Chapter 3: Chemical Compounds

Sept 13, 2022

Chemistry Department, Cypress College

Class Announcements

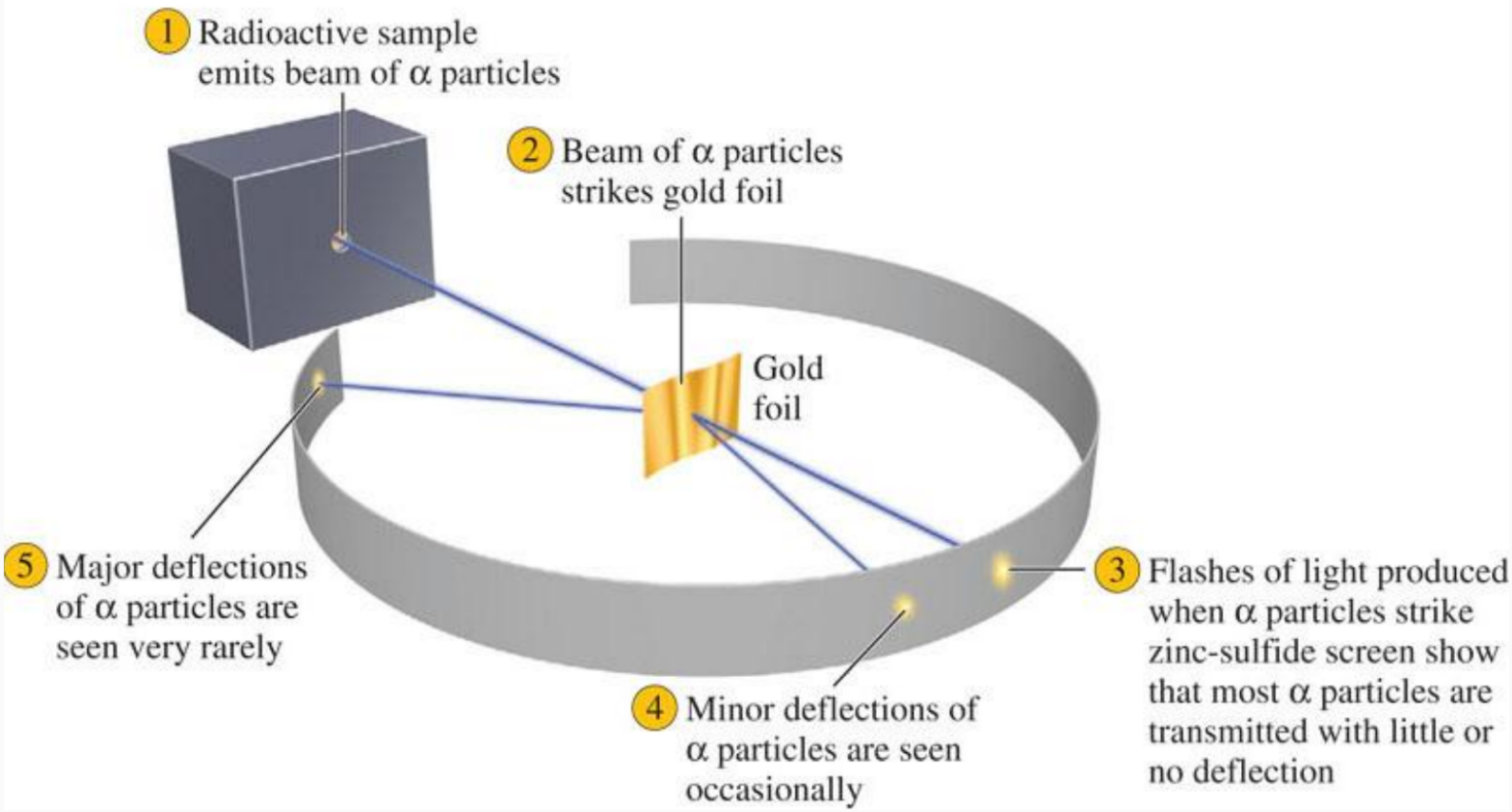
- Go over homework assignment; present your work for 1pt EC
- Begin Ch 3 - Chemical Compounds and Types of Bonding
- Quiz #3 released this Fri, Sept 16 at 3pm and due Tues, Sept 20 at 11:59pm
- Homework #3 released this Fri, Sept 16 at 3pm and due Fri, Sept 23 at 11:59pm

Lecture Weekly Agenda

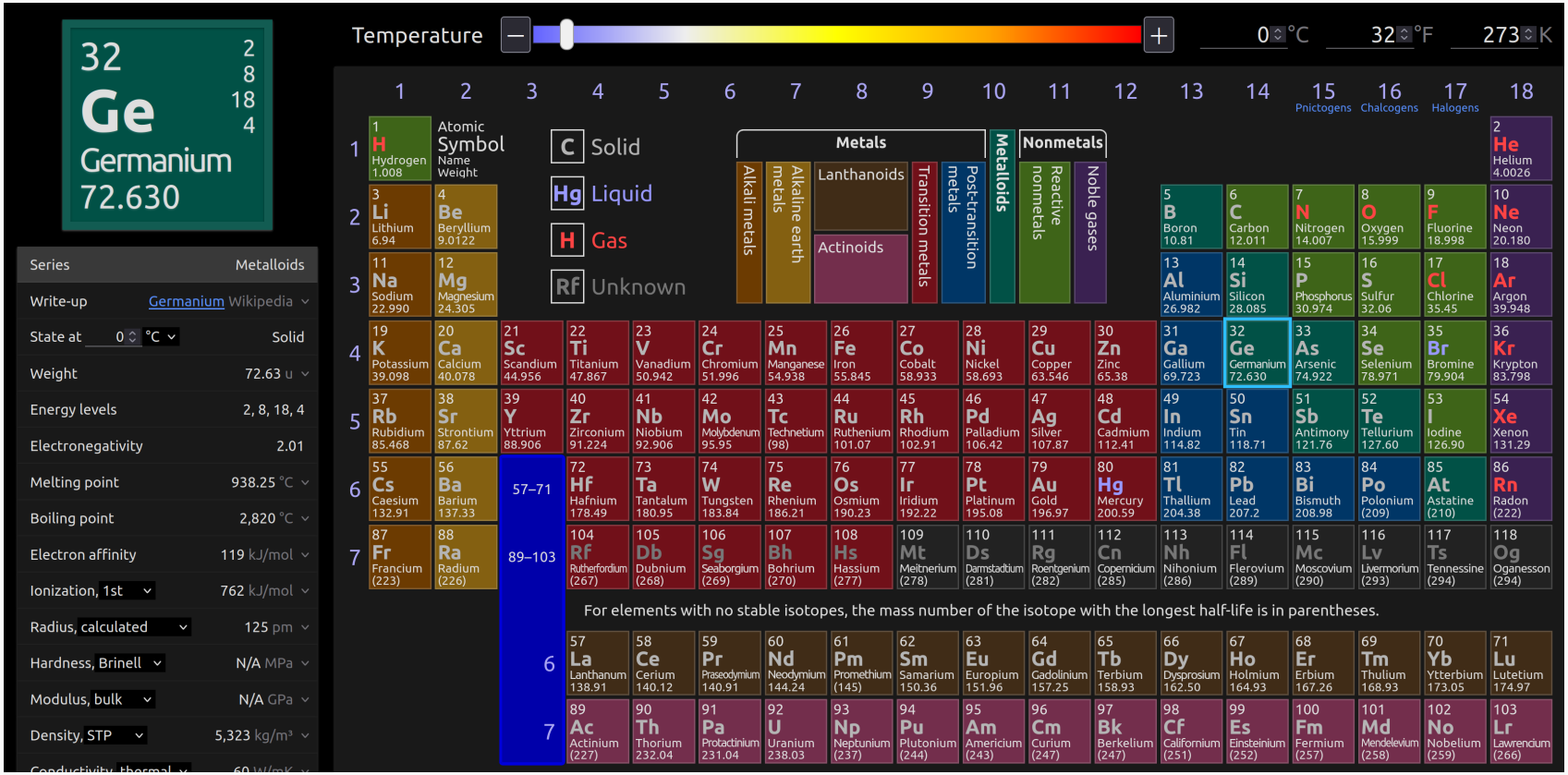
- Go over homework assignment; present your work for 1pt EC
- Review Ch 2 - Atoms, Ions, and the Periodic Table
- Begin lecture on Ch 3 - Chemical Compounds and Nomeclature
- Nomenclature Lab assignments due Sept 19 at 11:59pm

Outline

J.J. Thompson's Plum Pudding Model



Review: Modern Period Table



Relative Atomic Mass

$$\text{Relative Atomic Mass} = (I_1 \times A_1) + (I_2 \times A_2) + \ldots \qquad (1)$$

where I is the mass of the isotope, and A is the relative abundance between 0 and 1

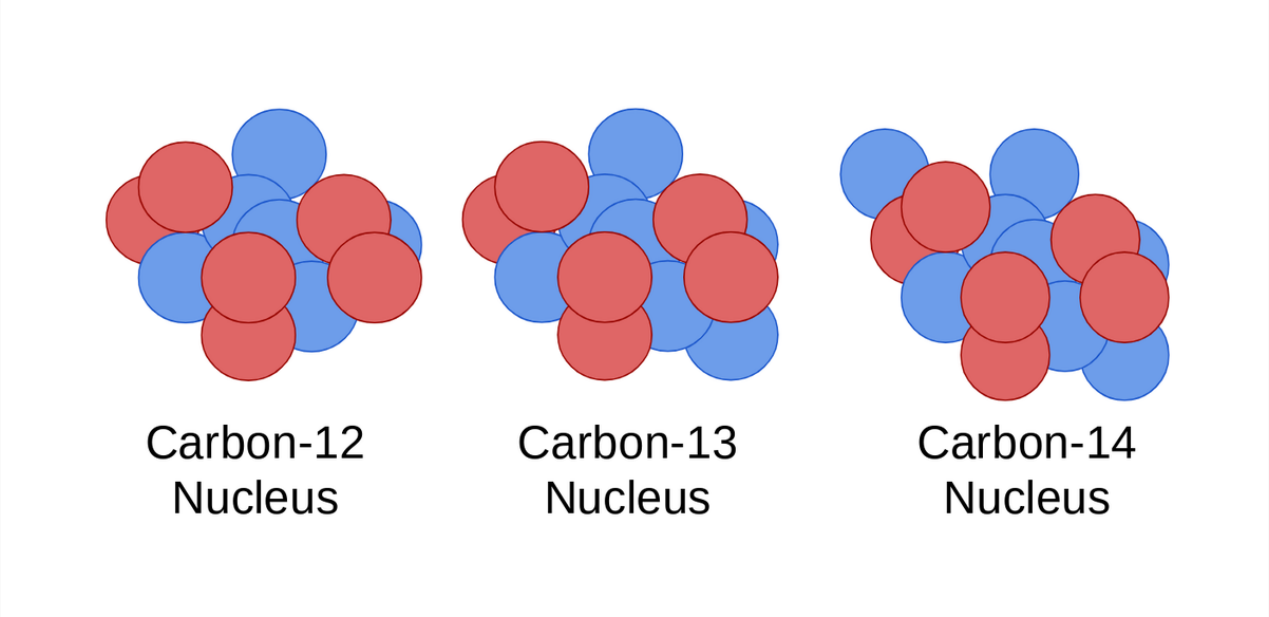
Defining Atomic Number and Mass

$$^{A}_{Z}X^{C} \tag{2}$$

where A is the atomic mass, Z is the atomic number, X is atomic symbol, and C is the overall charge

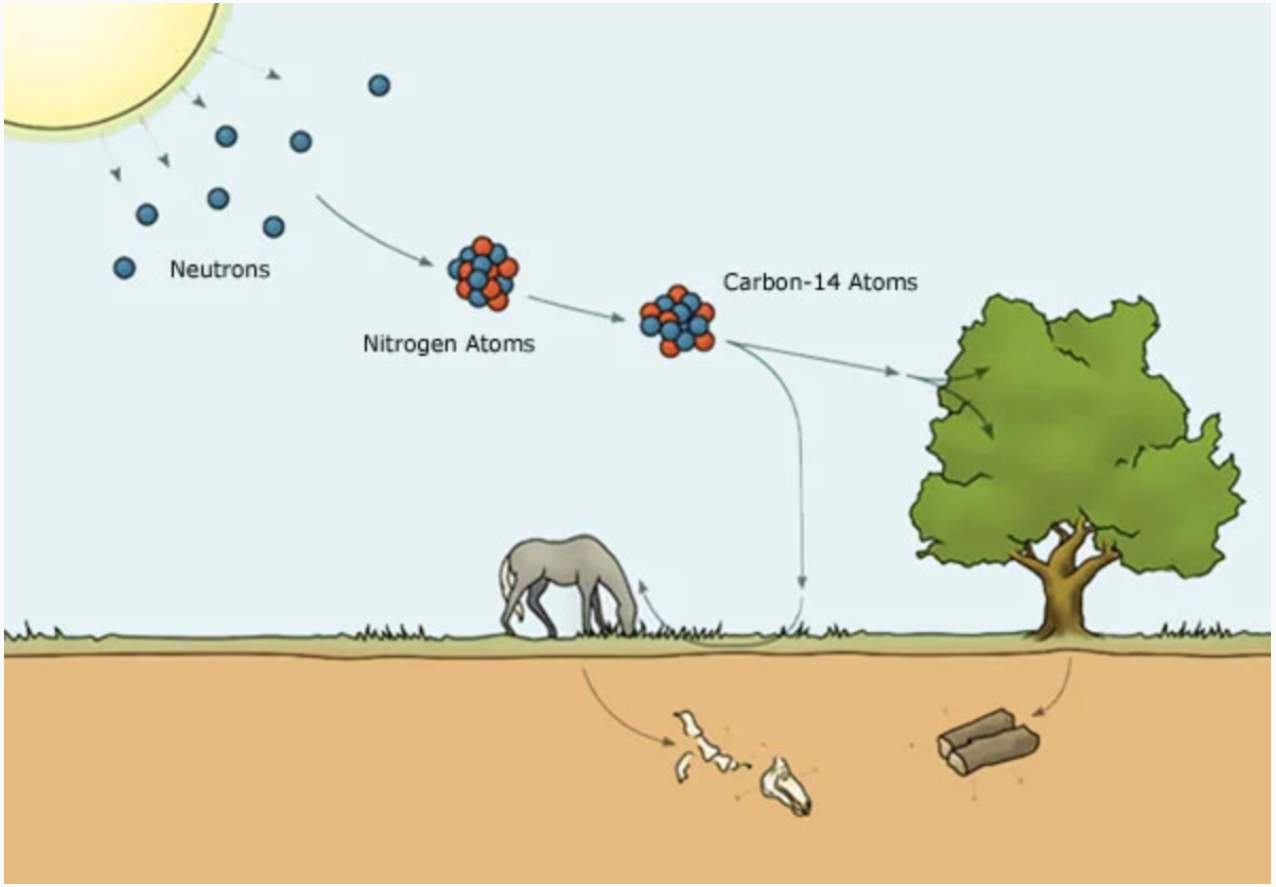
Isotopes - chemically same atom (same number of protons) but physically different (different number of neutrons)

Hydrogen Isotopes and Applications



- Carbon-12, carbon-13, and carbon-14 have relative abundances of 98.9%, 1.1%, and 0.1%, respectively
- **Q:** Which carbon isostope is the highest in abundance?

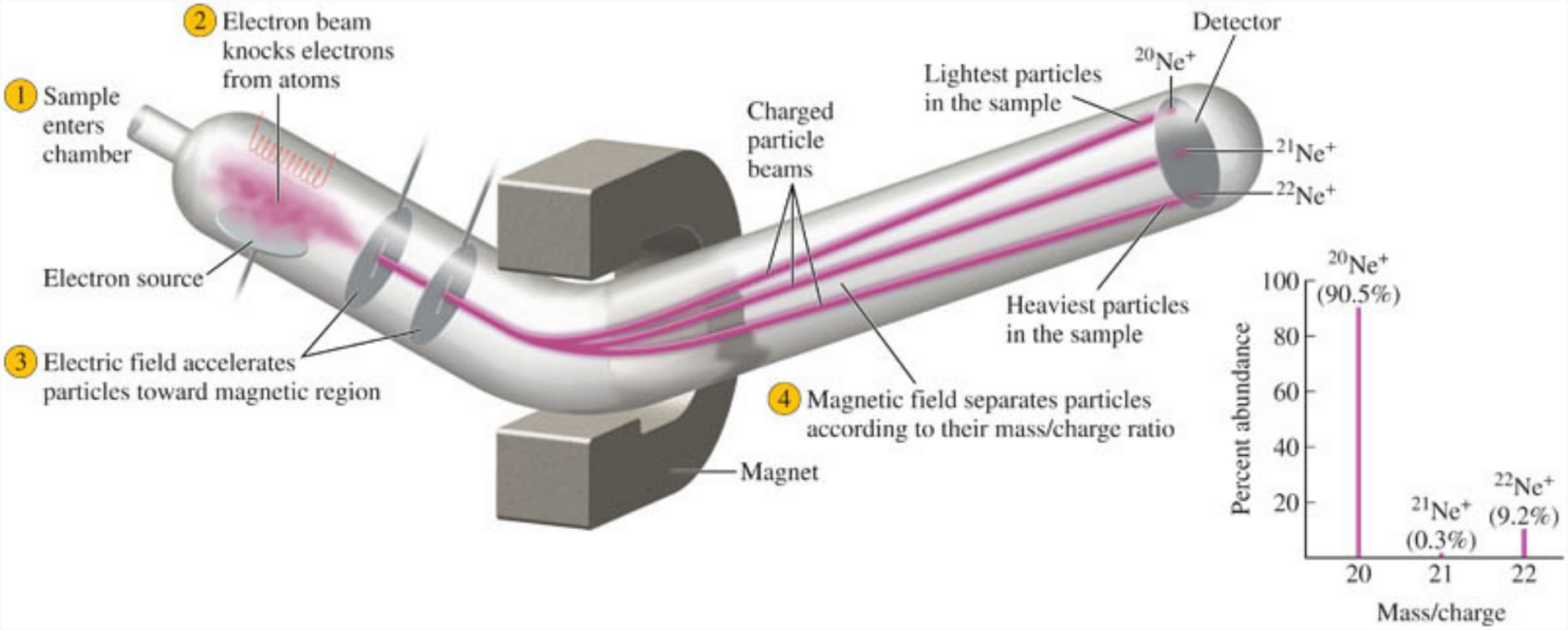
Carbon-14 Dating



Applications

- Rough estimation of fossils because known half-life $\sim 5,730$ years

Experiment: Mass Spectroscopy



- Ionizes the atom and electric field accelerates atoms
- Time of flight - heavier atoms will travel slower than lighter ones
- Weighted average of atomic masses

Outline

Ionic and Molecular Compounds

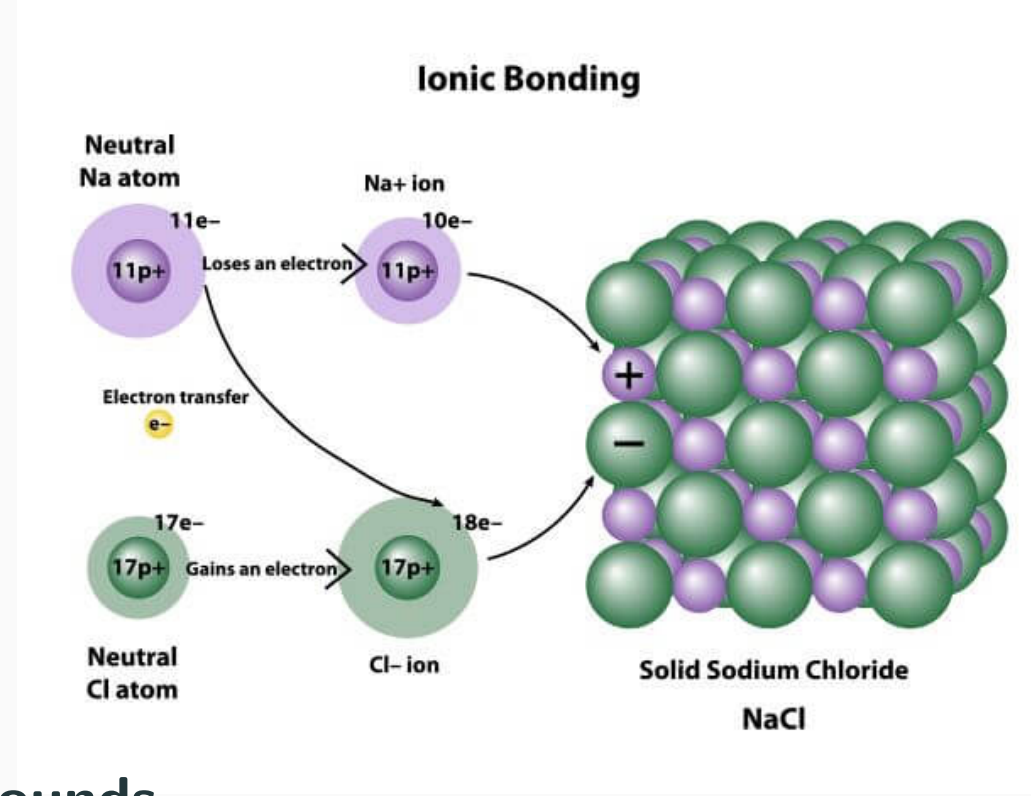
Ionic Compounds

- Consists of oppositely charged cations and anions such that the overall charge is neutral e.g $CaCl_2(s)$, BaF(s), and $Fe_2O_3(s)$
- Electrolyte - substances that separate into the ions e.g. NaCl(aq) dissociates into Na^+ and Cl^-
- Forms ionic bonds (purely electrostatic interactions)

Molecular Compounds

- Composed of atoms from two or more nonmetals
- Forms covalent bonds (sharing of electrons)

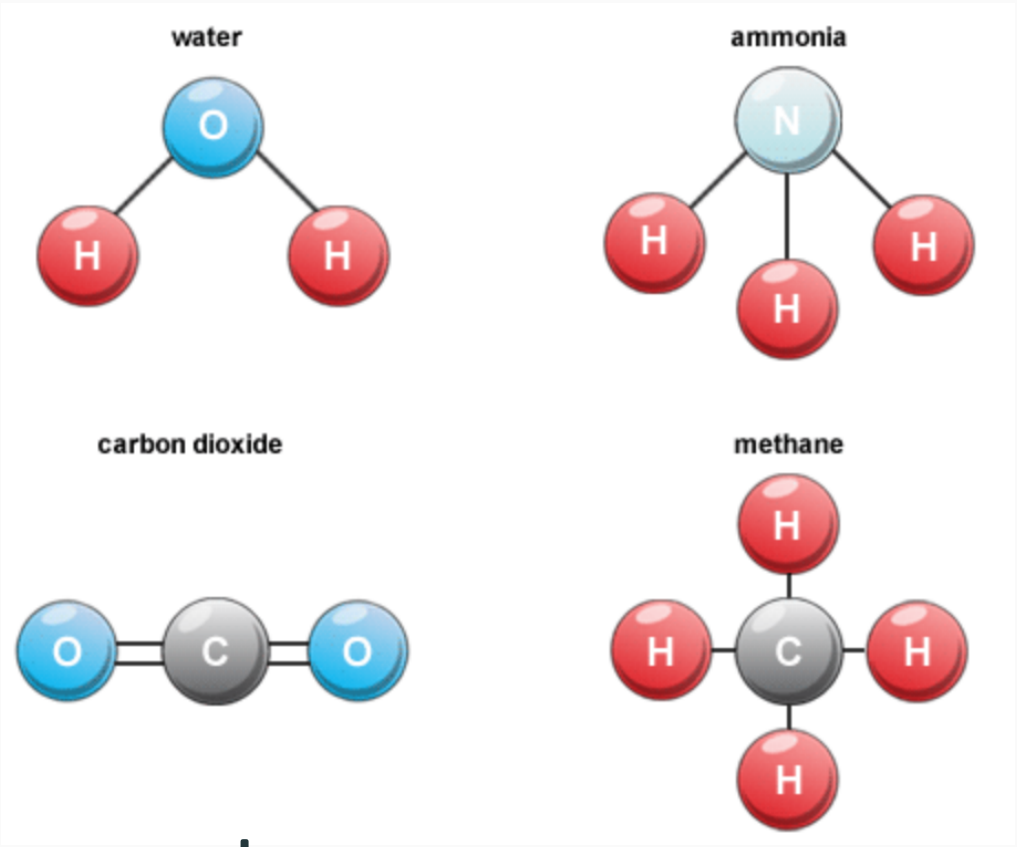
Properties of Ionic and Molecular Compounds



Ionic Compounds

- Highly conductive and strong electrolyte - ability to carry electricity (electrons)
- High melting and boiling points, high density

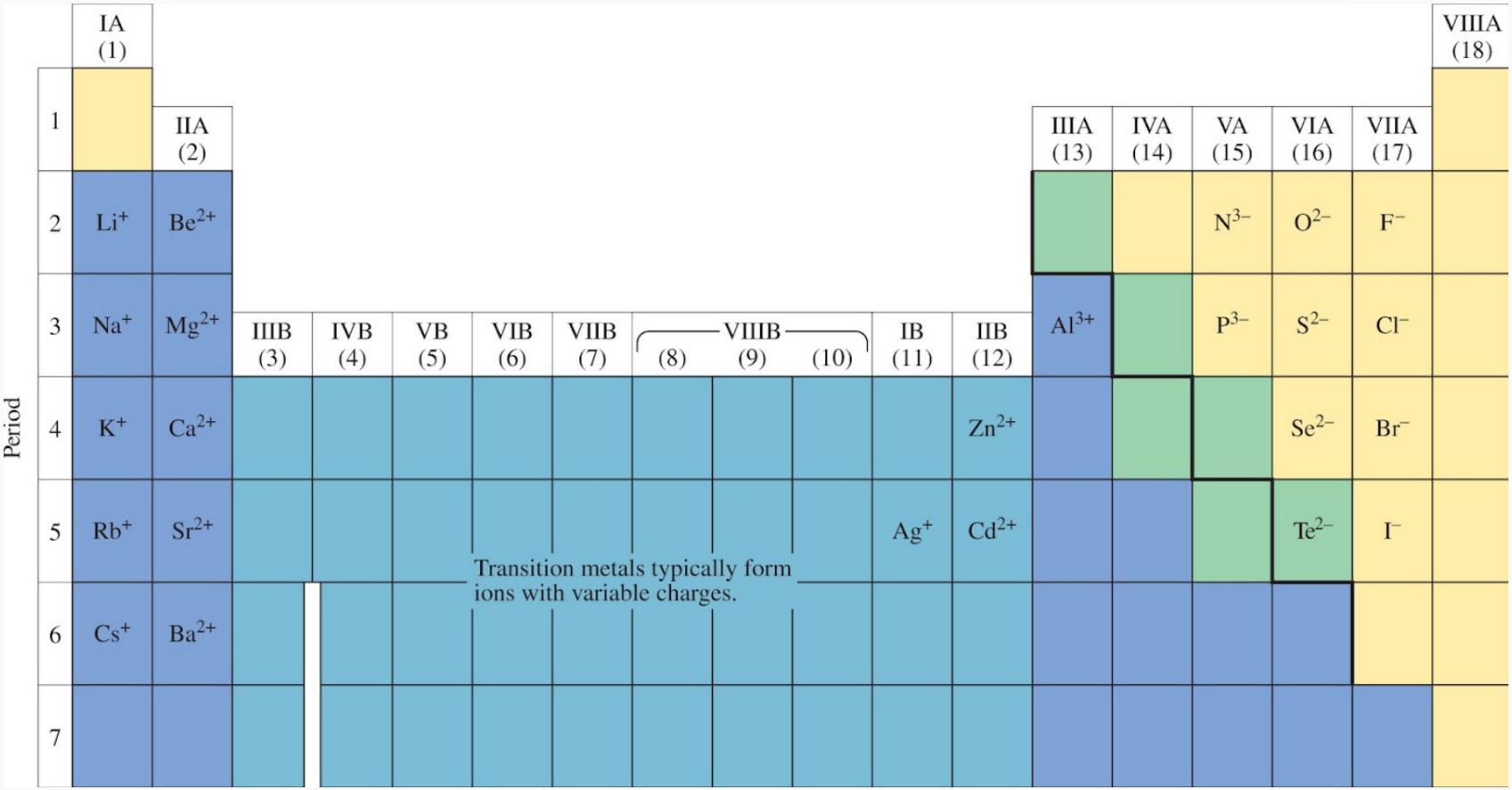
Properties of Ionic and Molecular Compounds



Molecular Compounds

- Not conductive and weak electrolyte
- Low melting and boiling points, low density

Monoatomic Ions



Polyatomic Ions

B BO_3^{3-} borate	**C** CO_3^{2-} carbonate	**N** NO_3^- nitrate NO_2^- nitrite N^{3-} nitride	**O** O_2^{2-} peroxide O^{2-} oxide	**F** No oxoanions F^- fluoride
	Si SiO_4^{4-} silicate	**P** PO_4^{3-} phosphate P^{3-} phosphide	**S** SO_4^{2-} sulfate SO_3^{2-} sulfite S^{2-} sulfide	**Cl** ClO_4^- perchlorate ClO_3^- chlorate ClO_2^- chlorite ClO^- hypochlorite Cl^- chloride
		As AsO_4^{3-} arsenate AsO_3^{3-} arsenite As^{3-} arsenide	**Se** SeO_4^{2-} selenate SeO_3^{2-} selenite Se^{2-} selenide	**Br** BrO_4^- perbromate BrO_3^- bromate BrO_2^- bromite BrO^- hypobromite Br^- bromide
			Te TeO_4^{2-} tellurate TeO_3^{2-} tellurite Te^{2-} telluride	**I** IO_4^- periodate IO_3^- iodate IO_2^- iodite IO^- hypoiodite I^- iodide

Additional Polyatomic Ions

SCN^-	thiocyanate
NH_4^+	ammonium
H_3O^+	hydronium
O_2^{2-}	peroxide
OH^-	hydroxide
CN^-	cyanide
$C_2H_3O_2^-$	acetate
MnO_4^-	permanganate
$C_2O_4^{2-}$	oxalate
CrO_4^{2-}	chromate
$Cr_2O_7^{2-}$	dichromate

Molecular Formulas for Ionic Compounds

The sum of the cations and anions equals to zero. The cation is written first then anion.

Examples: Practice determining the oxidation states

- $CaCO_3$
- $BaCl_2$
- $FeCl_3$
- $Ca(NO_3)_2$

Outline

Naming Ions

Metals - start with the element and end with ion

Element	Stem	Charge	Modern Name	Common Name
iron	ferr-	2+	iron(II) ion	ferrous ion
		3+	iron(III) ion	ferric ion
copper	cupr-	1+	copper(I) ion	cuprous ion
		2+	copper(II) ion	cupric ion
tin	stann-	2+	tin(II) ion	stannous ion
		4+	tin(IV) ion	stannic ion
lead	plumb-	2+	lead(II) ion	plumbous ion
		4+	lead(IV) ion	plumbic ion
chromium	chrom-	2+	chromium(II) ion	chromous ion
		3+	chromium(III) ion	chromic ion
gold	aur-	1+	gold(I) ion	aurous ion
		3+	gold(III) ion	auric ion

Naming Nonmetal Ions

Nonmetals - replace suffix with -ide and end with ion

Ion	Name
F^-	fluoride ion
Cl^-	chloride ion
Br^-	bromide ion
I^-	iodide ion
O^{2-}	oxide ion
S^{2-}	sulfide ion
P^{3-}	phosphide ion
N^{3-}	nitride ion

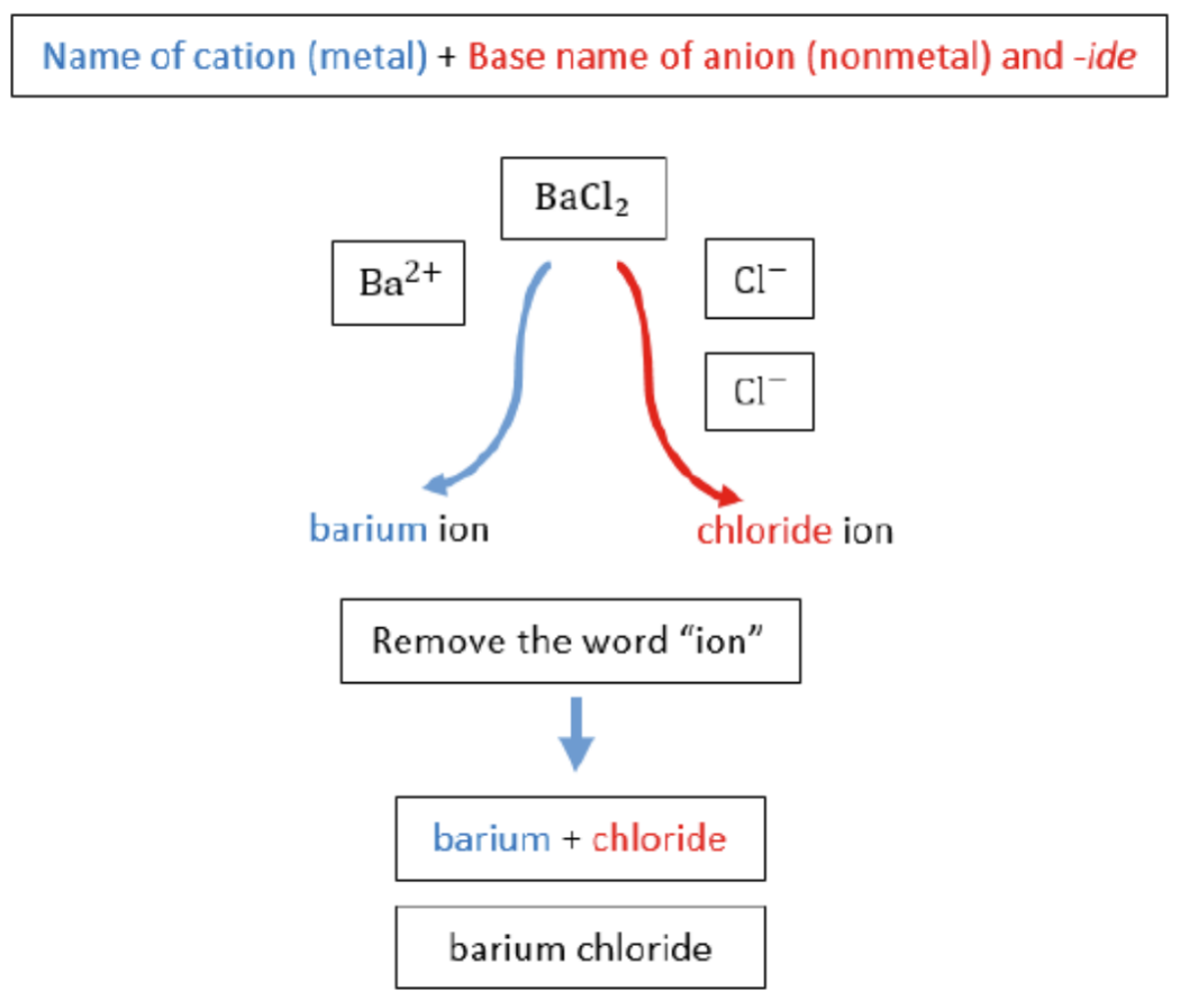
Practice: Name Each Ion

- Fe^{2+}
- F^{-}
- Ba^{+}
- S^{2-}

Naming Binary Ionic Compounds

The metal cation is named first, followed by the nonmetal anion.

The word ion is dropped from both parts.



Practice: Name the Ionic Compound

- $CaCl_2$
- Ca_3P_2
- MgO
- $FeCl_2$
- Co_2O_3

Naming Molecular Compounds

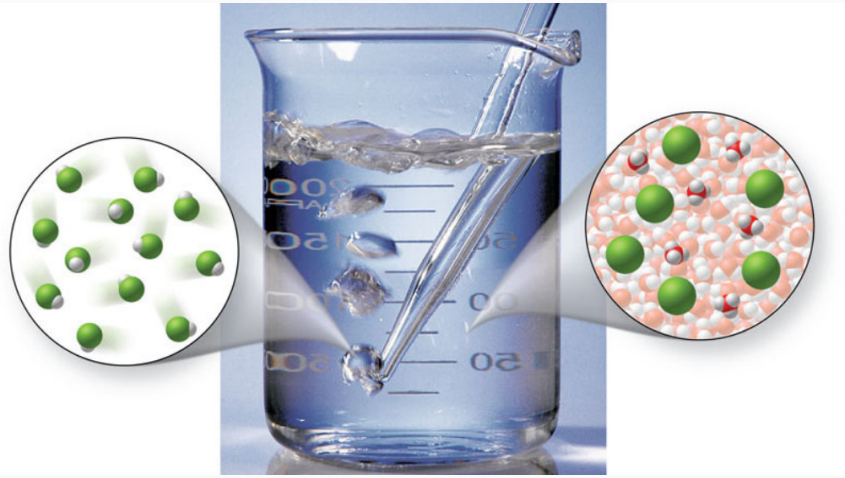
Prefix	Number	Prefix	Number	Prefix	Number
mono-	1	penta-	5	octa-	8
di-	2	hexa-	6	nona-	9
tri-	3	hepta-	7	deca-	10
tetra-	4				

1. Use numerical prefix for the element (usually ignore the first when using "mono")
2. Add "-ide" to the second element

Naming Binary Molecular Compounds

- H_2O
- N_2O_4
- CO
- CH_4

Naming Acids and Bases



1. If anion ends in "-ide," add "hydro" before the root of the anion name followed by "-ic acid"
2. If anion ends in "-ate," use the root of the anion name followed by "-ic acid"
3. If anion ends in "-ite," use the root of the anion name followed by "-ous acid"

Practice: Naming the Acid

- HCl
- HNO_3
- H_2CO_3
- H_2SO_3