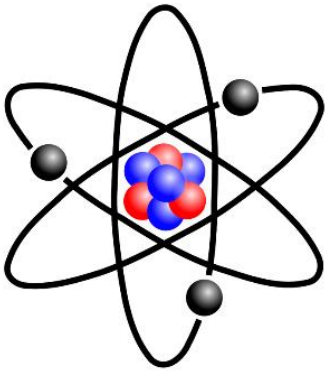
Nomenclature

1

models



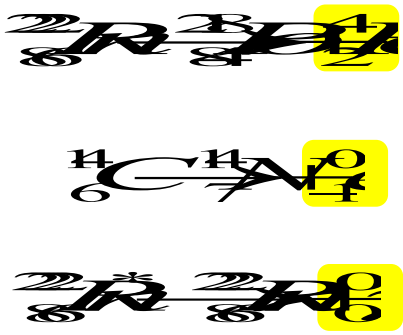
2

From last time

There are three types of radioactivity:

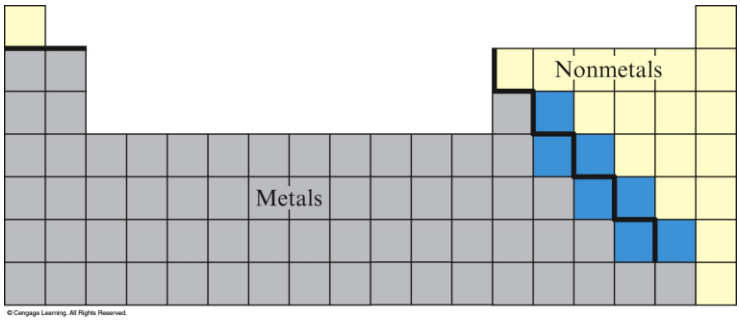
1. ***Alpha particles*** (α) are identical to helium nuclei, containing two protons and two neutrons.
2. ***Beta particles*** (β) are identical to electrons.
3. ***Gamma rays*** (γ) are high-energy photons.

Examples



3

The Periodic Table



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- Most elements are metals and occur on the left side.
- The nonmetals appear on the right side.
- Metalloids (semimetals) are elements that have some metallic and some nonmetallic properties.

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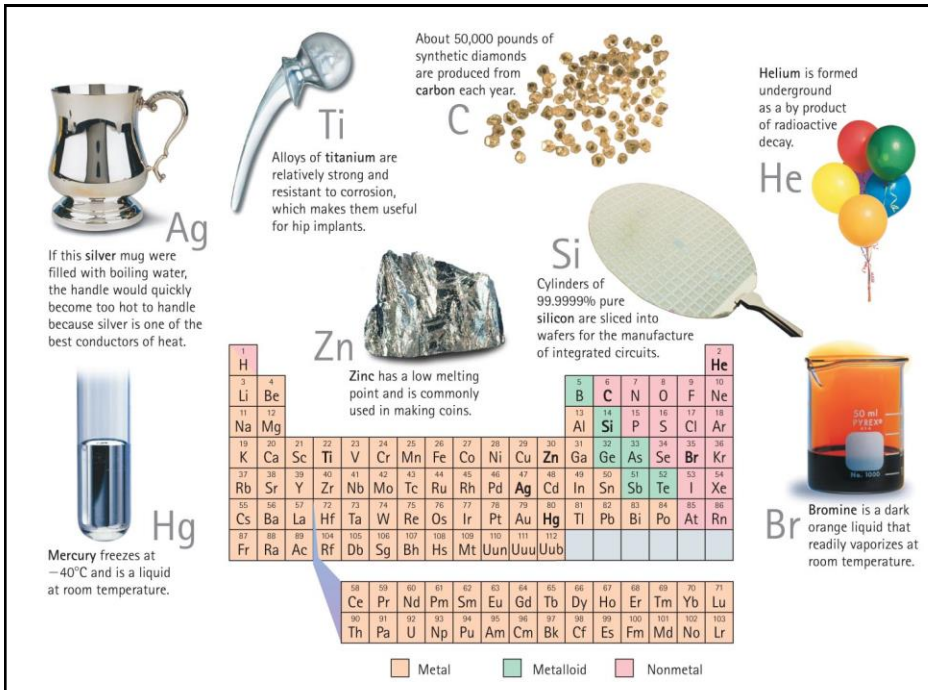
Common Names of Groups (Families)

5



6

Elements to Compounds

- **Element:** A material made of only one kind of atom. Pure gold is an example as it is made of only gold atoms.
- **Atom:** The fundamental unit of an element.

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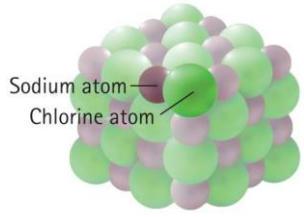
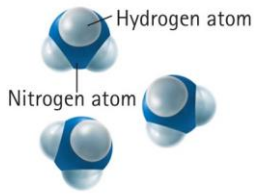
Elements to Compounds

- **Compound:**
  A substance consisting of atoms of different elements.



Sodium chloride, NaCl



Ammonia, NH_3

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Element Symbols

Each element has its own unique symbol. One or two letter symbols are used to represent elements. Most of the time, the symbol is derived from the name of the element. The first letter is always capitalized and the second letter is always a lower case.

Examples: C is the symbol for carbon
Cr is the symbol for chromium

Cu

Copper: The origin of the name comes from the Latin word *cuprum* meaning the island of *Cyprus* famed for its copper mines

Fe

Iron: The origin of the name comes from the Latin word *ferrum* meaning *iron*.

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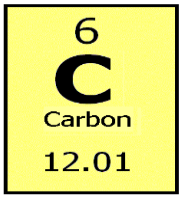
The Periodic Table and the Elements

- What is the periodic table ?
- What information is obtained from the table ?
- How can elemental properties be predicted base on the PT ?



- Different periodic tables can include various bits of information, but usually:
  - atomic number
  - symbol
  - Average atomic mass
  - number of valence electrons
  - state of matter at room temperature.

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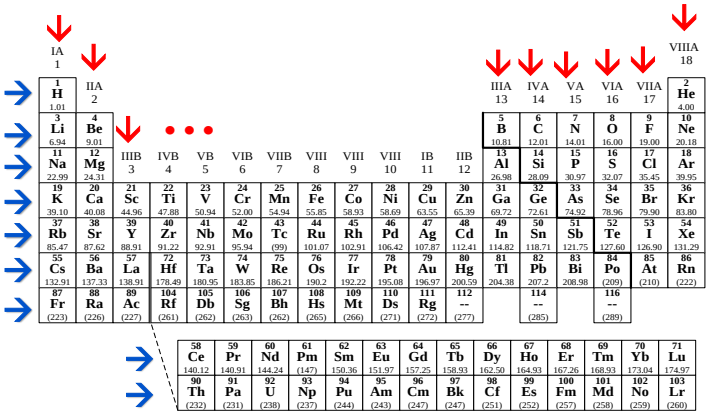
Groups and Periods of Elements

- A vertical column on the periodic table is a ***group*** or family of elements.
- A horizontal row on the periodic table is a ***period*** or series of elements.
- There are 18 groups and seven periods on the periodic table.



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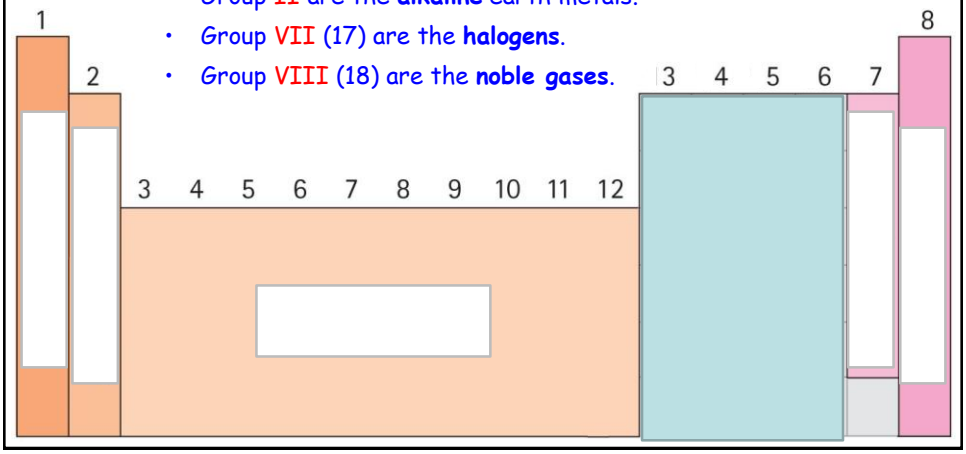
Common Names of Groups (Families)

Several families have common trivial names.

- Group I are the **alkali** metals.
- Group II are the **alkaline** earth metals.
- Group VII (17) are the **halogens**.
- Group VIII (18) are the **noble gases**.



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Ionic Charges

- **Valence electrons**
  - Most atoms will gain or lose electrons in order to get a full valence electron shell (outmost sublevel)
  - The number of valence electrons in a neutral atom can be found from the periodic table (group number)
  - **Octet** "rule": Most elements need **8 e^-** to have a full valence electron shell.
    - 2 exceptions: H and He (2 valence e^-)

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Atoms vs. Ions

Atoms can gain or lose e^- to form IONS

- ANY charged particle is called an ***ion***
- Losing e^- gives **POSITIVELY** charge
  - Called **cations**
  - Usually formed from metals

$Na \rightarrow Na^+ + e^-$
cation

- Gaining e^- gives a **NEGATIVELY** charged ion
  - Called **anions**
  - Usually formed from non-metals

$Cl + e^- \rightarrow Cl^-$
anion

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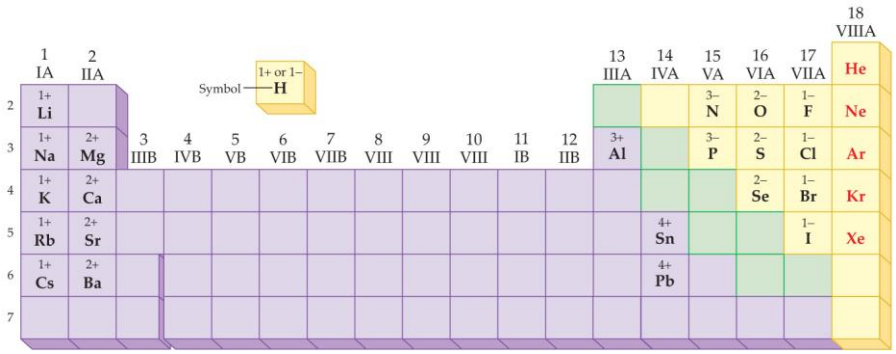
Ions

- Shown are the elements on the periodic table and their common charges.



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Predicting Ionic Charge

- Group I metals form 1+ ions,
  Group II metals form 2+ ions,
  Group III metals form 3+ ions, and
  Group IV metals form 4+ ions.
- By losing their valence electrons, they achieve a noble gas configuration.
- Similarly, nonmetals can gain electrons to achieve a noble gas configuration.
- Group V nonmetals form –3 ions,
  Group VI nonmetals form –2 ions, and
  Group VII (halogens) elements form –1 ions.

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Writing Chemical Formulas

- An ionic compound is composed of positive and negative ions.
- A ***formula unit*** is the simplest representative particle of an ionic compound.
- A formula unit is neutral, so the total positive charge must equal the total negative charge in the formula unit.

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Formulas of Ionic Compounds

- If the ions in the ionic compound have the same charge, the formula unit contains one of each ion.
  - K^+ and Br^- combine to form KBr.
  - Ca^{2+} and O^{2-} combine to form CaO.
- If the charges are not equal, we must balance the positive and negative charges.
  - Ba^{2+} and Cl^- combine to form $BaCl_2$.
  - Li^+ and S^{2-} combine to form Li_2S.

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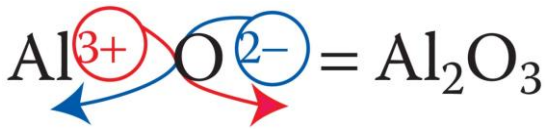
Crossover Rule

- You can quickly verify that the chemical formula is written correctly by crossing over the charge on each ion.



- The charge on the aluminum ion becomes the subscript for the oxygen, and the charge on the oxide ion becomes the subscript for the aluminum ion.

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Naming Ions (the letters)

Monatomic ions

- Some charges can be predicted based on group number
- Cation name is the same as element name with ***ion*** added

element: zinc (Zn)	ion: zinc **ion** (Zn^{2+})
element: cesium (Cs)	ion: cesium **ion** (Cs^{+})

- Anion name changes ending of element name to ***ide***

element: nitrogen (N)	ion: nitr**ide** (N^{3-})
element: iodine (I)	ion: iod**ide** (I^{-})

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Monoatomic ions

Non-metals (anions)

Nonmetal Neutral Elements		Ion (anion)	
Element Name	Symbol	Ion Name	Formula
bromine	Br	bromide	Br^-
chlorine	Cl	chloride	Cl^-
fluorine	F	fluoride	F^-
hydrogen	H	hydride	H^-
iodine	I	iodide	I^-
nitrogen	N	nitride	N^{3-}
oxygen	O	oxide	O^{2-}
phosphorus	P	phosphide	P^{3-}
carbon	C	carbide	C^{-4}

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Did you get it?

Element	Valence e^-	Ion charge	Ion name
iodine	7	-1	iodide
aluminum	3	+3	aluminum ion
phosphorus	5	-3	phosphide
barium	2	+2	barium ion

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Monoatomic Cations

- Metal atoms can lose valence electrons and become positively charged cations.
- Cations are named for the parent atom followed by the word "ion."
  - Na^+ is named "sodium ion"
  - Al^{3+} is named "aluminum ion"

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Metals That Form Multiple Ions

- If a metal can form more than one cation, it is named for the parent, followed by the charge in Roman numerals in parentheses, followed by the word "ion."
  - Fe^{2+} is the iron(II) ion
  - Fe^{3+} is the iron(III) ion

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Summary of Ions (the letters)

Practice: Give the name OR symbol for these ions:

tin (II) ion	S^{2-}	Fe^{3+}	copper (I) ion
Sn^{2+}	sulfide	iron (III) ion	Cu^{+}
Mg^{2+}	bromide	Mn^{4+}	Ag^{+}
magnesium ion	Br^{-}	manganese (IV) ion	silver ion

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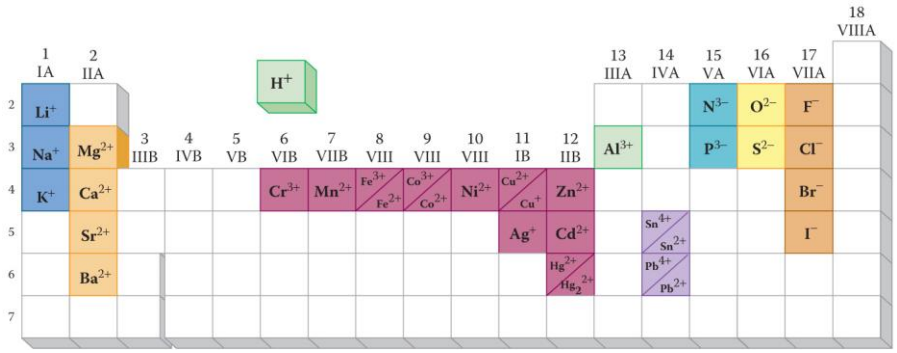
Ions

- Shown are the elements on the periodic table and their common charges.



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nomenclature

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IUPAC

- The **I**nternational **U**nion of **P**ure and **A**pplied **C**hemistry, IUPAC, has set rules for naming compounds.
- IUPAC set the rules for the naming and classification of inorganic compounds in 1940.
- These rules, referred to as ***IUPAC nomenclature***, are still in use today.

Chemistry Connection: Antoine and Marie Lavoisier

- Antoine Lavoisier (1743–1794) was a French scientist and is generally considered the father of modern chemistry.
- He published the book *Methods of Chemical Nomenclature* in 1787. It became the basis for modern nomenclature rules.
- His wife, Marie-Anne, helped him in his experimental work and record keeping.
- Antoine Lavoisier was executed in 1794 during the French revolution.

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Nomenclature (binary compounds)

Type I

Metal + nonmetal

The metal has only one charge and takes the name of the element

Ending changes to -ide

Example:
KCl Potassium chloride
$MgBr_2$ Magnesium bromide

Common Type I cations

Alkali,
Alkaline
Al^{3+},
Ag^{+},
Zn^{2+}

Type II

Metal + nonmetal

The metal has a variable oxidation state (different charge). A Roman number indicates the charge

Ending changes to -ide

Examples: CuBr Copper(I) bromide
FeS Iron(II) sulfide

Common Type II Cations

Ion	Systematic Name
Fe^{3+}	iron(III)
Fe^{2+}	iron(II)
Cu^{2+}	copper(II)
Cu^{+}	copper(I)
Co^{3+}	cobalt(III)
Co^{2+}	cobalt(II)
Sn^{4+}	tin(IV)
Sn^{2+}	tin(II)
Pb^{4+}	lead(IV)
Pb^{2+}	lead(II)
Hg^{2+}	mercury(II)
Hg_2^{2+}*	mercury(I)

*Mercury(I) ions always occur bound together in p

Type III

nonmetal + nonmetal

For nonmetal+nonmetal, prefixes indicate the number of atoms.

Ending changes to -ide

Example: tetranitrogen nonachloride
Step 1: N_4
Step 2: N_4Cl_9

Example: O_2F
Step 1: dioxygen
Step 2: dioxygen monofluoride

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

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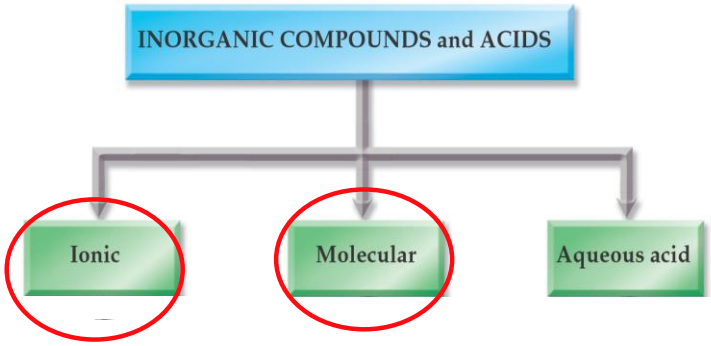
Classification of Compounds



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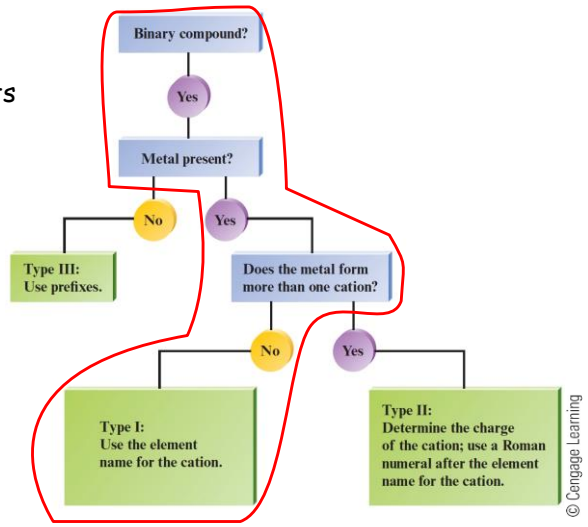
Binary Ionic Compounds (Type I)

Binary Compounds:
Composed of two elements



Binary Ionic Compounds

- Metal—nonmetal

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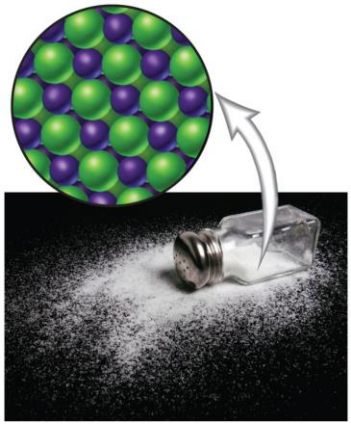
Binary Ionic Compounds (Type I)

- ***Binary ionic compounds*** contain two elements: one metal and one nonmetal.
  - NaCl
  - and $AlCl_3$ are binary ionic compounds.



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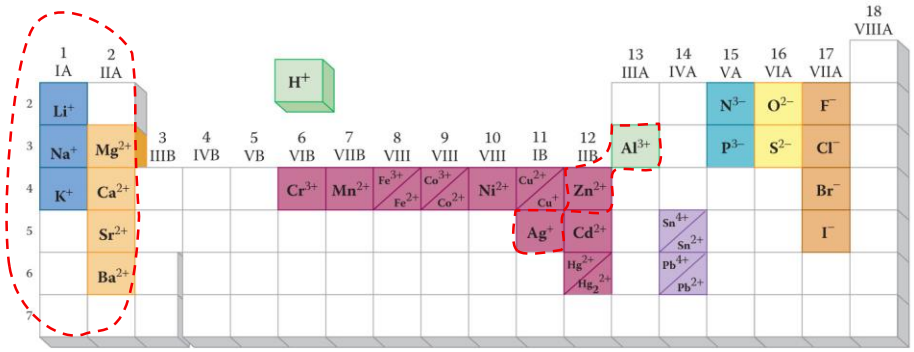
Binary Ionic Compounds (Type I)

- Shown are the elements on the periodic table and their common charges.



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Binary Ionic Compounds (Type I)

- Examples:

KCl	Potassium chloride
$MgBr_2$	Magnesium bromide
CaO	Calcium oxide

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Did you get it?

- Name or give the formula for the following type I compounds:

1) Na_2Se	1) sodium selenide
2) lithium nitride	2) Li_3N
3) SrI_2	3) strontium iodide
4) barium sulfide	4) BaS
5) KCl	5) potassium chloride
6) aluminum oxide	6) Al_2O_3

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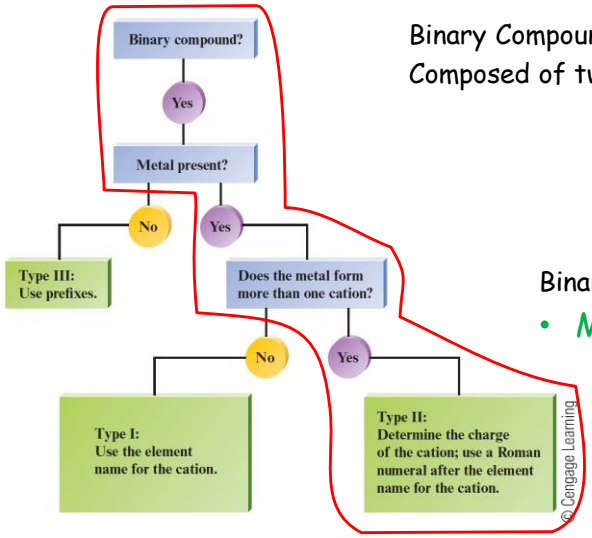
Binary Ionic Compounds (Type II)



Binary Compounds:
Composed of two elements

Binary Ionic Compounds
- Metal(VOS)—nonmetal

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Metals That Form Multiple Ions

- If a metal can form more than one cation, it is named for the parent, followed by the charge in Roman numerals in parentheses, followed by the word *ion*.
  - Cu^{+} is the copper(I) ion.
  - Cu^{2+} is the copper(II) ion.
- This is called the ***Stock system*** of naming transition metal cations.

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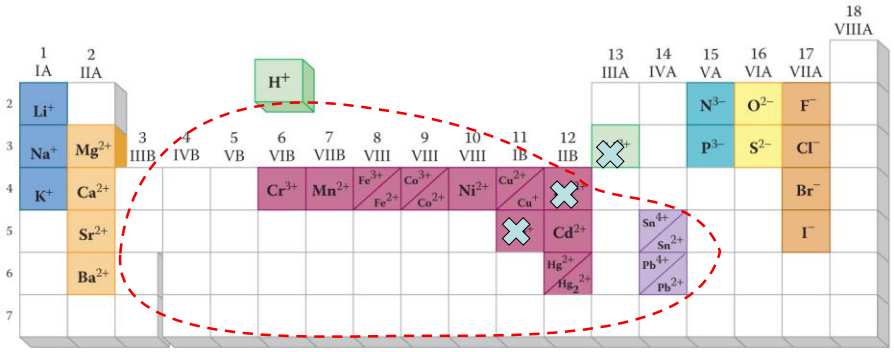
Binary Ionic Compounds (Type II)

- Shown are the elements on the periodic table and their common charges.



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Binary Ionic Compounds (Type II)

Common Type II Cations

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+}.

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Binary Ionic Compounds (Type II)

- Examples:

CuBr	Copper(I) bromide
FeS	Iron(II) sulfide
PbO_2	Lead(IV) oxide

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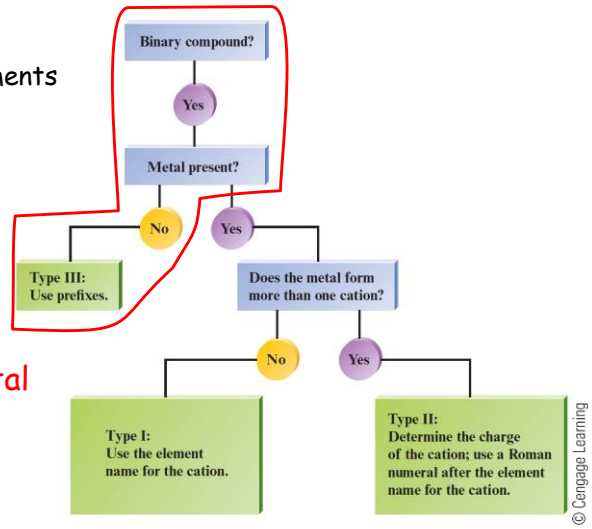
Binary Covalent/Molecular Compounds (Type III)

Binary Compounds:
Composed of two elements

Binary Compounds
Nonmetal — nonmetal



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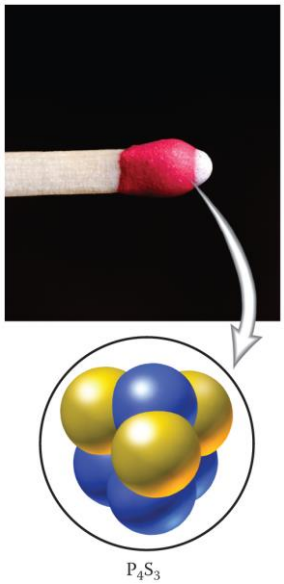
Molecular Compounds (Type III)

- ***Binary molecular compounds*** contain two elements and *both* are nonmetals.
  - Some examples of binary molecular compounds are ammonia, NH_3 and water, H_2O.



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Binary Covalent Compounds (Type III)

Prefixes Used to Indicate Numbers in Chemical Names

Prefixes Used to Indicate Numbers in Chemical Names

Prefix	Number Indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8

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Naming Binary Molecular Compounds, Continued

- What is the name of the molecular compound P_4S_3?
  - There are 4 P atoms, use *tetra-*.
  - There are 3 S atoms, use *tri-*.
  - The name for N_2O_5 is tetraphosphorus trisulfide.
- What is the name for P_4S_7?
  - Tetraphosphorus heptasulfide

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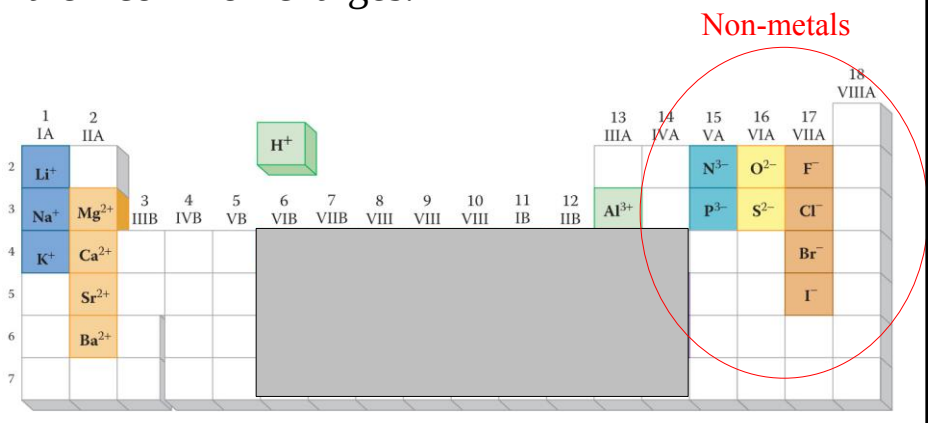
Ions

- Shown are the elements on the periodic table and their common charges.



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Binary Covalent Compounds (Type III)

- Examples:

CO_2	Carbon dioxide
SF_6	Sulfur hexafluoride
N_2O_4	Dinitrogen tetroxide

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Nomenclature of Covalent Compounds

1) I_3Se_7

2) SO_4

3) NH_3

4) SiO_2

5) dinitrogen pentoxide

6) xenon hexafluoride

7) nitrogen trioxide

8) carbon tetrachloride

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Nomenclature of Covalent Compounds

1) I_3Se_7	1) triiodine heptaselenide
2) SO_4	2) sulfur tetroxide (NOT sulfate)
3) NH_3	3) nitrogen trihydride (ammonia)
4) SiO_2	4) silicon dioxide
5) dinitrogen pentoxide	5) N_2O_5
6) xenon hexafluoride	6) XeF_6
7) nitrogen trioxide	7) NO_3
8) carbon tetrachloride	8) CCl_4

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Polyatomic Ions

- Polyatomic ions are charged entities composed of several atoms bound together.
- They have special names and must be memorized.

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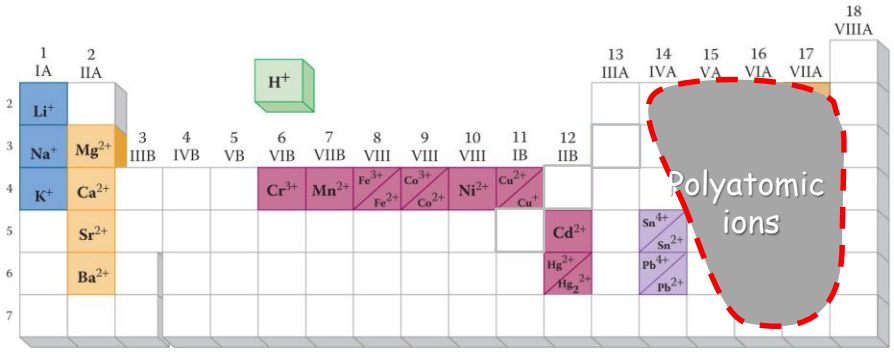
Binary Ionic Compounds (Type I & II)

- Compounds with polyatomic ions are named with the cation (type I & II) and anion name (without -ide)



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Names of Common Polyatomic Ions

Names of Common Polyatomic Ions

Ion	Name	Ion	Name
NH_4^+	ammonium	CO_3^{2-}	carbonate
NO_2^-	nitrite	HCO_3^-	hydrogen carbonate (bicarbonate is a widely used common name)
NO_3^-	nitrate		
SO_3^{2-}	sulfite	ClO^-	hypochlorite
SO_4^{2-}	sulfate	ClO_2^-	chlorite
HSO_4^-	hydrogen sulfate (bisulfate is a widely used common name)	ClO_3^-	chlorate
		ClO_4^-	perchlorate
OH^-	hydroxide	$C_2H_3O_2^-$	acetate
CN^-	cyanide	MnO_4^-	permanganate
PO_4^{3-}	phosphate	$Cr_2O_7^{2-}$	dichromate
HPO_4^{2-}	hydrogen phosphate	CrO_4^{2-}	chromate
$H_2PO_4^-$	dihydrogen phosphate	O_2^{2-}	peroxide

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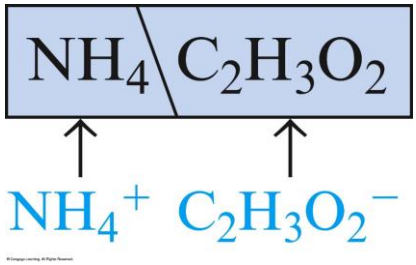
- Naming ionic compounds containing polyatomic ions follows rules similar to those for binary compounds.



Ammonium acetate

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Examples

Na_2SO_4	$FePO_4$	$Al_2(CO_3)_3$
$Na_2\boxed{SO_4}$	$Fe\boxed{PO_4}$	$Al_2(\boxed{CO_3})_3$
Sodium sulfate	Iron(III) phosphate	Aluminum carbonate

55

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Nomenclature (binary compounds)

Type I
Metal + nonmetal

The metal has only one charge and takes the name of the element

Ending changes to -ide

Example:
KCl Potassium chloride
$MgBr_2$ Magnesium bromide

Common Type I cations

Alkali,
Alkaline
Al^{3+},
Ag^{+},
Zn^{2+}

Type II
Metal + nonmetal

The metal has a variable oxidation state (different charge). A Roman number indicates the charge

Ending changes to -ide

Examples: CuBr Copper(I) bromide
FeS Iron(II) sulfide

Common Type II Cations

Ion	Systematic Name
Fe^{3+}	iron(III)
Fe^{2+}	iron(II)
Cu^{2+}	copper(II)
Cu^{+}	copper(I)
Co^{3+}	cobalt(III)
Co^{2+}	cobalt(II)
Sn^{4+}	tin(IV)
Sn^{2+}	tin(II)
Pb^{4+}	lead(IV)
Pb^{2+}	lead(II)
Hg^{2+}	mercury(II)
Hg_2^{2+}*	mercury(I)

*Mercury(I) ions always occur bound together in p

Type III
nonmetal + nonmetal

For nonmetal+nonmetal, prefixes indicate the number of atoms.

Ending changes to -ide

Example: tetranitrogen nonachloride
Step 1: N_4
Step 2: N_4Cl_9

Example: O_2F
Step 1: dioxygen
Step 2: dioxygen monofluoride

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

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Naming Compounds

1-Identify the elements…metal, non-metal

CO

CO_2

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Naming Compounds

Examples:

H_2O dihydrogen monoxide

H_2O_2 dihydrogen dioxide

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Naming Compounds

Examples:

H_2O “Water”

H_2O_2 “Hydrogen peroxide”

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Naming Compounds

What is the name of the compound with the formula CBr_4?

A. Chrobrofor
B. SeeBer4
C. Carbon bromide
D. Carbon tetrabromide.

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