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

Making the Most of It

Questions to consider:

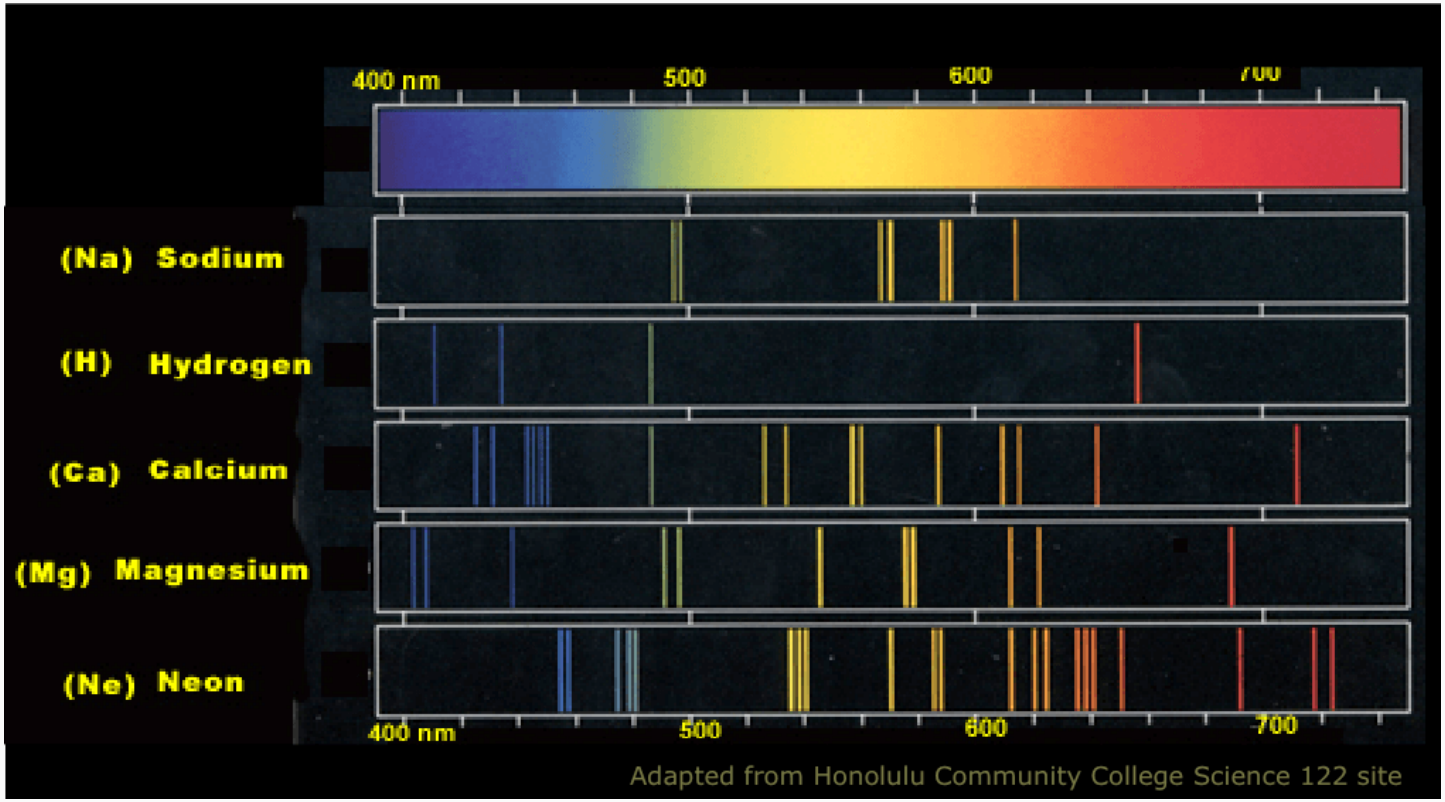
- Why am I taking this course?
- What would I like to achieve?
- What methods/tools/resources work for me?

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

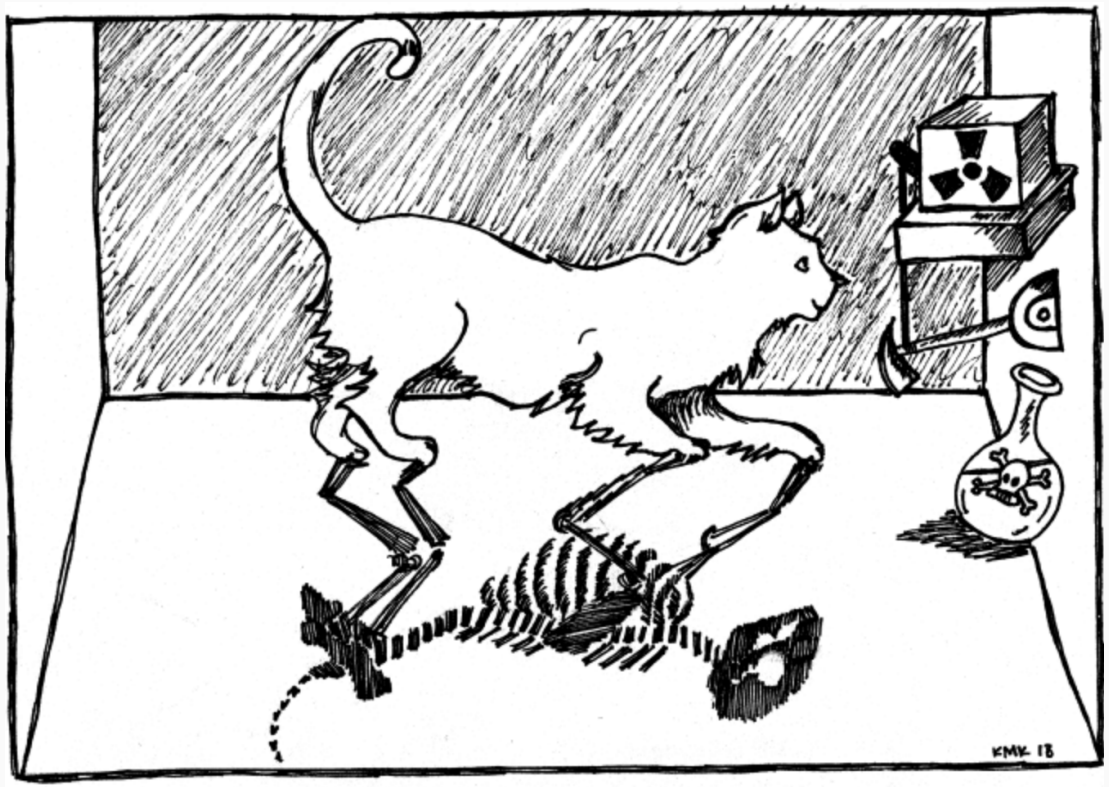
Outline

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?

Schrödinger's Cat - Thought Experiment



The world that we know is deterministic, however, dealing with electrons or small subatomic particles, we have to think of it in terms of probabilities

The Wavefunction Ψ

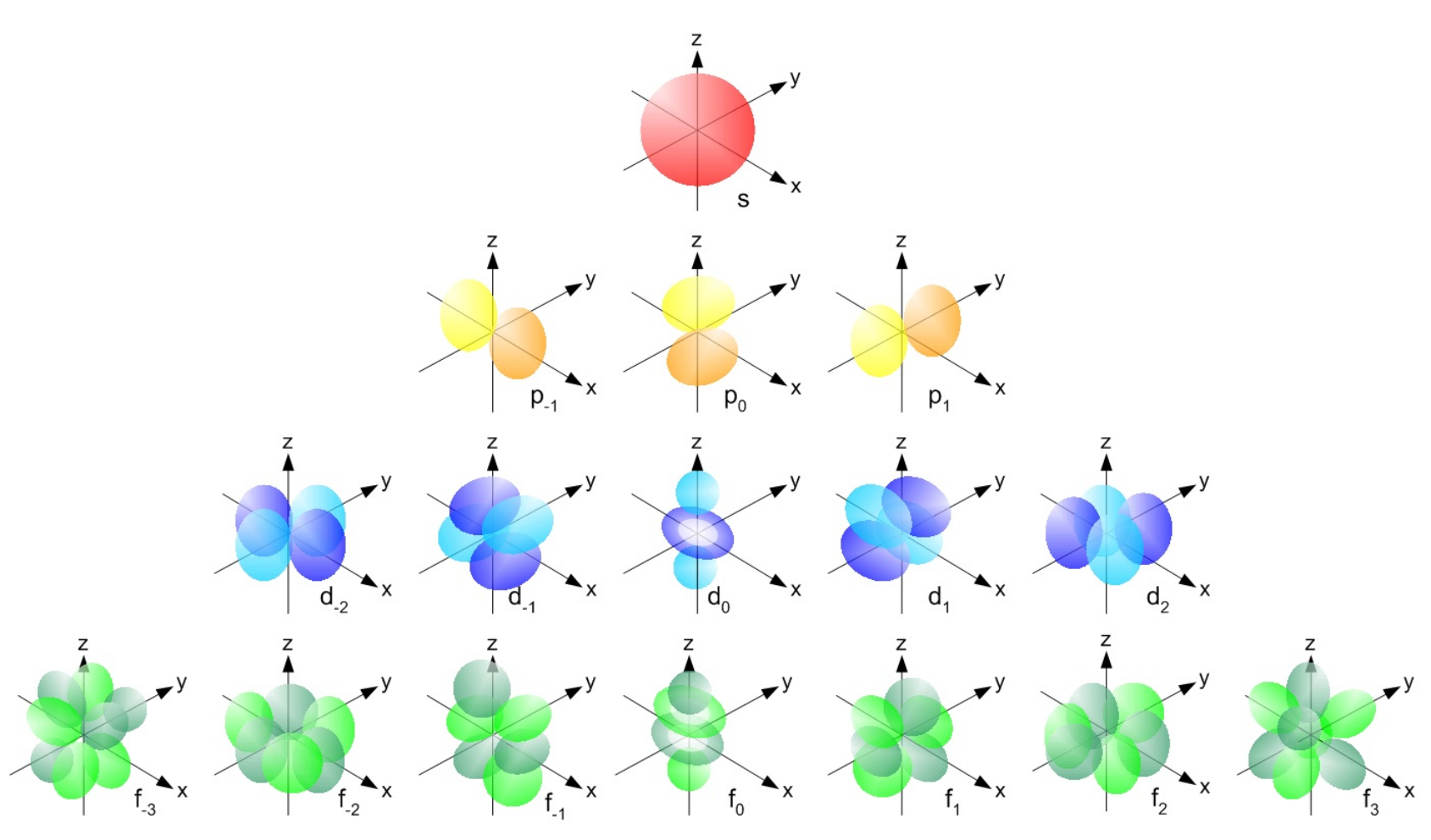
Schrödinger's Equation

$$\hat{H}\Psi = E\Psi \tag{1}$$

where $\hat{H}$ is the Hamiltonian, E is the energy, and Ψ is the wavefunction

- Equation that explain everything about your system
- Chemical and physical properties can be determined from the Ψ

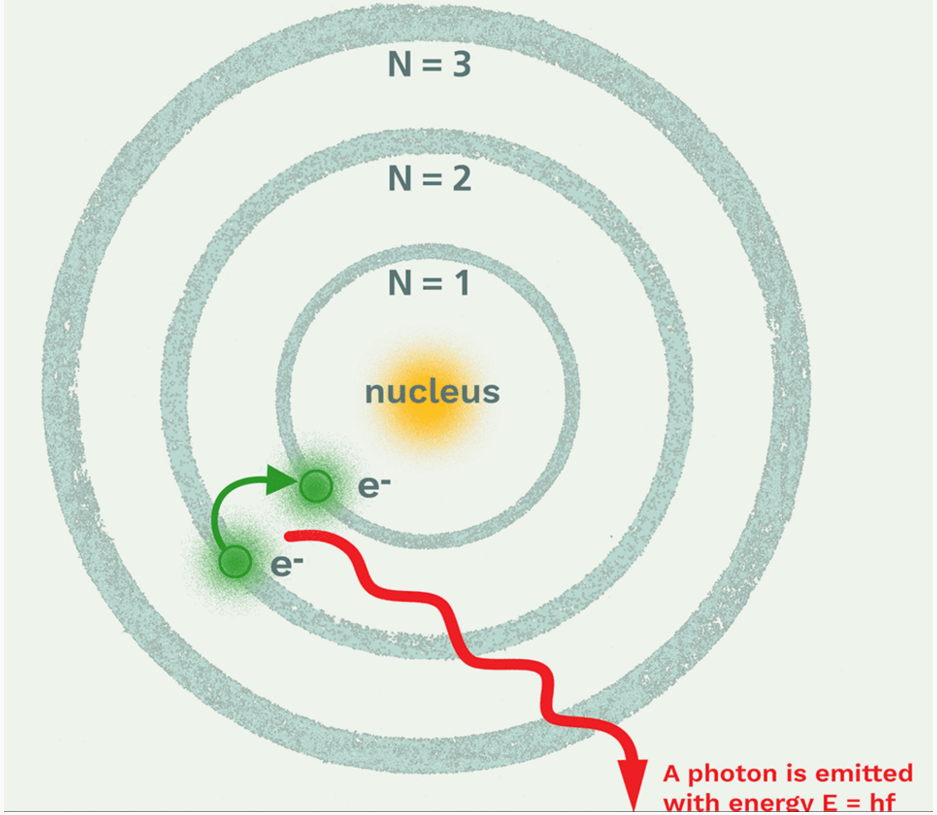
Atomic Orbitals



Outline

Rydberg Formula

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



Rydberg Formula

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

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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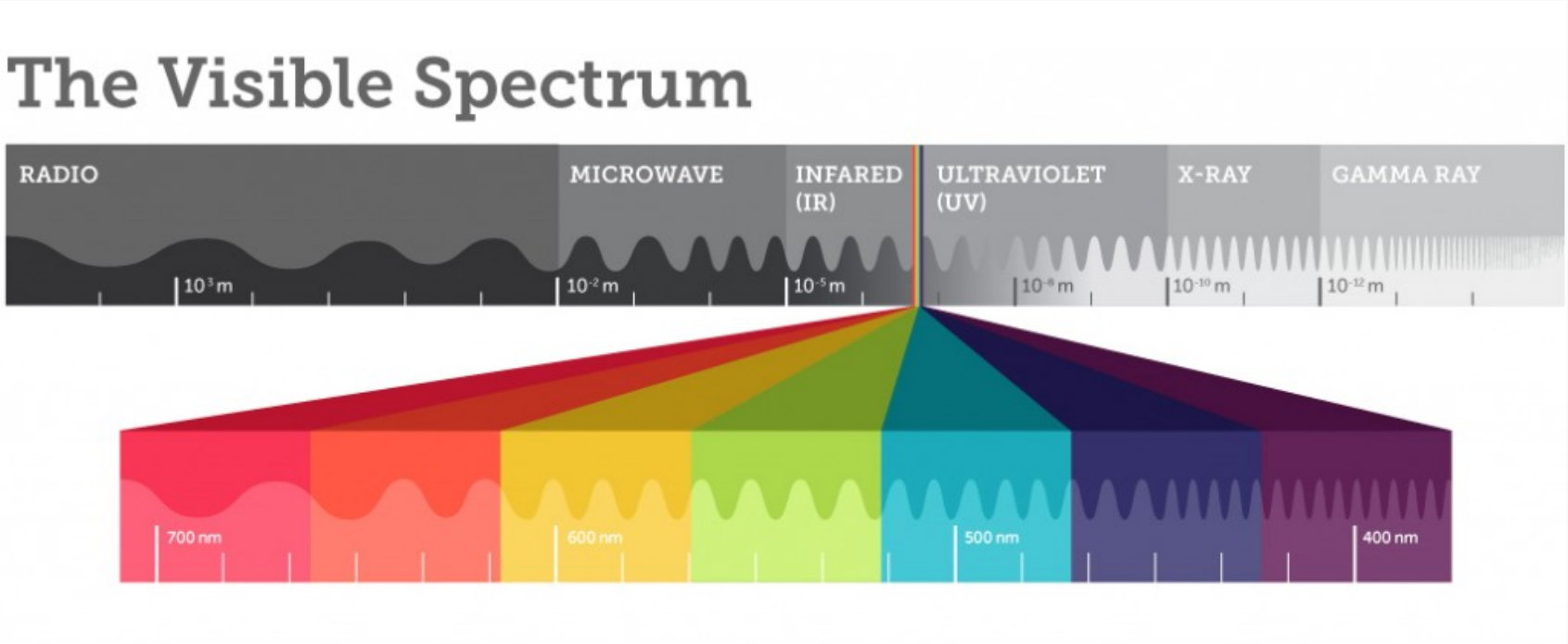
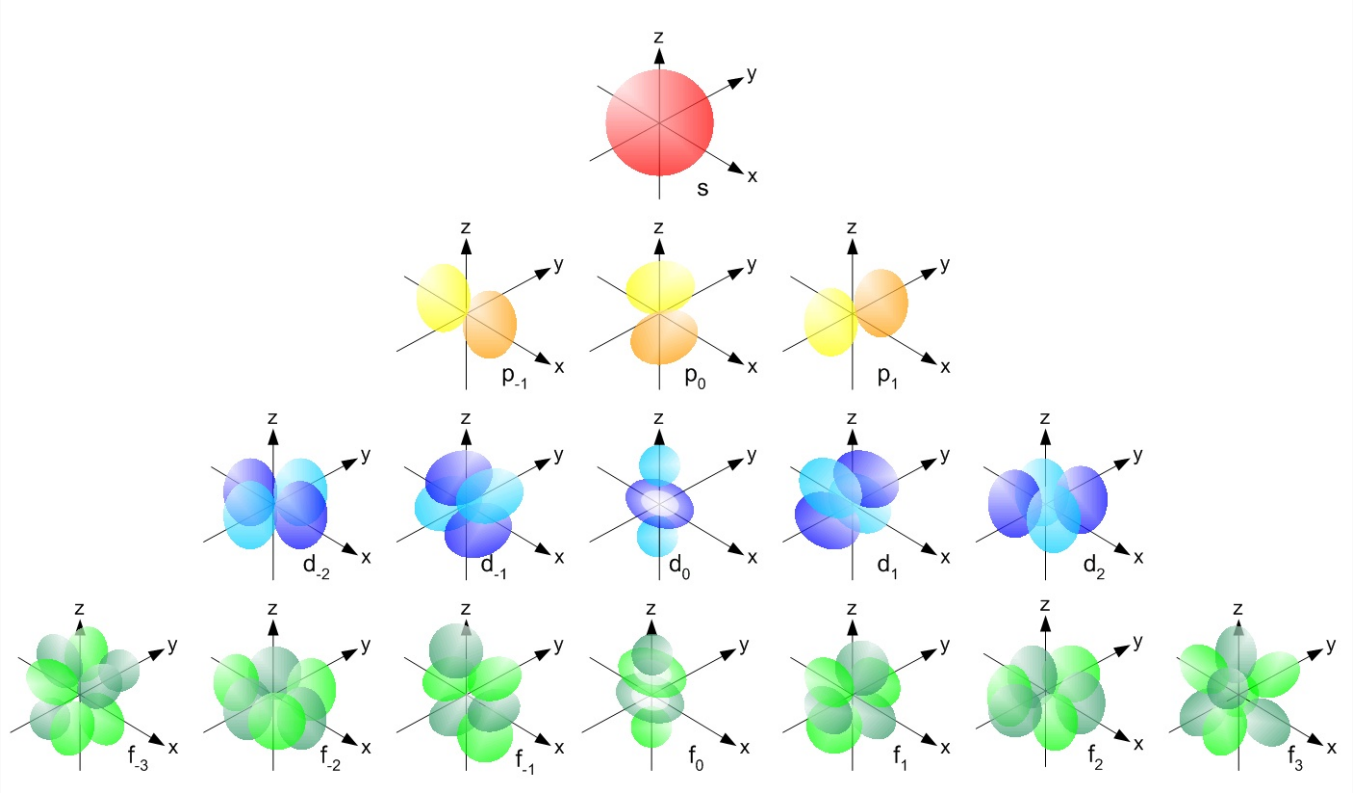


Practice: Using Rydberg Formula

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

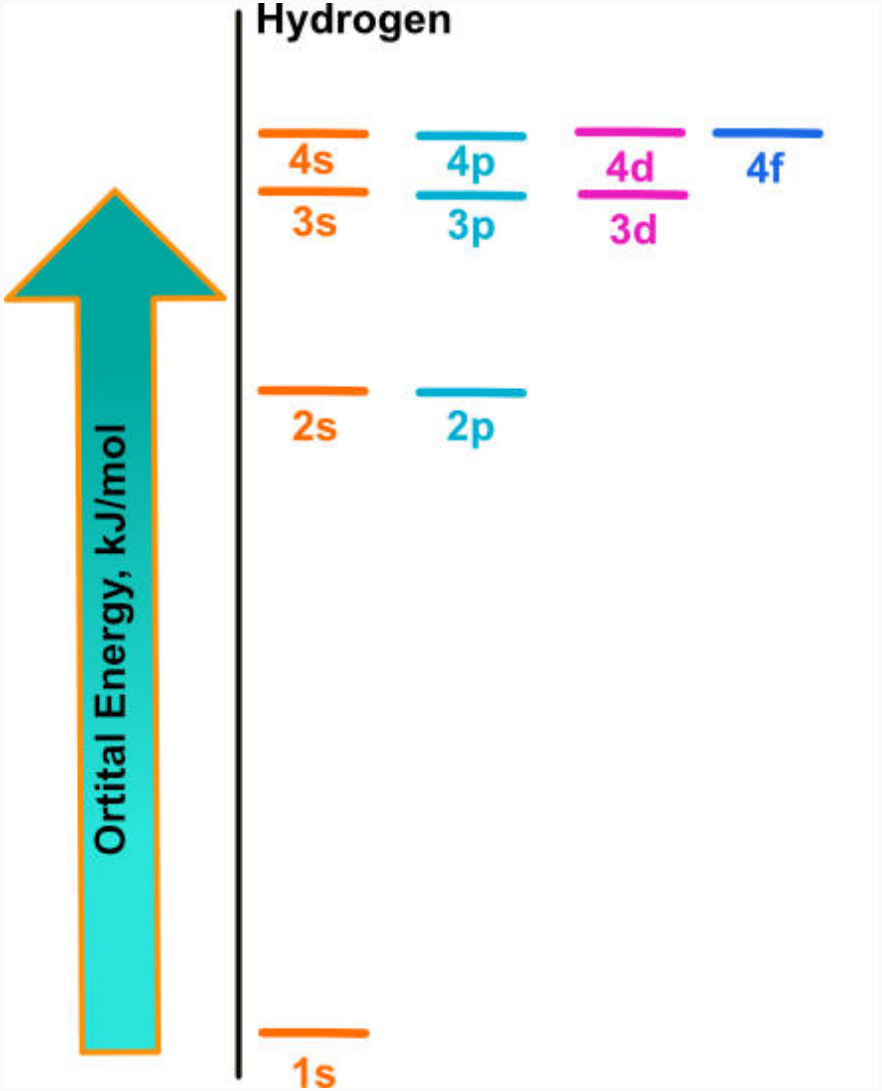
Outline

Atomic Orbitals



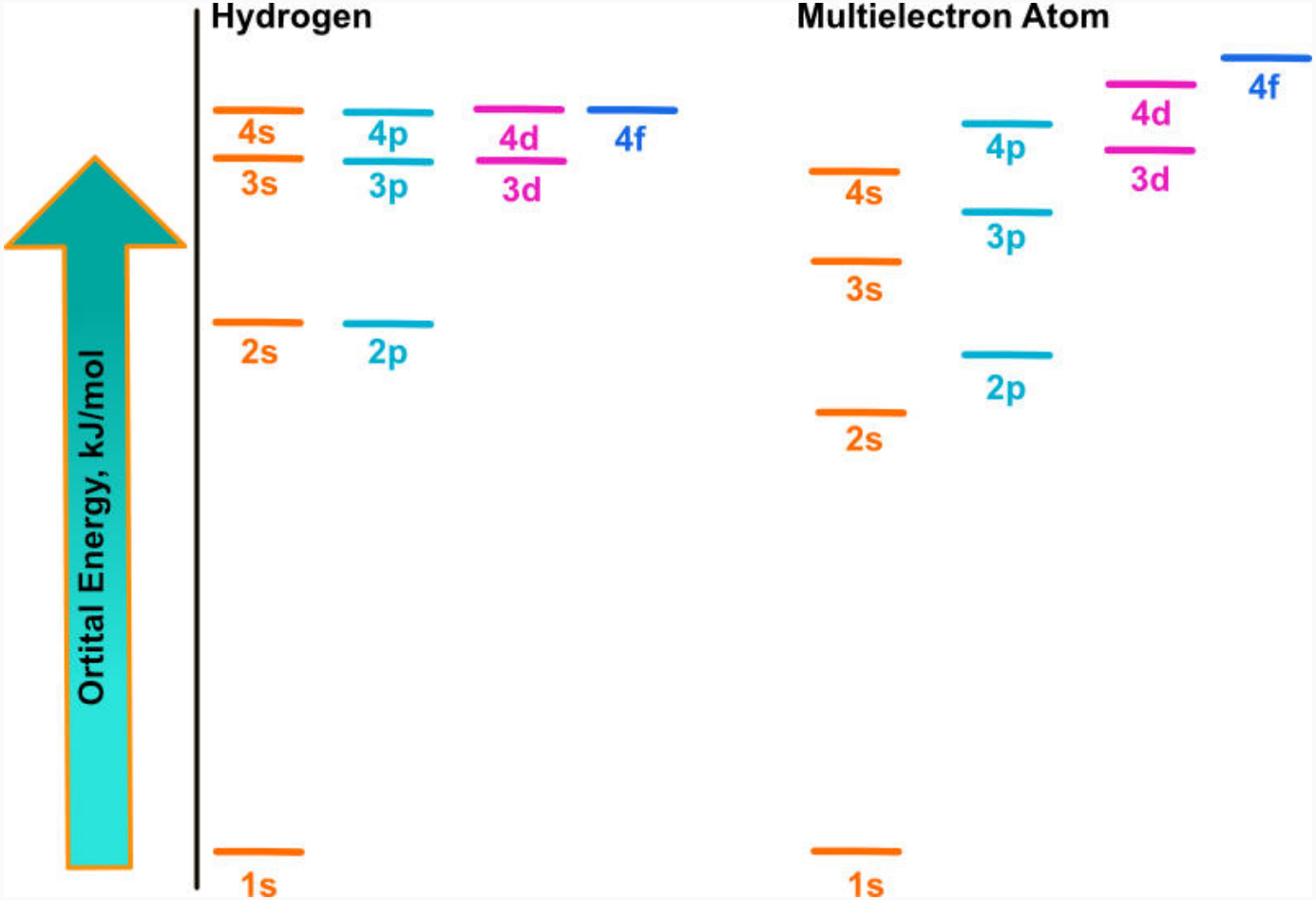
- Specific orbitals occupy certain **principal energy level** e.g. $n = 1, 2, 3, \cdots$
- Basis in which atoms form bond; atomic orbitals combine to make molecular orbitals

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

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