Chapter 7: Electron Structure of the Atom

November 1, 2022

Chemistry Department, Cypress College

Class Announcements

Lecture

- Share previous UCI Teaching Evaluation
- Hold off on reviewing the Exam and homework 8
- Review material from Chs 3 - 6
- Quiz and Homework assignment released Fri, Nov 4th at 3pm

Making the Most of It

Questions to consider:

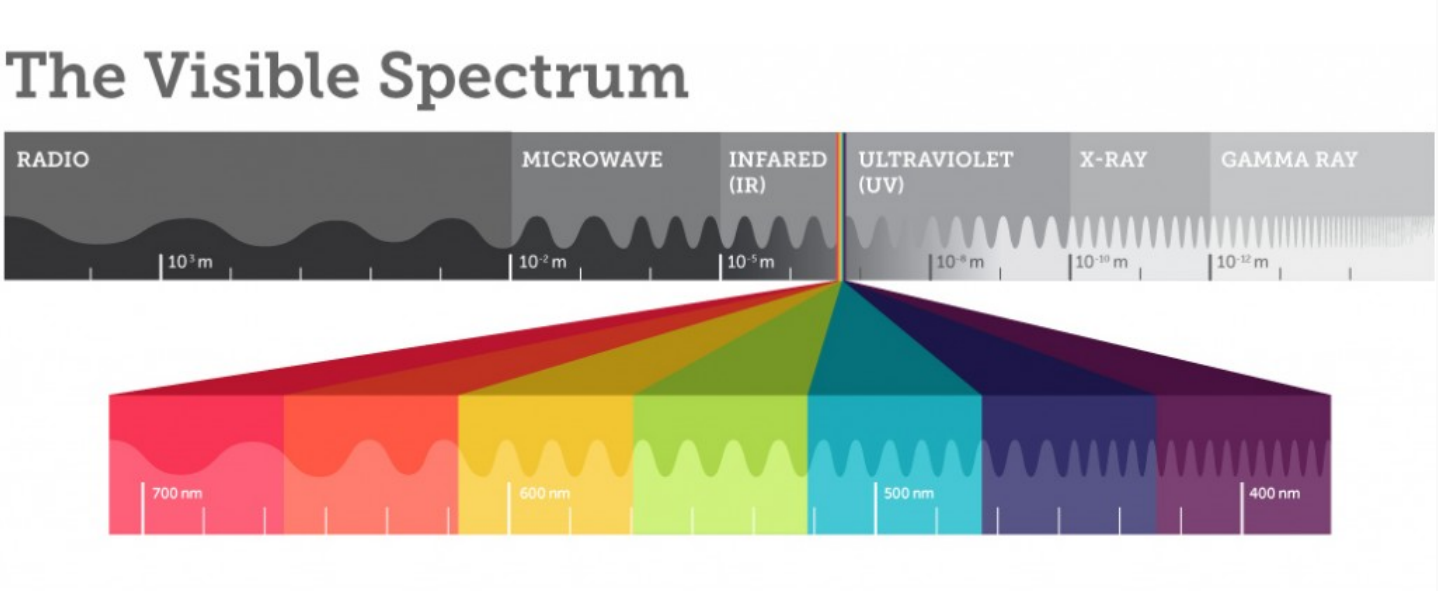
- Why am I taking this course?
- What would I like to achieve?
- What methods/tools/resources work for me?

Your feedback, questions, participation are vital:

- Attend lectures and discussions, if possible
- Give on-going feedback to instructors through facial expression, emojis, chat, email, during office hours etc.
- Fill out evaluations
- Own your education
- Be proactive, do not hesitate to speak up or get help

Outline

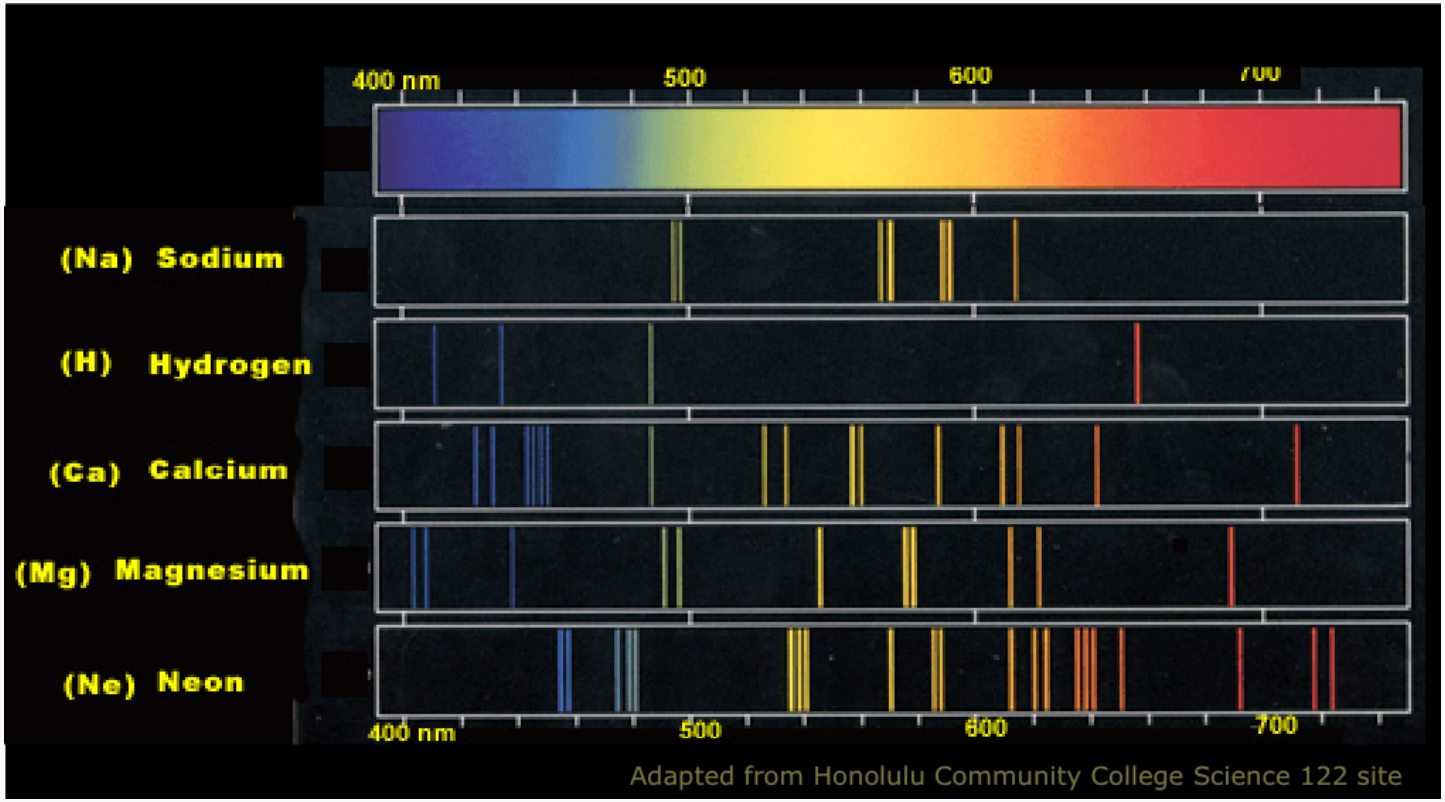
Revisit: Radiation Energy



$$E = \frac{hc}{\lambda} = h\nu \tag{1}$$

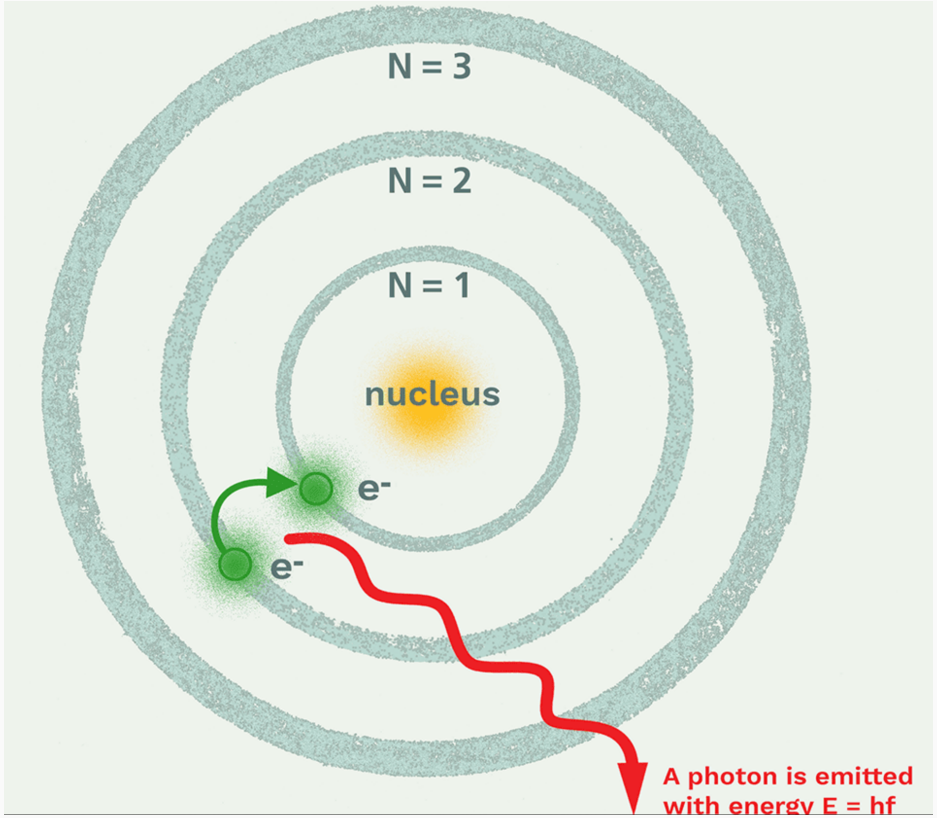
- High frequency and larger wavelengths lead to higher radiation energy
- Energy are contained in packages known as photons; Eqn 1 computes the energy for 1 photon

Atomic Spectra



- Continuous spectra is given at the top and discrete lines are emitted by atoms
- **Q:** Why are there discrete lines for the atomic spectra?

Bohr Model of the H Atom



$$\Delta E = E_{\text{final}} - E_{\text{initial}} \tag{2}$$

Note: Keep in mind of sign conventions ($\Delta E > 0$ and $\Delta E < 0$)

Bohr Model

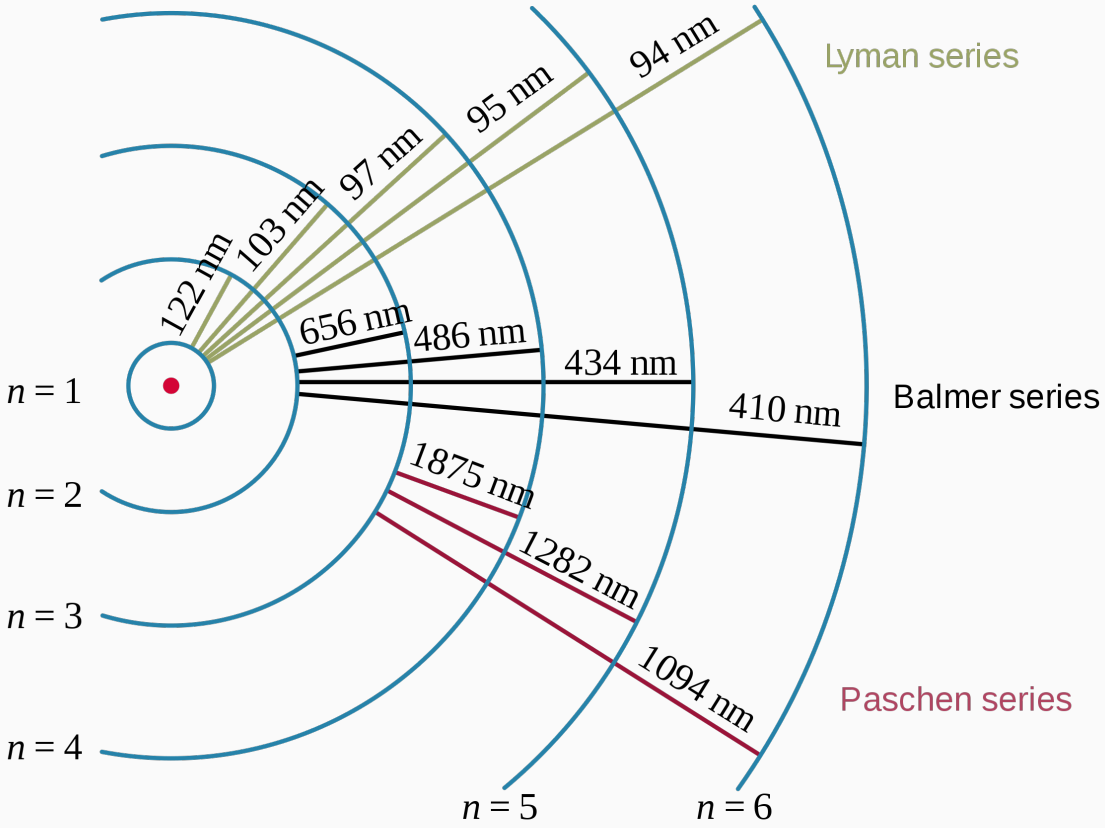
- Energy is quantized
- Electrons orbit the nucleus in orbits that have a set size and energy
- The energy of the orbit is related to its size; the lowest energy is found in the smallest orbit
- Radiation is absorbed or emitted when an electron moves from one orbit to another

Limitation of the Bohr Model

- Violates the Heisenberg Uncertainty Principle
- Poor predictions regarding the spectra of larger atoms
- Does not predict the relative intensities of spectral lines

Example: H atom spectra

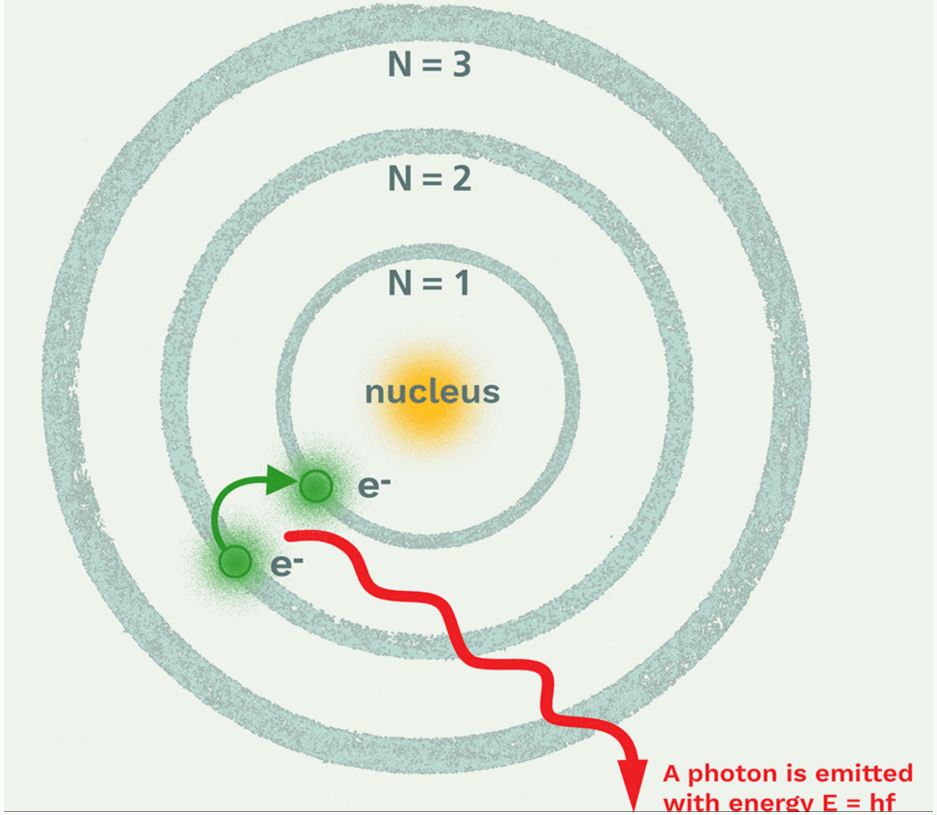
Q: According to the image, which energy level transition is the lowest energy? Which one has the largest energy?



Outline

Rydberg Formula

Mathematical formula to compute the wavelength between energy levels n of a hydrogen atom



Rydberg Formula

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \tag{3}$$

where n_f and n_i are the final and initial energy state, λ is the wavelength, and R is the Rydberg constant (1.097×10^7 m^{-1})

Practice: Using Rydberg Formula

Calculate the wavelength of light emitted when a hydrogen atom relaxes from $n = 6$ to $n = 2$. Is this light in the visible region of electromagnetic spectrum? If so, what color is it?

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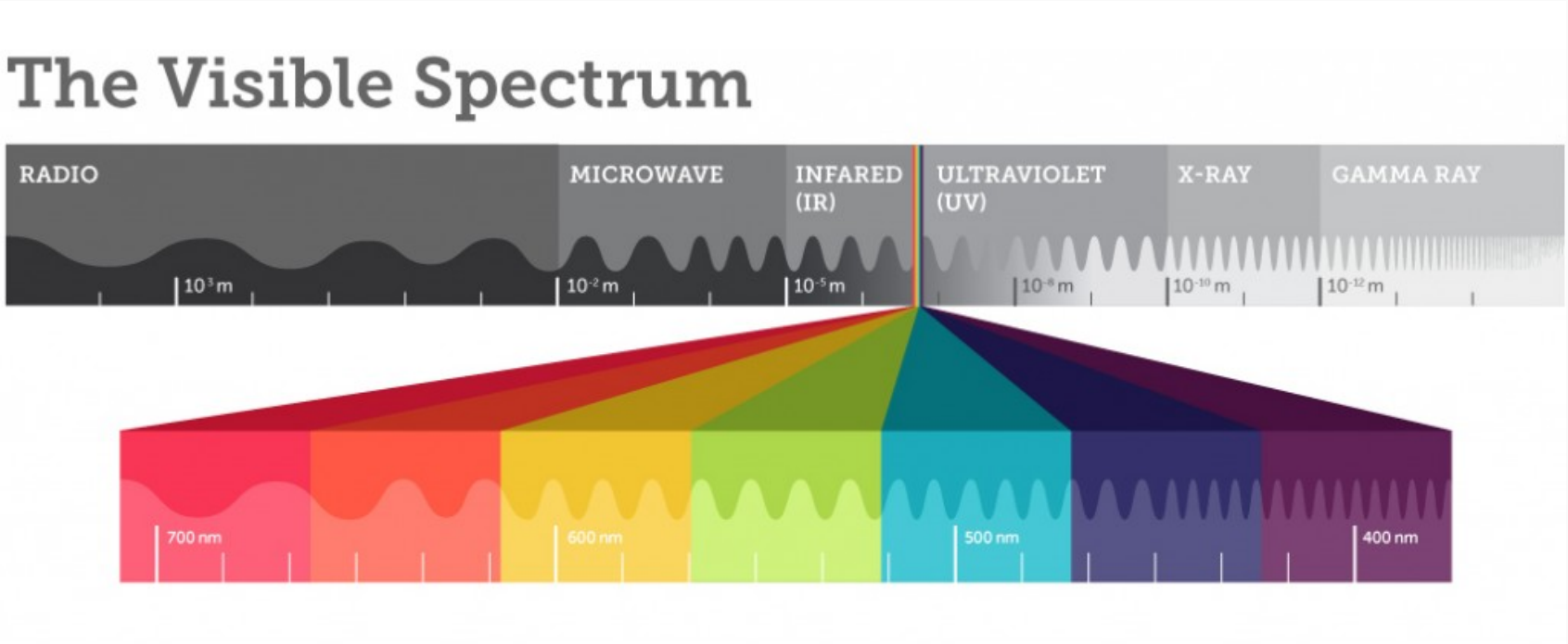
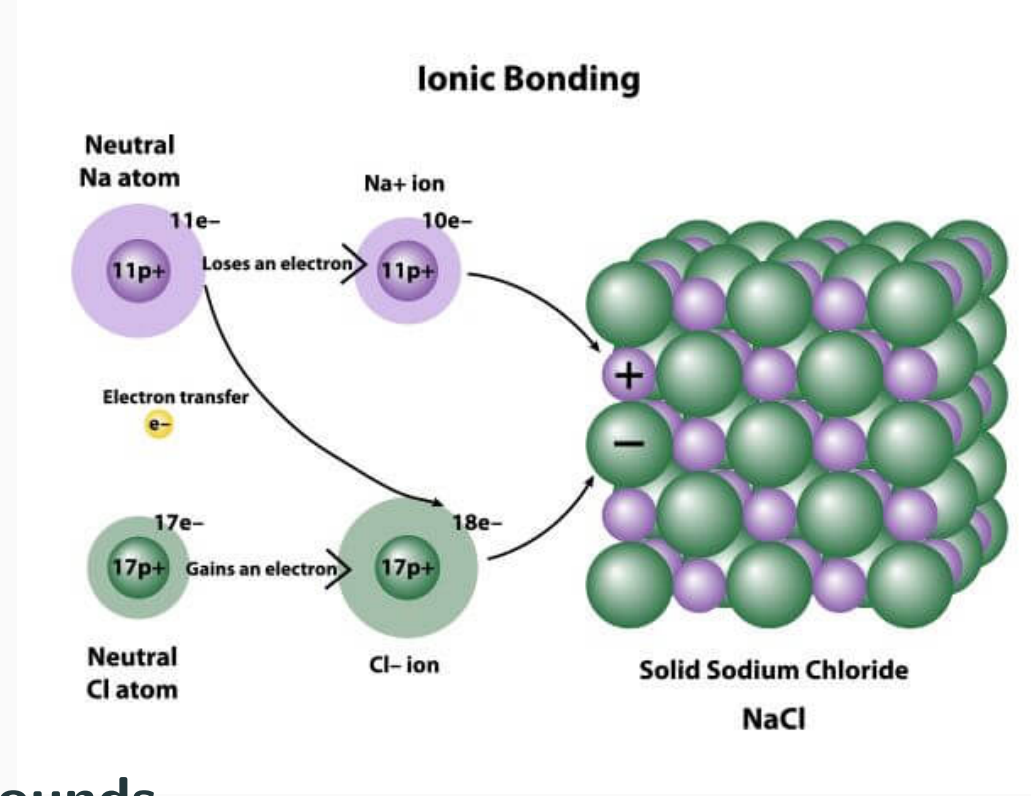


Practice: Using Rydberg Formula

What is the energy of the wavelength when a hydrogen atom relaxes from $n = 6$ to $n = 2$?

Outline

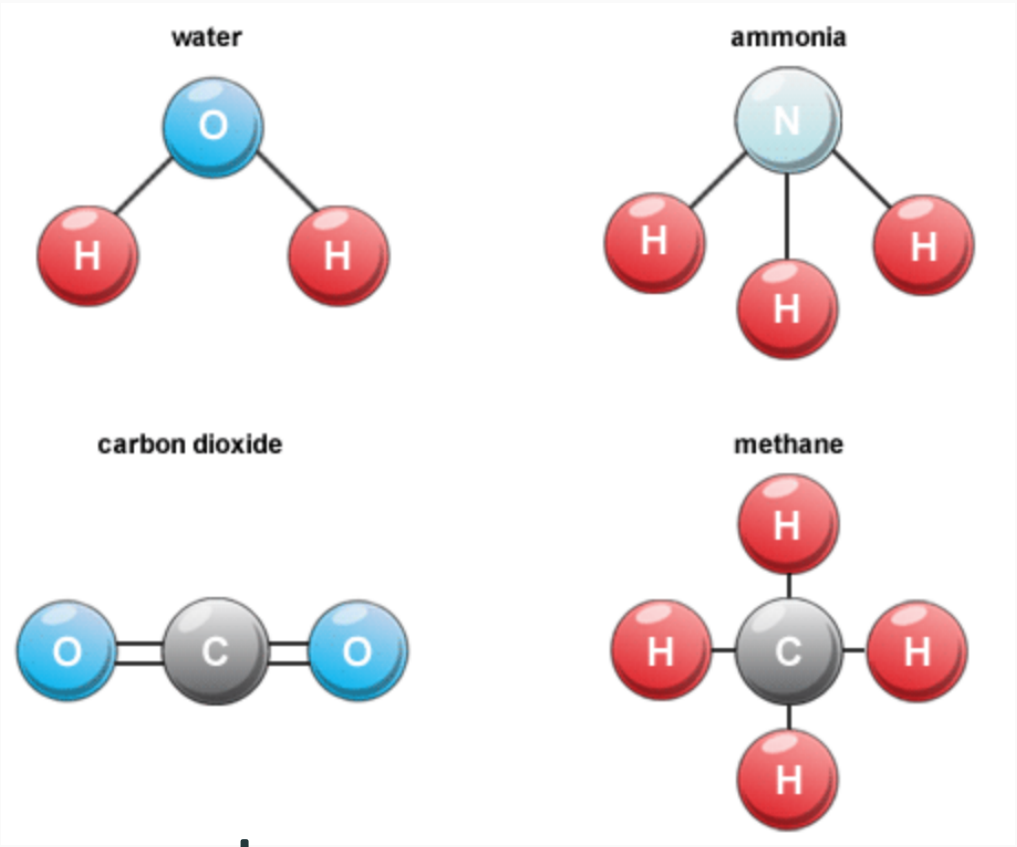
Properties of Ionic Compounds



Ionic Compounds

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

Properties of Molecular Compounds



Molecular Compounds

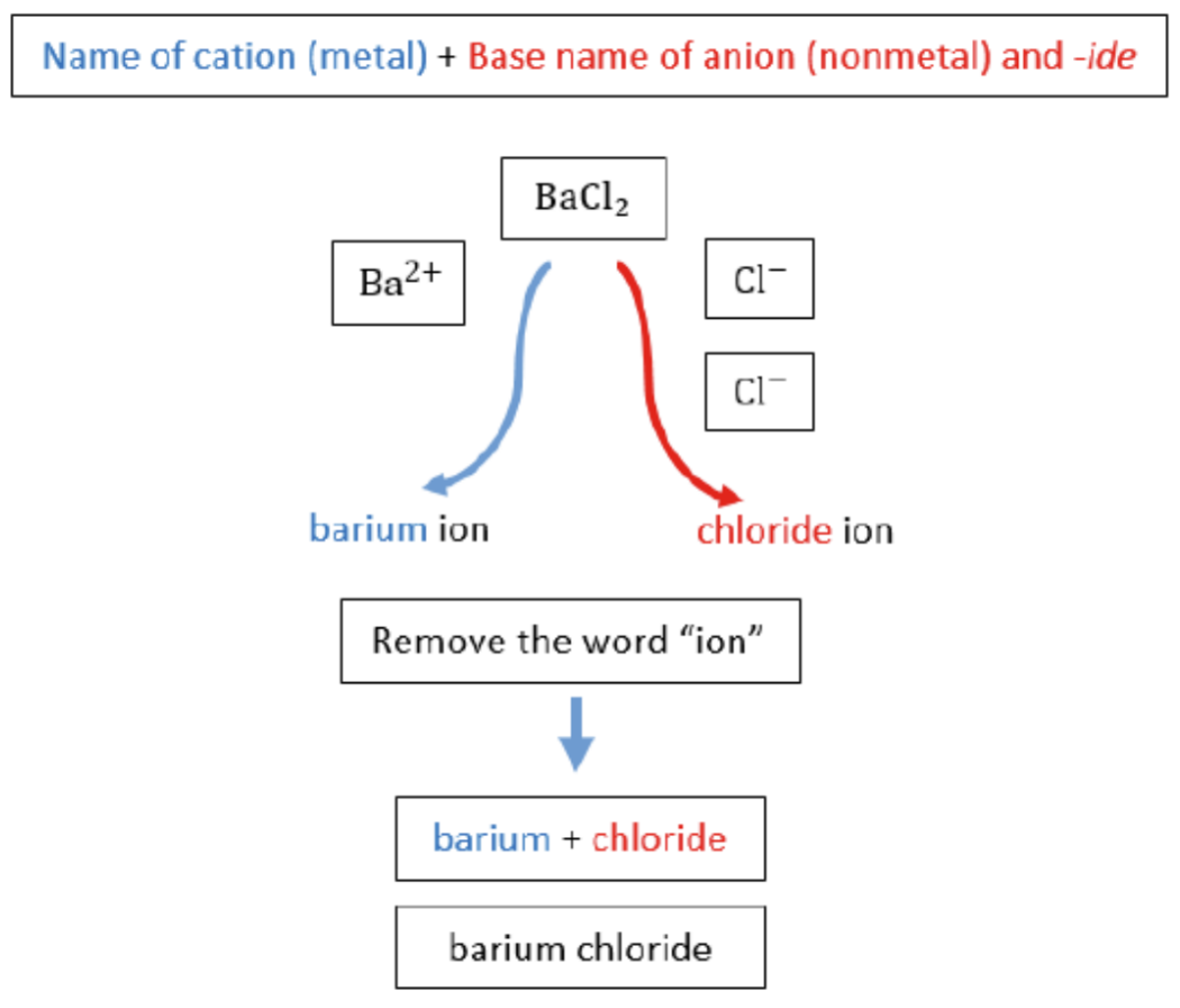
- Not conductive and weak electrolyte
- Low melting and boiling points, low density

Practice: Determine the following as Ionic or Molecular

- $CaCl_2$
- Ca_3P_2
- MgO
- $FeCl_2$
- Co_2O_3
- V_2O_5
- NH_4F
- H_3PO_4

Naming Ionic Compounds

The metal cation is named first, followed by the nonmetal anion. The word ion is dropped from both parts.



Special: Certain metals

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

Practice: Name the Ionic Compound

- $CaCl_2$
- Ca_3P_2
- MgO
- $FeCl_2$
- Co_2O_3
- V_2O_5

Practice: Determining Molecular Formula

- Vandium(V) Oxide
- Chromium(VI) Oxide
- Iron(III) Oxide
- Sodium chloride
- Barium fluoride
- Lead(IV) fluoride
- Ammonium sulfate
- Calcium phosphate
- Aluminum perchlorate
- Sodium bicarbonate

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

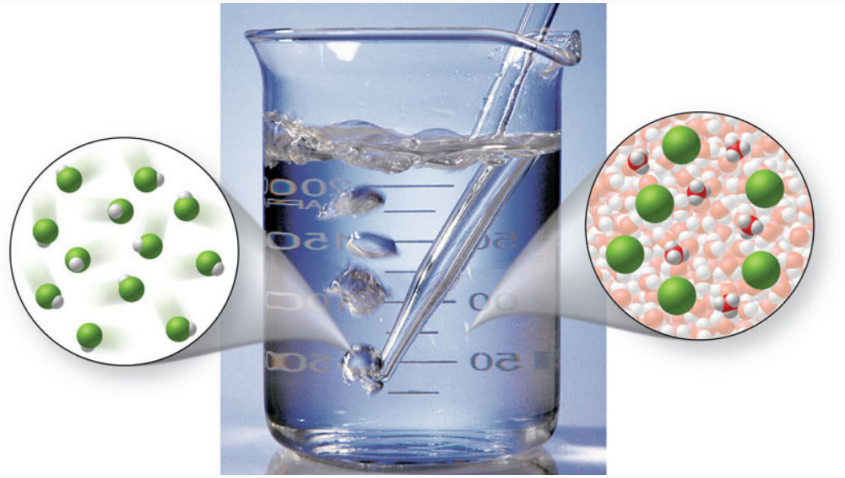
Practice: Naming Binary Molecular Compounds

- H_2O
- N_2O_4
- CO
- CH_4
- PF_5
- BF_3
- SiO_2
- XeF_4

Practice: Determining Molecular Formula

- Sulfur trioxide
- Nitrogen trihydride
- Dihydrogen monoxide
- Carbon tetrafluoride
- Selenium dichloride
- Dinitrogen pentaoxide
- Sulfur hexafluoride
- Phosphorus trifluoride

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
- H_3PO_4
- $HClO_2$
- HBr
- HNO_2
- H_2SO_3
- H_2S

Practice: Determining Molecular Formula

- Cloric acid
- Phosphoric acid
- Sulfurous acid
- Hydrosulfuric acid
- Chromic acid
- Nitric acid
- Hypochlorous acid
- Hydrobromic acid