CHEM 14A
FALL 2023

Instructor: Dr. Laurence Lavelle

The Quantum World

Students must view the Audio-Visual Focus-Topics available at the Chem 14A class web-site.
For each module take the pre-assessment, then watch the video, then take the post-assessment, and then the brief survey.

Focus 1 (Omit 1C.2 & Table 1D.1)
Problems 1A: 3, 5, 7, 9, 11, 15; 1B: 3, 5, 7, 9, 15, 19, 21, 23, 25, 27; 1D: 1, 11, 13, 15, 17, 19, 21, 23, 25; 1E: 1, 5, 7, 9, 11, 13 (omit e), 15 (omit d), 17 (omit d), 21(omit c), 23, 25; 1F: 1, 3, 5, 7, 19, 21; and 1.3, 1.13, 1.27, 1.31

After going through the readings & problems and attending the lectures & discussion groups, you should be able to:

- Describe the nature of light as electromagnetic radiation (wave model) and as a stream of photons (photon model).
- Calculate the wavelength or frequency of light from the relation $c = \lambda\nu$.
- Use the Einstein equation $E = h\nu$ to calculate the energy, frequency, or number of photons emitted from a light source.
- Understand and explain the significance of the photoelectric effect, and solve problems using

  $$E(\text{photon}) - E(\text{energy to remove e-}) = E\ (\text{excess}) = E_K\ (\text{e-}) = \tfrac{1}{2}\, mv^2$$
- Use the Bohr frequency condition to explain the origin of the lines in the spectrum of an element.
- Know how to calculate electron transitions for the H-atom spectrum: $E_n = -\dfrac{h\mathcal{R}}{n^2}$
- With respect to electron transitions that give rise to a UV or visible spectrum: understand the difference between electronic transitions in atomic orbitals (atomic spectroscopy) and electronic transitions in molecular orbitals (molecular spectroscopy).
- Know the DeBroglie particle-wave duality for the electron, proton, etc., $\lambda = \dfrac{h}{p}$, and how to derive it.
- Know how to solve problems using Heisenberg's indeterminacy equation, $\Delta p\, \Delta x \geq \dfrac{h}{4\pi}$.
- Understand the relationship between Schrodinger's equation ($H\psi = E\psi$), wave functions, and orbitals.
- Describe and identify s-, p-, and d-orbitals.
- Describe the interpretation of atomic orbitals in terms of probability.
- Name and explain the relationship of each of the four s-, p-, and d-orbitals to the properties of electrons in these states.
- List the allowed energy levels of a bound electron in terms of the quantum numbers n, l, and m_l.
- State how many orbitals of each type are contained in the shell corresponding to a given principal quantum number and how many electrons can be accommodated in those orbitals.
- Describe the factors affecting the energy of an electron in a many-electron atom.
- Write the ground-state electron configuration for an element or ion (Aufbau Principle).
- Use the periodic table to predict and explain trends in atomic radius, ionic radius, ionization energy, and electron affinity.