In this unit, you will derive (with help) and explore the energy eigenstates for the hydrogen atom. Then we will explore how to do calculations and finally what these real world wavefunctions look like and how they represent graphs you may have seen in chemistry courses.

Motivating Questions

- What do the quantum numbers for the hydrogen atom represent physically and what values can they have?
- What shapes do the probability densities for the energy eigenstates of the hydrogen atom have?
- What is the algebraic form for the energy eigenstates of the hydrogen atom?

Key Activities/Problems

- Activity: Quantum Calculations on the Hydrogen Atom
- Activity: Hydrogen Probabilities in Matrix Notation
- Problem: Hydrogen Atom Representation Matching

Unit Learning Outcomes

At the end of this unit, you should be able to:

- Write the energy eigenstates for the hydrogen atom in wave function form using a table of radial solutions and a table of spherical harmonics.
- Describe how the values of the quantum numbers for the hydrogen atom are related to each other and remember the limits on their ranges.
- For a state of the hydrogen atom, given in bra/ket, matrix, or wave function notation, calculate the probabilities associated with energy, total angular momentum (squared), z-component of angular momentum, or position.
- For a state of the hydrogen atom, given in bra/ket, matrix, or wave function notation, determine how it evolves with time.
- Relate the wave function and bra/ket notations for stationary states of the hydrogen atom to their graphs.

Equation Sheets for This Unit

- Radial Functions for a Hydrogenic Atom Equation Sheet
- Quantum Systems Reference Sheet