Chapter 7: Electron Structure of the Atom

October 24, 2022

Chemistry Department, Cypress College

Class Announcements

Lab

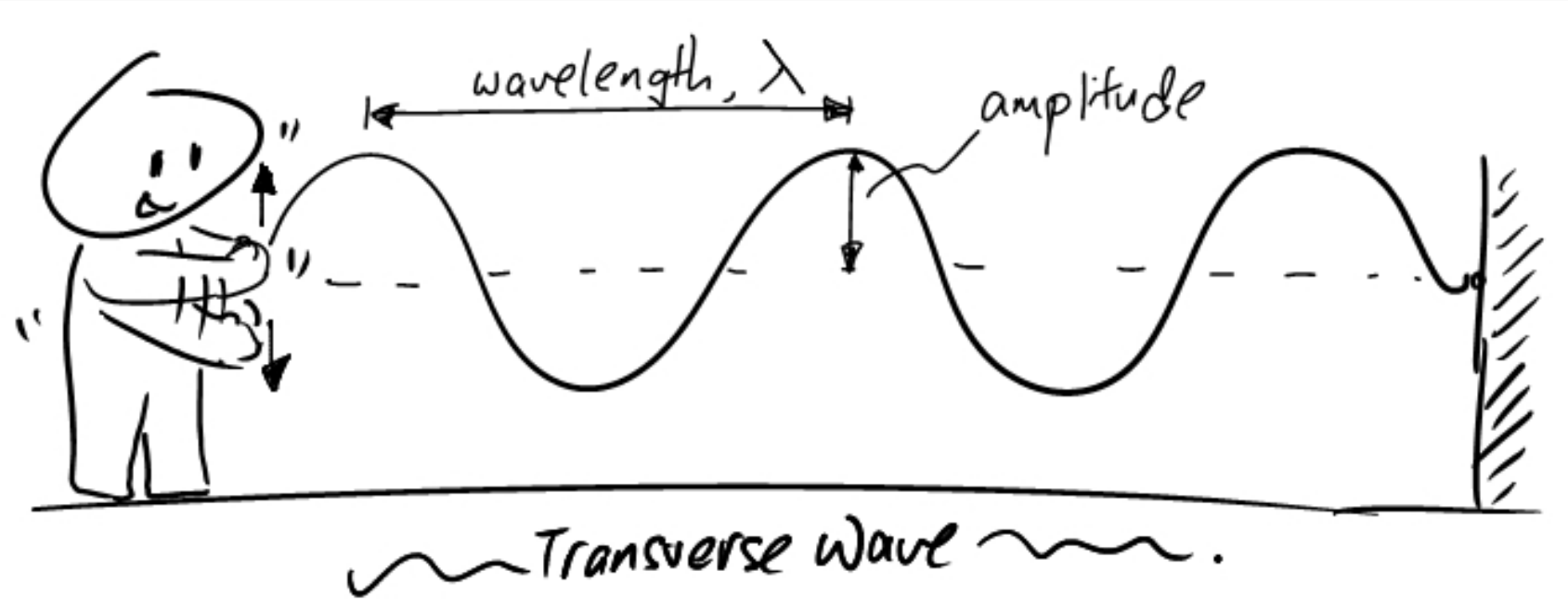
- Experiment 16 - Electromagnetic Energy and Spectroscopy
- Review - Wavelength and Excitation of Electron
- Reminder - Need 70% of laborator points to pass the course

Lecture

- Review the Exam and proposal
- Ch 7+8 - Electronic Structure of Atom and Chemical Bonding
- Go over homework 8 (EC for students who present)
- Quiz and Homework assignment released Fri, Nov 4th at 3pm

Outline

The Wave



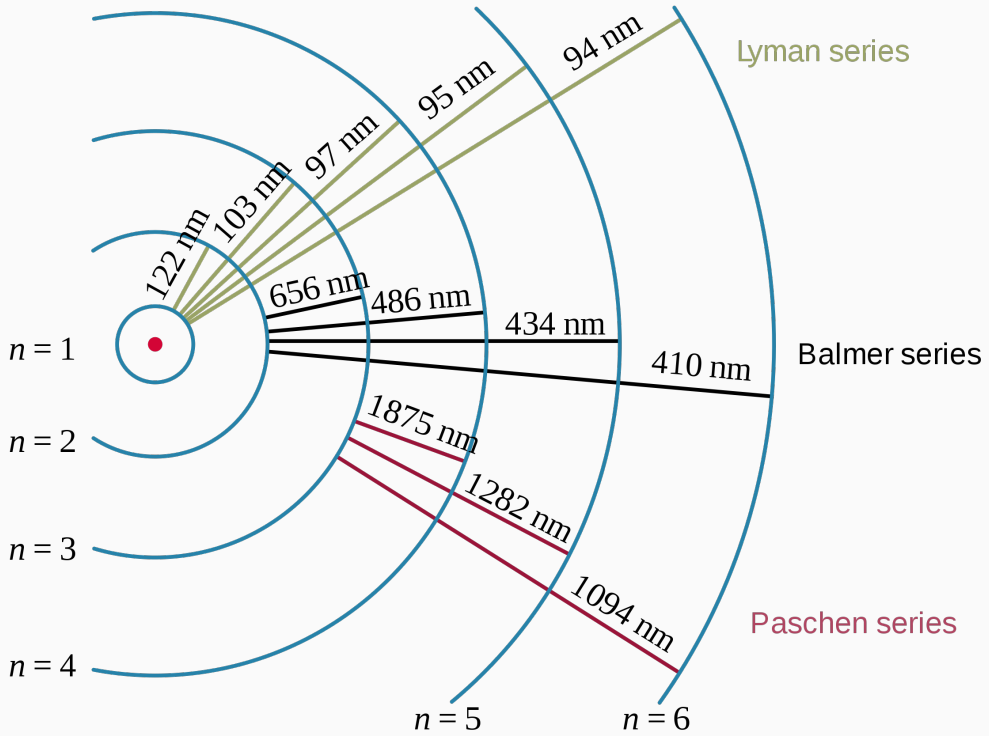
Practice: Determining the Wavelength

Suppose a 7.5m rope is shaken to yield 2.5 wavelength. Draw the wave for 7.5m rope. Determine the wavelength in m.

Rydberg Formula

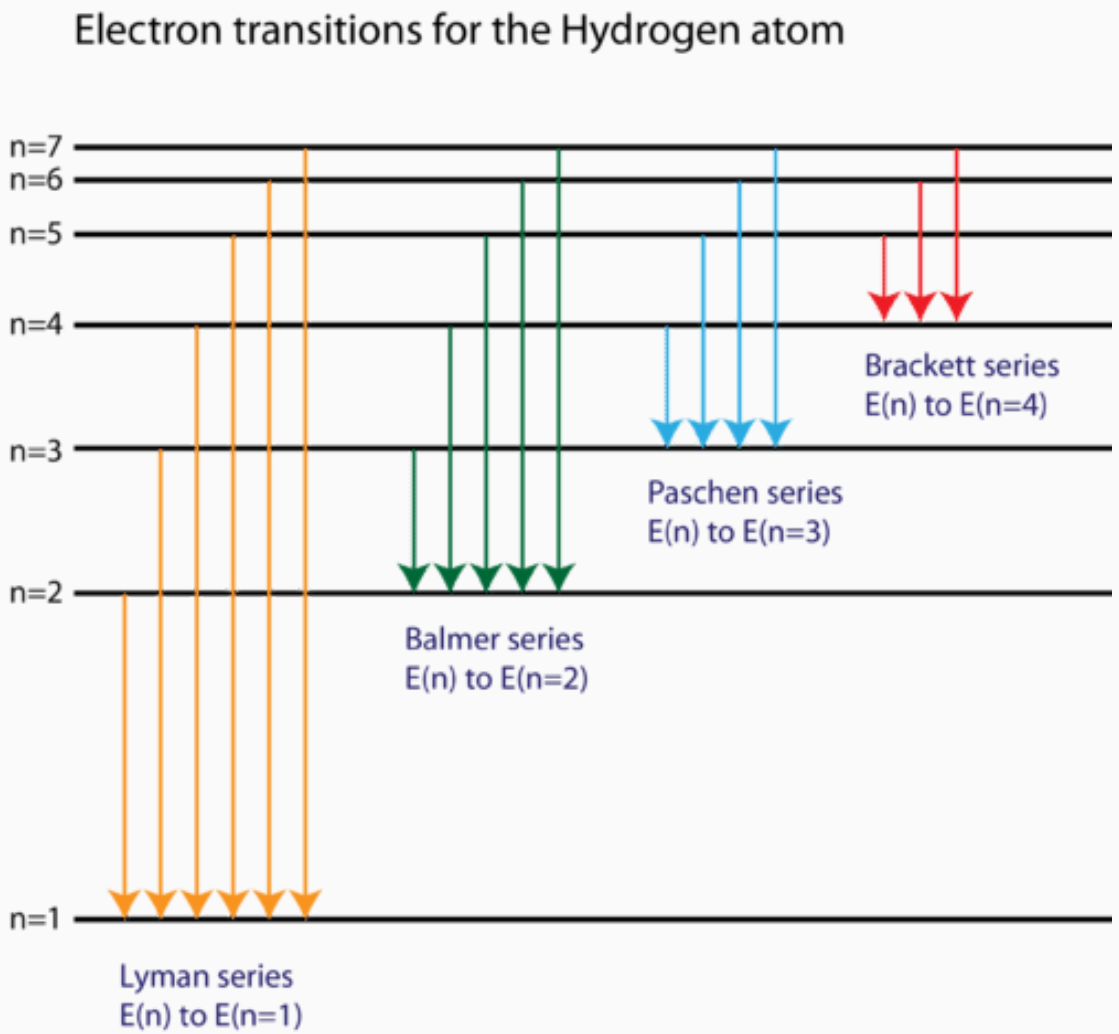
$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \tag{1}$$

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})



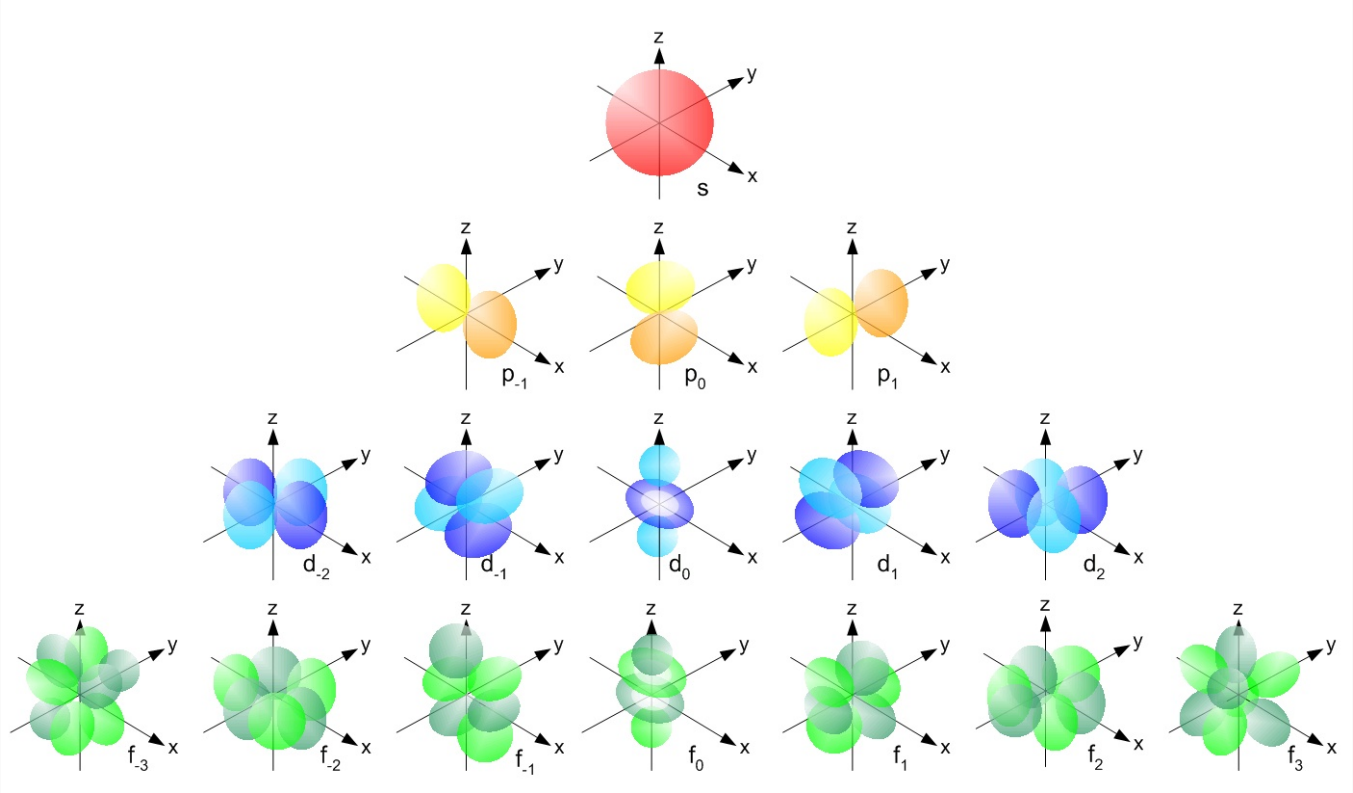
H Atom Spectra

Q: What do notice about the transition energy for n=1 to n=2 and n=2 to n=3?



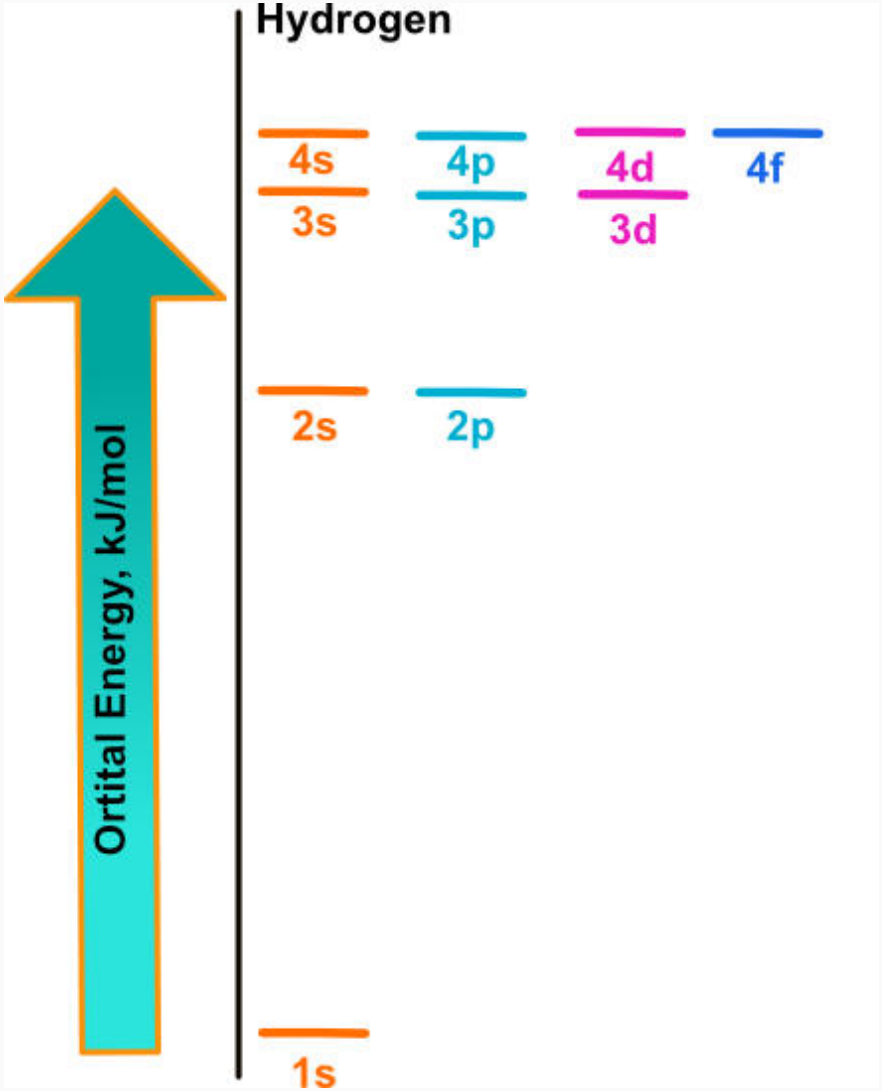
Outline

Atomic Orbitals



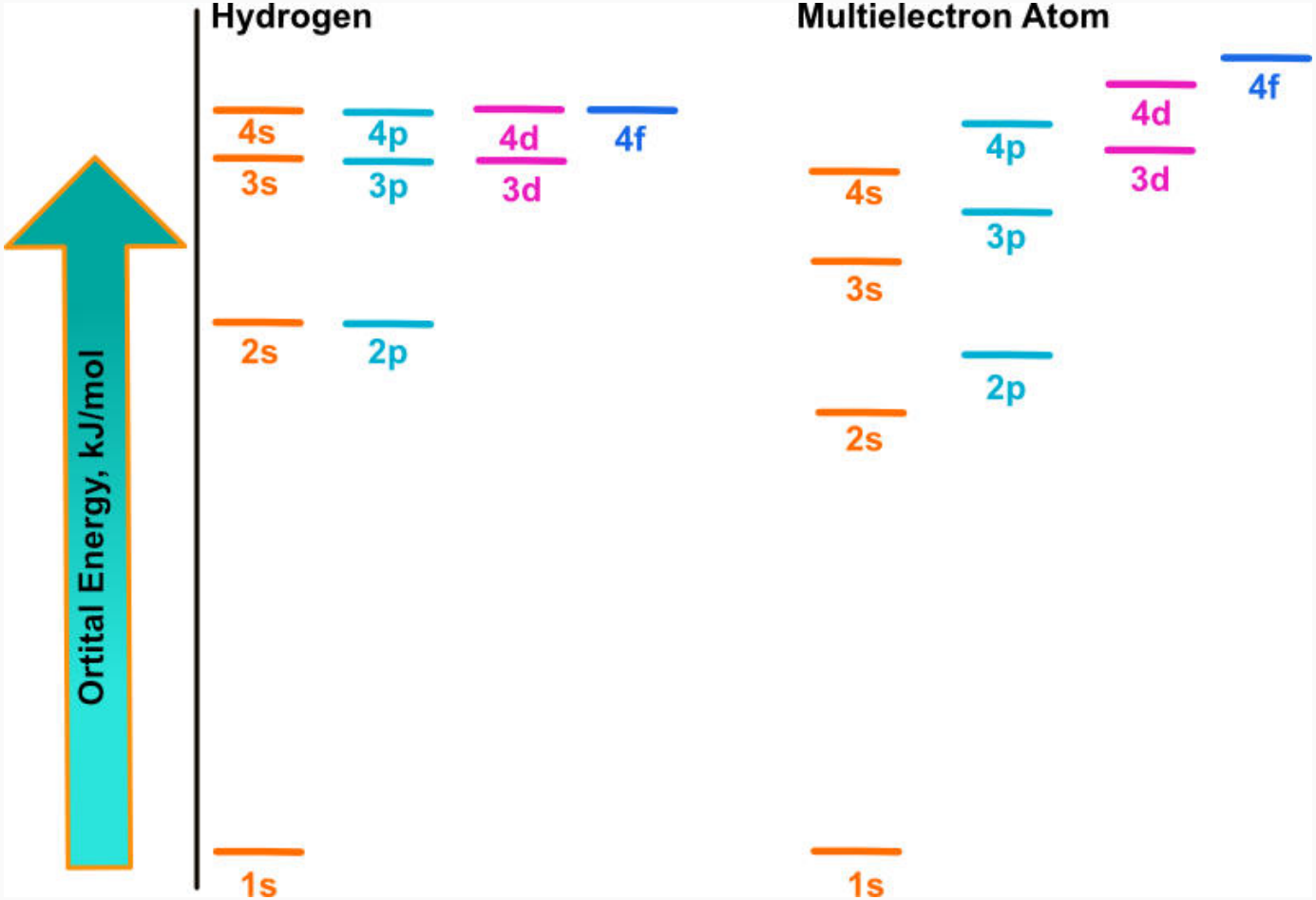
- Specific orbitals occupy certain **principal energy level** e.g. $n = 1, 2, 3, \cdots$
- Basis in which atoms form bond; atomic orbitals combine to make molecular orbitals

Orbital Diagram - Hydrogen



Orbital Diagram - Multielectron Element

Q: What do notice about the relative atomic orbital energies?



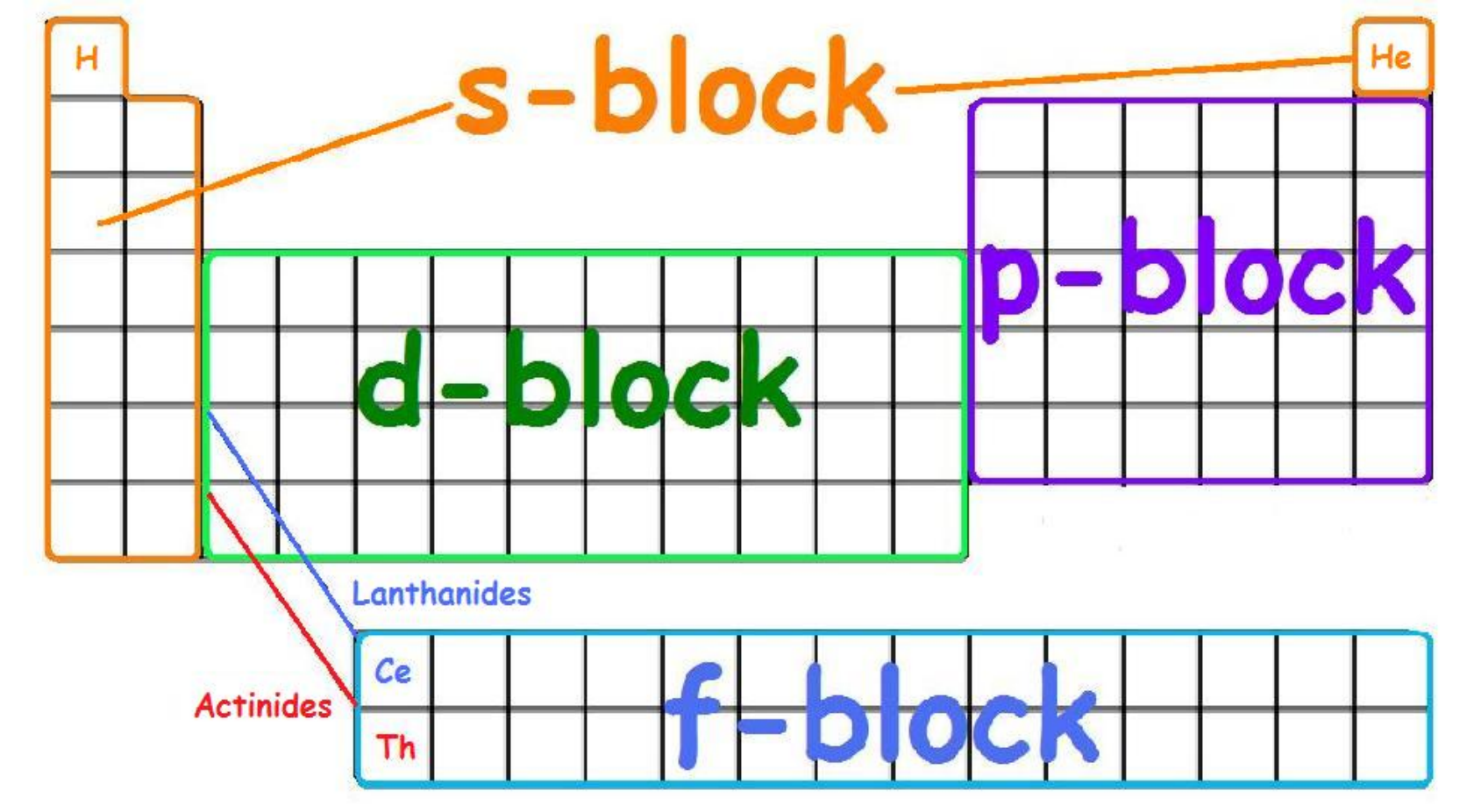
Principles for Filling Atomic Orbitals

Aufbau principle - electrons fill an orbital starting with the lowest energy level

Pauli exclusion princple - No two electrons with the same spin can occupy the same orbital

Hund's Rule - Maximize the number of unpaired electrons

Relating to Periodic Table



Examples: Write Electron Configurations

H

He

Li

Na

Purpose of Electron Configurations

- Outermost shell is referred to as the valence electrons (**Q:** What is special about valence electrons?)
- Innermost shell is the core electrons
- Predicts stability of the atom e.g. unfilled orbitals indicate instability
- Make predictions how elements react forming new chemical compounds

Practice: Writing Electron Configurations

F

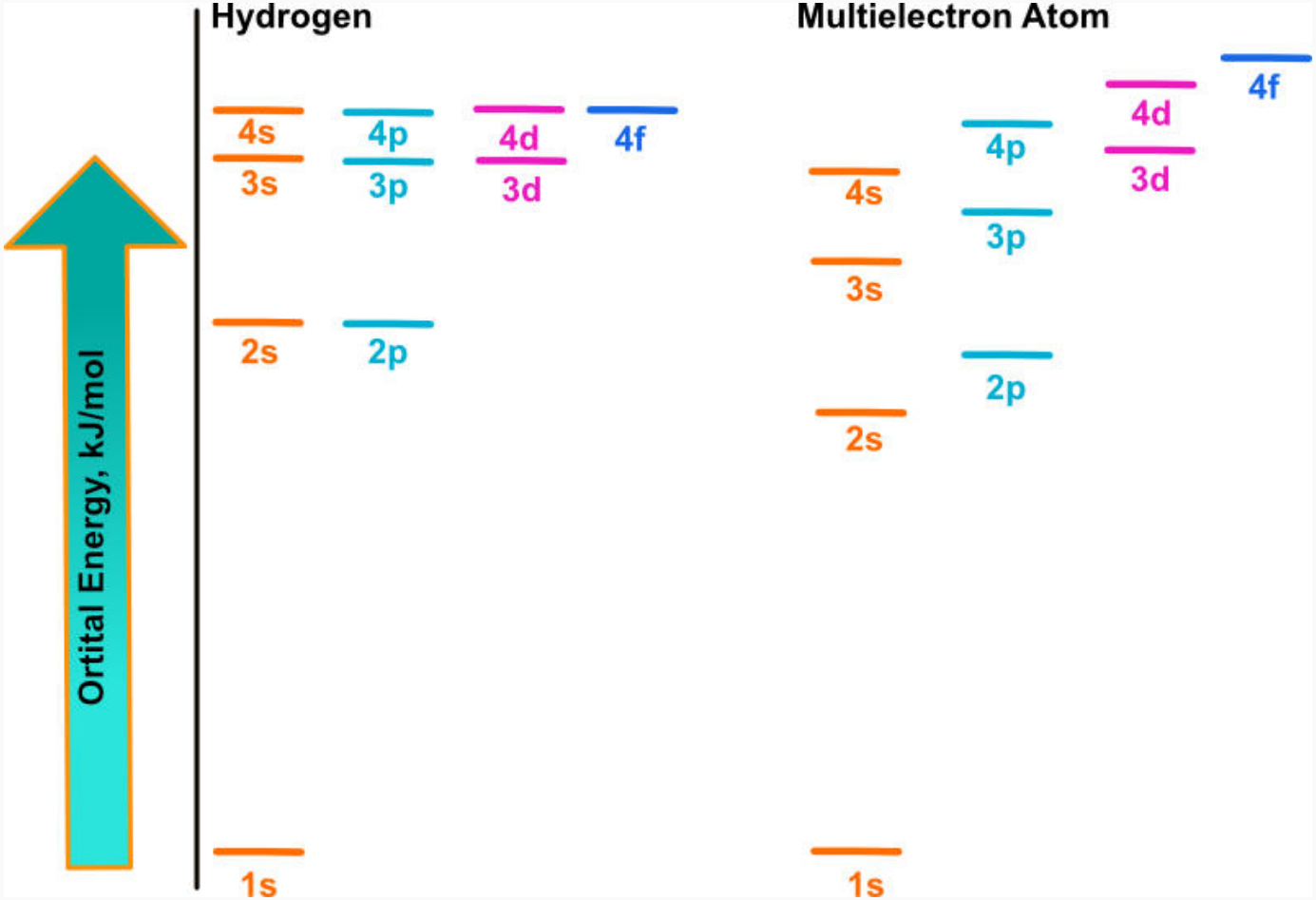
F^-

Na^+

Fe

Special Note about d-orbitals

Energy levels of 4s and 3d are close along with subsequent n levels e.g. 5s and 4d, 6s and 5d



Practice: Electron Configuration of Transition Metals

Cr

Mo

W

Cu

Ag

Au

Outline

Core and Valence Electrons

Core Electrons - Energy level n below the valence electrons and these are completely filled orbitals

Valence Electrons - Outermost electrons above the energy level n of the core electrons

Example: Si - $1s^2 2s^2 2p^6 3s^2 2p^2$

Practice: Determine number of valence electrons

Au

Na

Sb

Ag^{+}

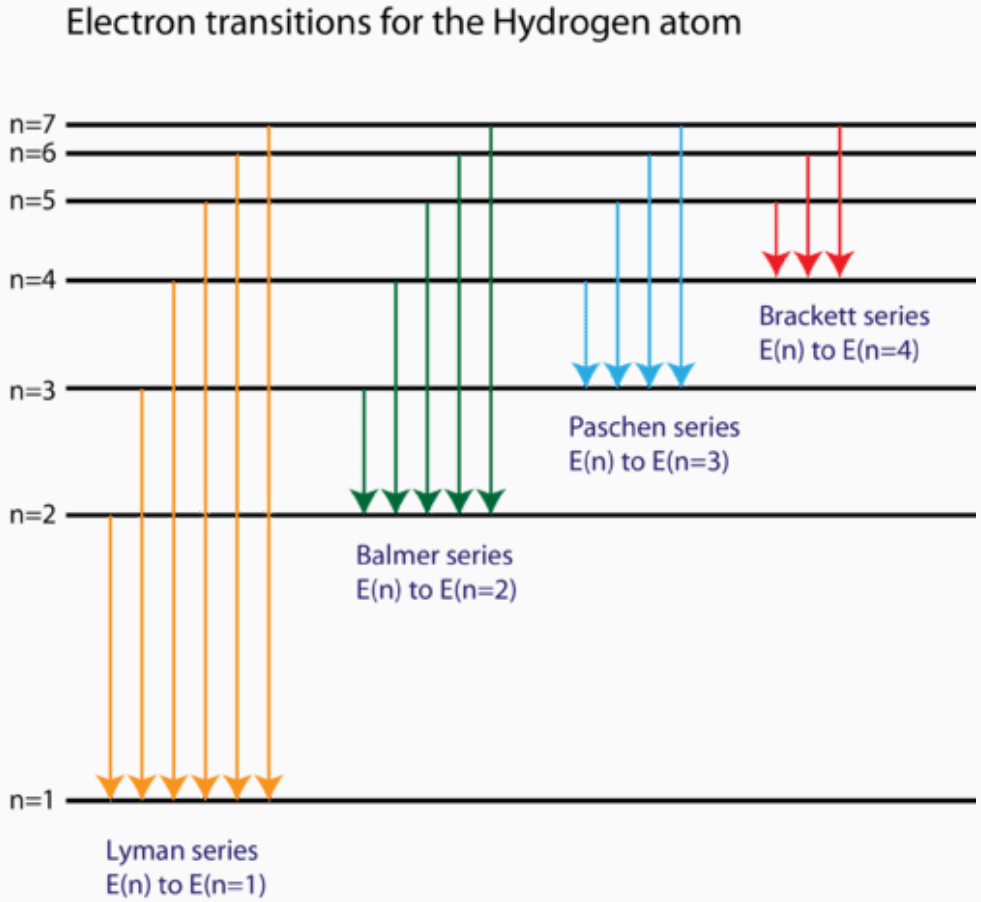
Cu^{3+}

Ca^{2+}

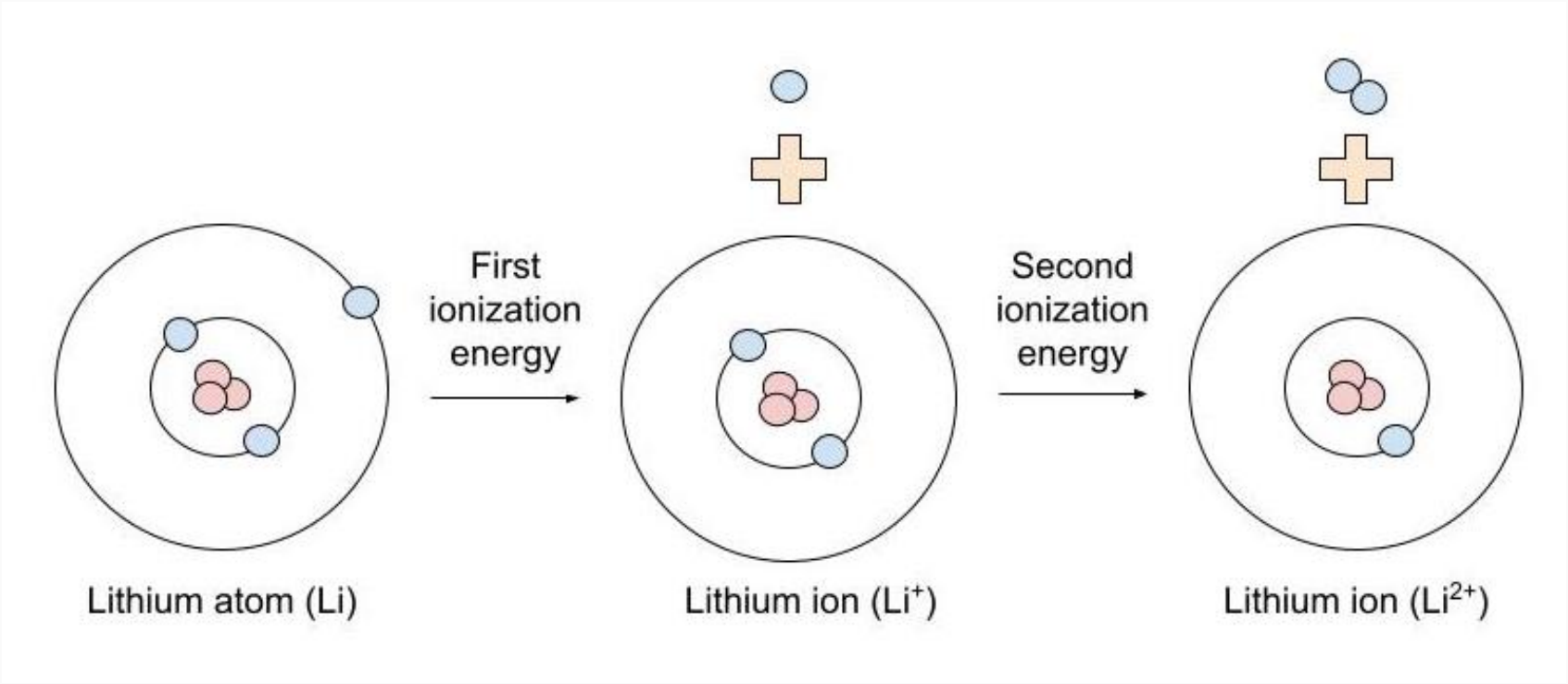
Outline

Ionization Energy

Ionization energy - Energy required to eject an electron



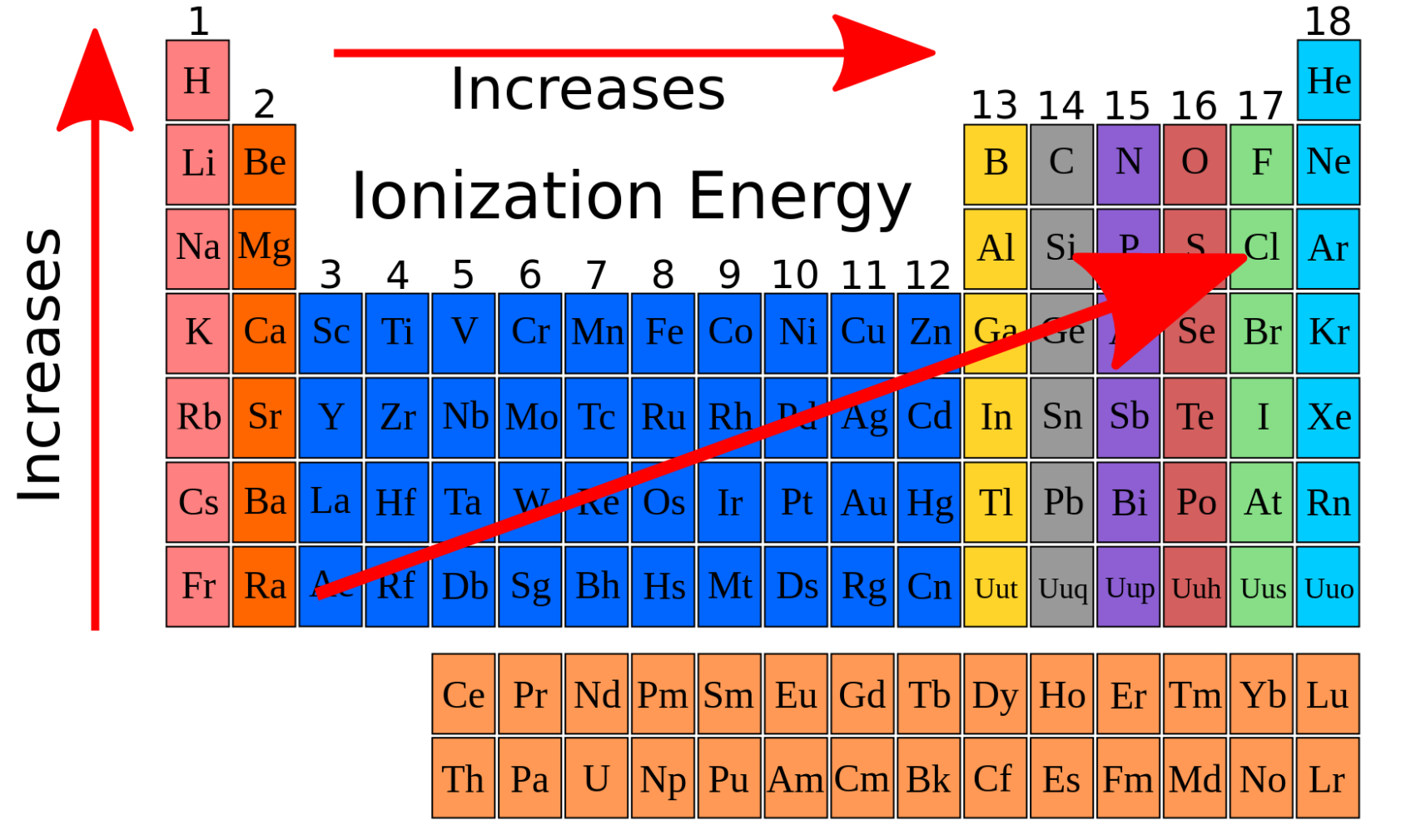
Meaning of Ionization



First ionization takes 520 kJ/mol and second ionization takes 7298 kJ/mol

Q: Why is the second ionization energy significantly higher?

First Ionization Energy Trends



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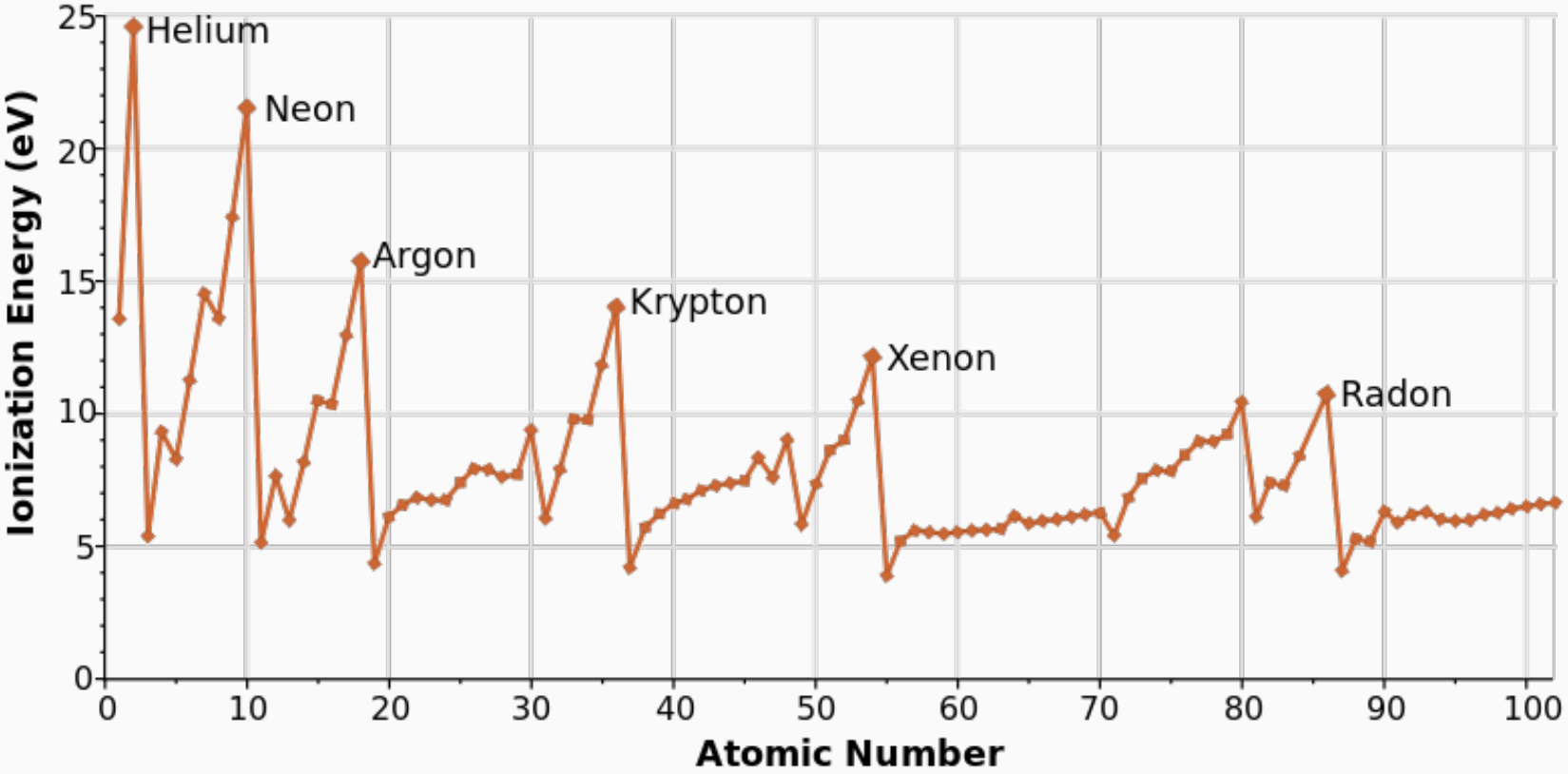
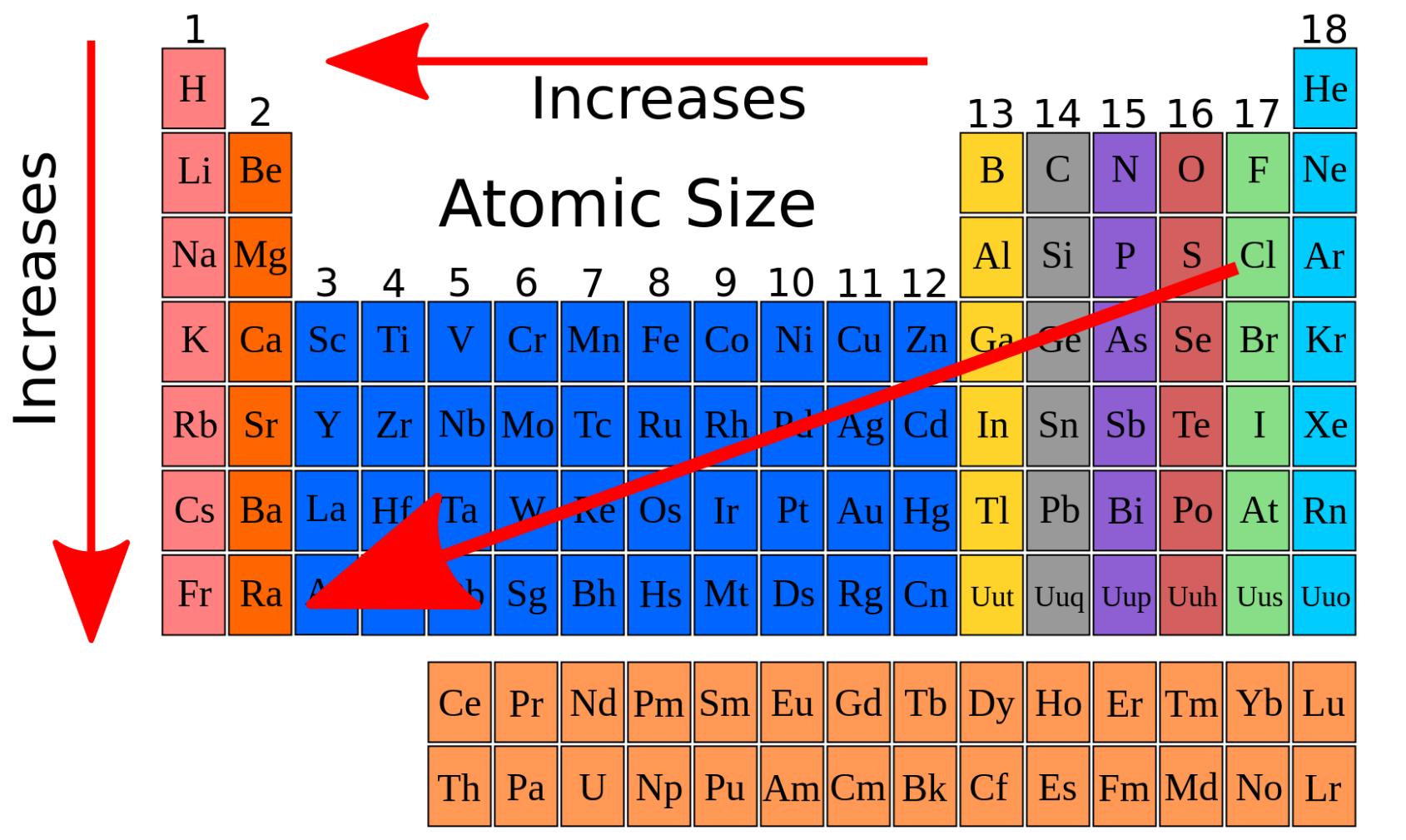


Atomic Sizes of Neutral Atoms



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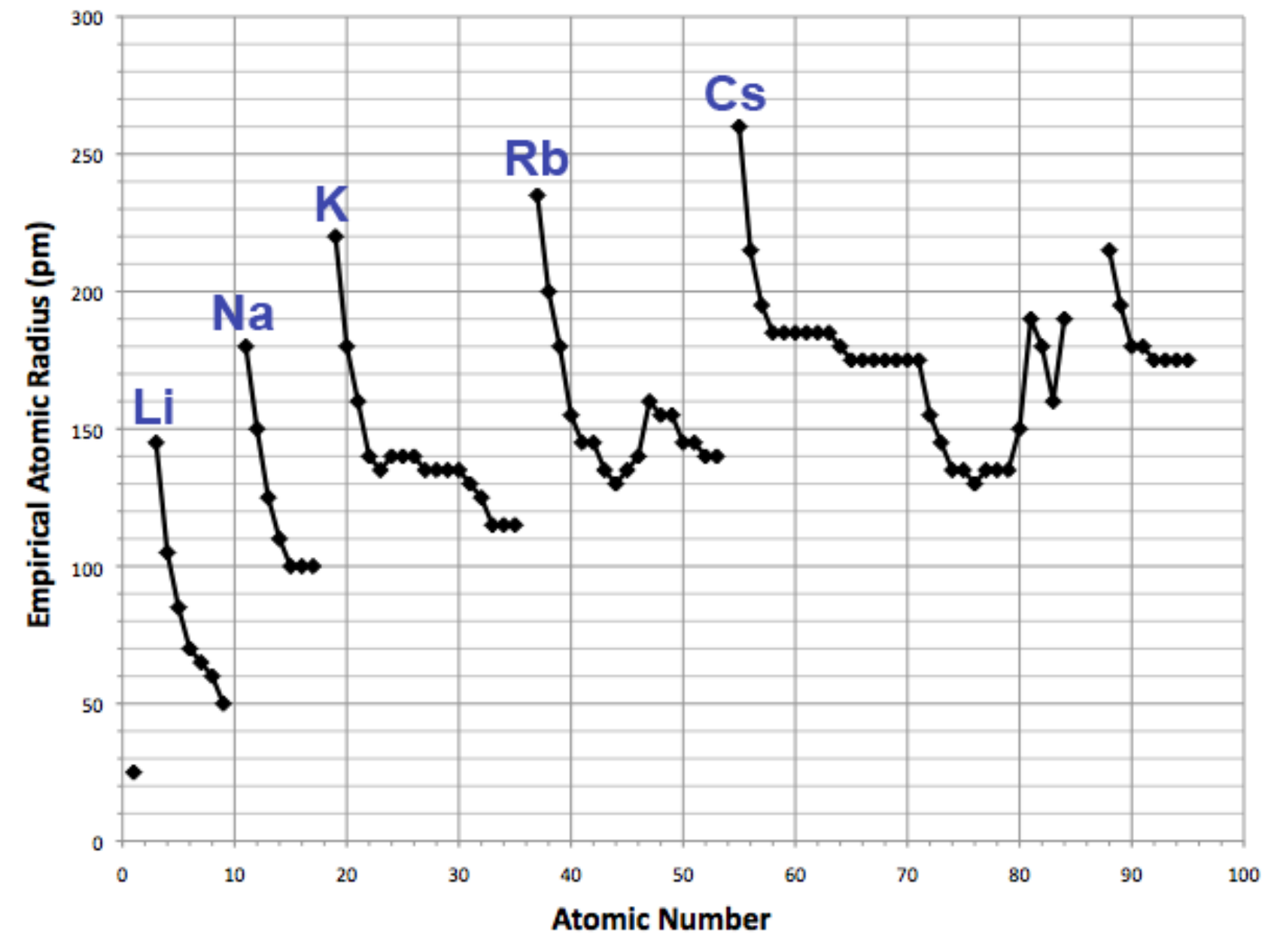

Atomic Sizes of Ions