The Bohr Atom

Equipment

- Spectrometer, grating (diffraction glasses)
- H_2 spectra tube and power supply, various light sources

Objective

Physics Concepts

- Electrostatic Potential (Voltage)
- Bohr Model, Energy Quantization

Experimental analysis

- Fit curves to data to determine mathematical relationships
- Recognizing the uncertainty in measurements

Conceptual (C-Level)

Bohr's idea that angular momentum is quantized is the basis for his atomic model [Chapter 11.10]. Using the electrostatic force along with quantized angular momentum, Bohr calculated that the allowed electron radii for the Hydrogen atom was $r = N^2 \frac{\hbar^2}{ke^2m}$, where N is an integer, $\hbar$ is Plank's constant divided by 2π, k is Coulomb's constant, and e is the charge and m the mass of an electron.

- Determine the voltage for a classical electron-proton system.
- Draw a graph of the potential energy (in eV) as a function of radius for your voltage equation.
- Determine the allowed energy levels for the quantized Bohr radii. Note the factor of 2 due to the kinetic energy term.

Light is both a wave and a particle. As a particle the energy of a photon is a multiple of Plank's constant, $E = hf = \frac{hc}{\lambda}$, where f is the frequency, λ is the wavelength and c is the speed of light.

- Determine the energy (in eV) of visible light photons (red, green and blue).

EXPLORATIONS:
Put on the diffraction glasses (also called "fireworks glasses") and observe different light sources.

Basic Lab (B-Level)

You will learn about diffraction gratings and spectrometers in later chapters. Suffice it to say that a spectrometer allows you to determine which energy photons are being emitted by a light source.

- Using a spectrometer determine the wavelengths of the light being emitted.
- Calculate the energy of the emitted light and match to the Bohr model.

Danger High Voltage! The spectra tubes are powered by a high voltage source. Do not touch HV!

Caution Fragile! The spectra tubes are glass – please handle the tubes by their ends to avoid oil.

Advanced/Extended Lab Ideas (A-Level)

- Use reduced mass for hydrogen to improve theoretical model.
- Investigate spectra (theory and experiment) for another light source.
- Investigate something about which you are curious.