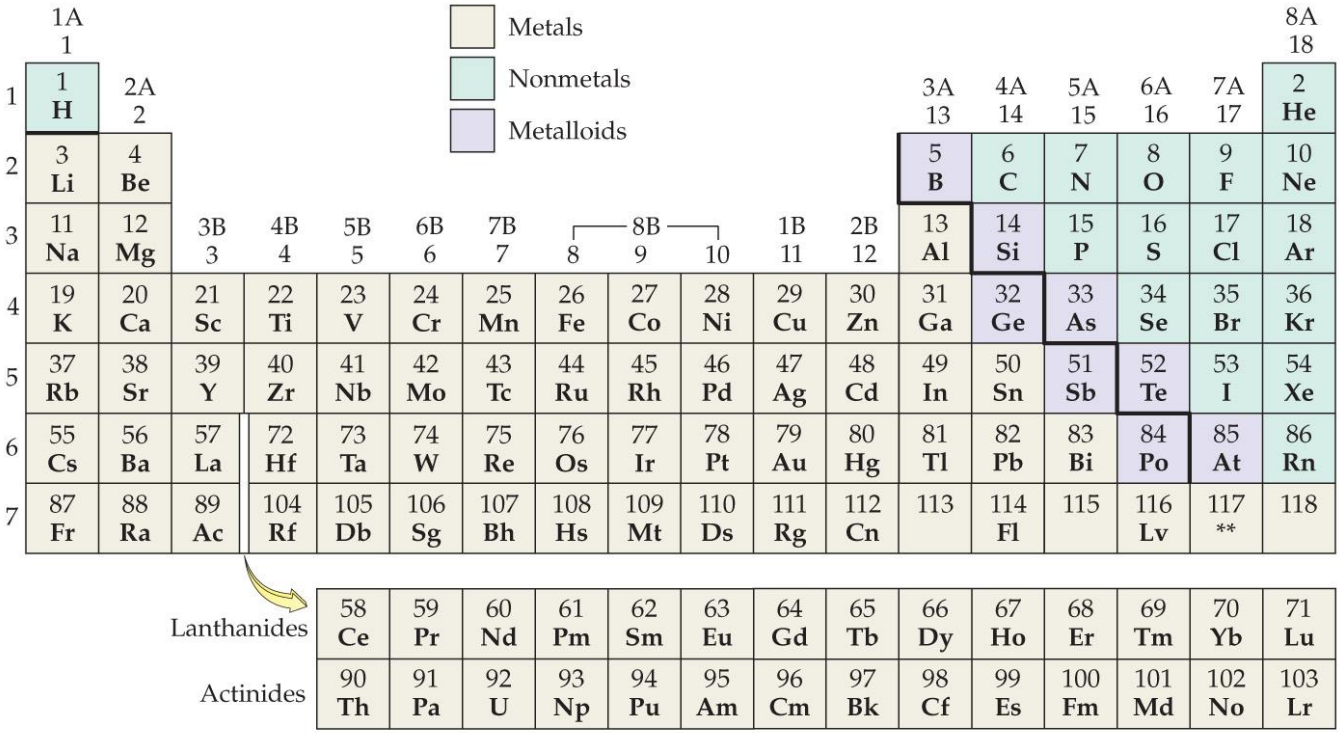
(a) Cl_2

(b) NO

(c) Au

(d) Na_2O

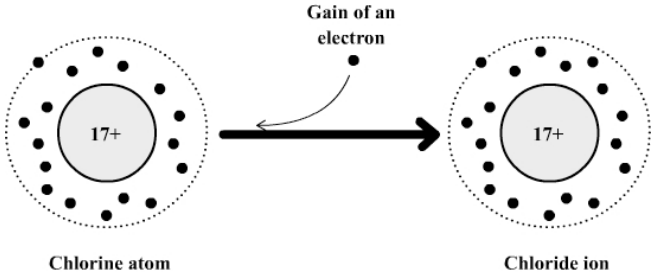
(e) $CrCl_3$



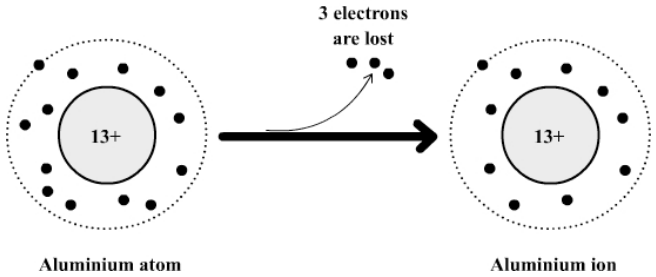
Ions & ionic compounds

Ions

- Atoms can lose or gain electrons
  - As a result, they become charged
  - Charged atoms are called **ions**
- Loss of electron = positive charge
  - Cation
  - Metal atoms tend to form cations
- Gain of electron = negative charge
  - Anion
  - Nonmetal atoms tend to form anions
- Formulas: superscript charge
- Names: Periodic Table of Ions

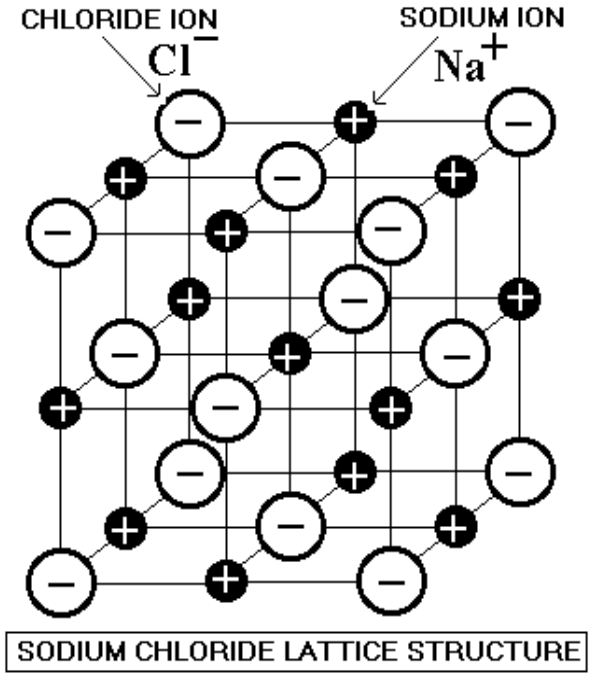


Cl^- (negative charge due to gain of an electron)



Al^{3+} (triply positive charge due to loss of three electrons)

Ionic compounds are made of ionic lattices (they are solids)



SODIUM CHLORIDE LATTICE STRUCTURE

- Definite ratio of cations:anions that is infinitely repeating itself
- Crystal structures

Writing Formulas for Ionic Compounds

Ionic compounds are neutral (charges cancel out)

Formulas can be predicted based on periodic table (charge rules)

Example: Na_xCl_y

Writing formula with polyatomic ions

- Ionic compounds often contain one or more polyatomic ions
    - Polyatomic ion: charged species (ion) made up of two or more atoms

Example: $Mg(NO_3)_2$

2 goes outside the parenthesis to indicate there are 2 NO_3^- ions.

Practice Exercise: What is the chemical formula of the following ionic compounds containing the listed elements?

1. Magnesium cation and chloride anion:

2. Aluminum cation and oxygen anion:

3. K^{+} and CO_3^{2-}:

4. Al^{3+} and SO_4^{2-}:

5. Magnesium cation and oxygen anion:

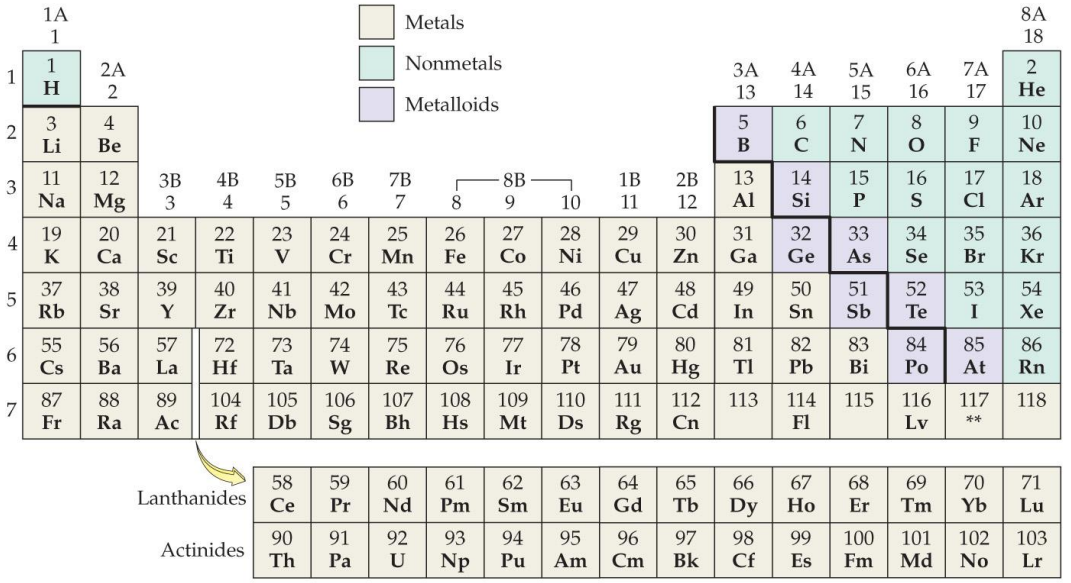
6. Na^{+} and HO^{-}:

Chapter Unit 2.7

Chemical Nomenclature

Nomenclature: Naming Ionic Compounds – Step 1

- The first step in naming an ionic compound is **identifying** it as one.
  - If there is a **metal** and a **nonmetal** (or polyatomic ion) together in a chemical formula, the compound is ionic.
  - Covalent compounds (made of nonmetals only) use *different* naming rules.



Nomenclature: Naming Ionic Compounds

- Cation name followed by anion name

(Say positive things first ☺)

- Follow rules for naming monoatomic ions

Binary ionic compounds

- Must memorize polyatomic ion names

Ionic compounds containing polyatomic ions. If a subscript is applied to a polyatomic ion, the ion will go inside a parenthesis.

- Overall formula charge = zero

This means that the total charge of cations must equal the total charge of anions in formula. Use subscripts to balance the charge. A quick way to do it: crossover charges.

- Formula should have the simplest cation:anion ratio.

Cancel equal subscripts, Reduce subscripts that are multiples of each other to lowest factors .

Nomenclature: Naming Ionic Compounds

Type 1 Metal: only forms one type of ion

ex: Na only forms 1+ ion (Na^+)

Group 1A, 2A, 3A

Zinc = Zn^{2+} and Silver = Ag^+

For naming:

Type 1 cation - name is just name of element

ex: Na^+ =

Type 2 Metal: can form more than one type of ion

ex: Fe forms Fe^{2+} and Fe^{3+}

Most transition metals form more than one type of ion

Type II Metal	Charges
Cr	2+, 3+
Fe	2+, 3+
Co	2+, 3+
Cu	1+, 2+
Sn	2+, 4+
Pb	2+, 4+
Hg_2^{2+} / Hg^{2+}	1+, 2+

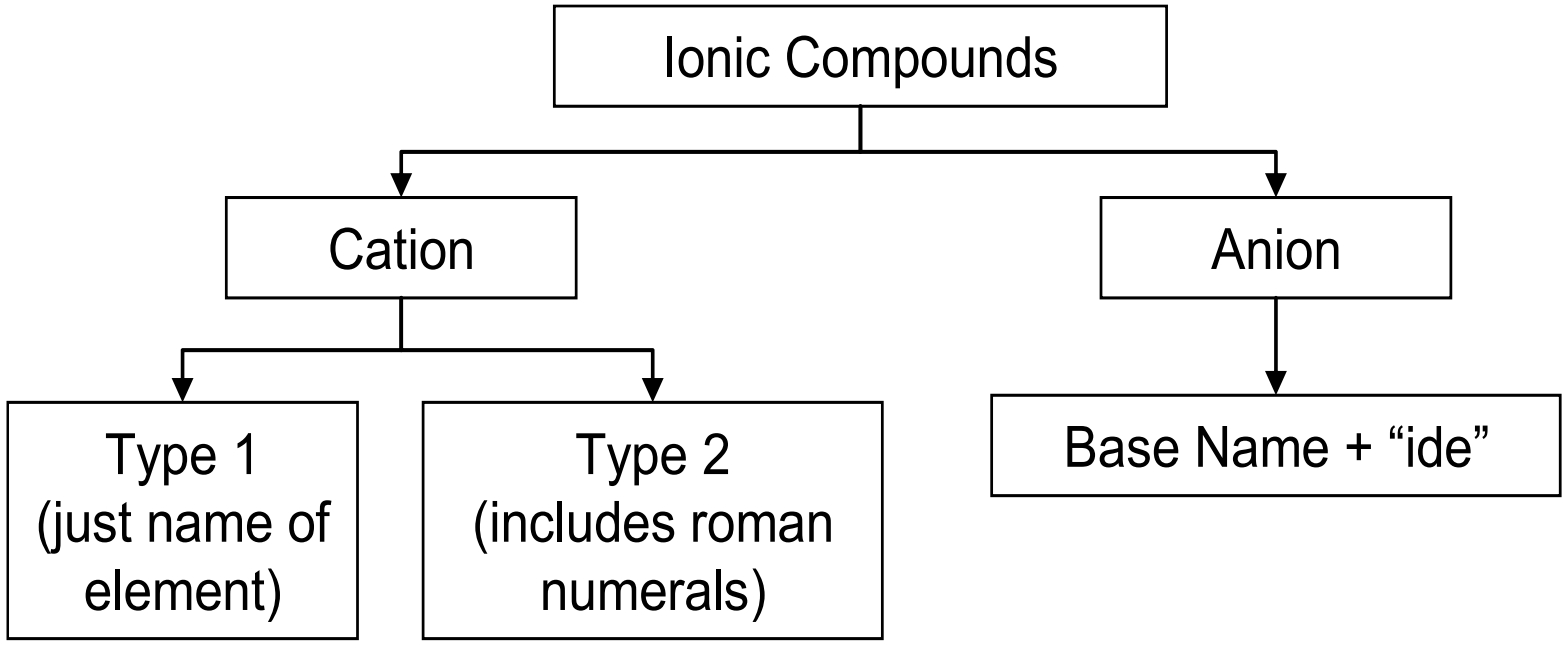
Type 2 cation - name includes the charge as a roman numeral

ex: Fe^{2+} =

Fe^{3+} =

If the cation is a polyatomic ion, just use its name
ex. NH_4^+ = ammonium

Naming Ionic Compounds



Naming Anions in Ionic Compounds

Drop ending of nonmetal's name and change it to –ide

Nonmetal	Symbol	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

If the anion is a polyatomic ion, just use its name.

Practice: Naming Ionic Compounds

$Cu(NO_2)_2$

$Fe(OH)_2$

KNO_3

NaClO

$NaHCO_3$

NaCl

KBr

Zn_3N_2

$FeCl_3$

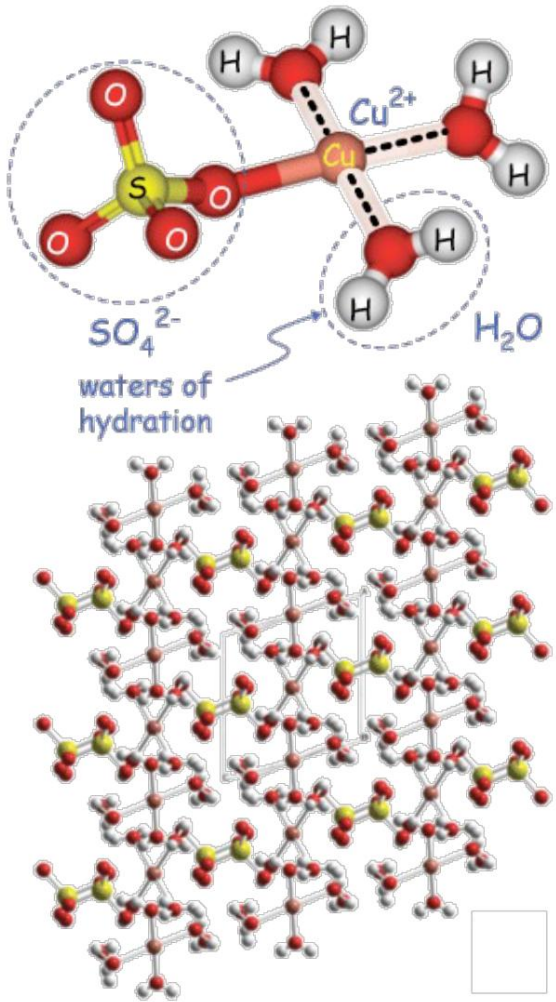
$PbCl_4$

PbO

Hydrates

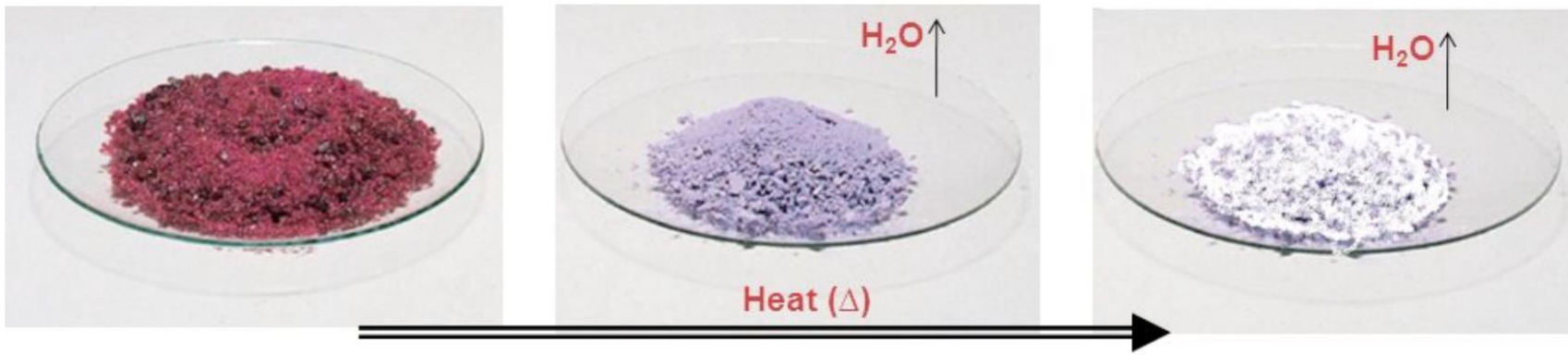
- Ionic substances containing water molecules incorporated into their crystal structures
- Contain water molecules combined <u>in a definite ratio</u> as integral part of crystal
- $CuSO_4 \cdot 5\ H_2O$ = copper (II) sulfate **pentahydrate**

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



Hydrates (Hydrated Salts)

- Ionic substances containing water molecules incorporated into their crystalline structure
- release water upon heating, absorb water under cool, humid conditions



$$CoCl_2 \cdot 6H_2O \underset{+4\ H_2O}{\overset{-\ 4H_2O}{\rightleftharpoons}} CoCl_2 \cdot 2H_2O \underset{+\ 2H_2O}{\overset{-\ 2H_2O}{\rightleftharpoons}} CoCl_2$$

Anhydrous

Naming Molecular/Covalent Compounds

Molecular (covalent) compounds – two nonmetals

- Use prefixes

mono = 1	penta = 5
di = 2	hexa = 6
tri = 3	hepta = 7
tetra = 4	octa = 8

- Mono is omitted for the first element (but used for the second element)

Practice: Naming Covalent Compounds

CO_2

CCl_4

NO

SF_6

N_2O

N_2O_4