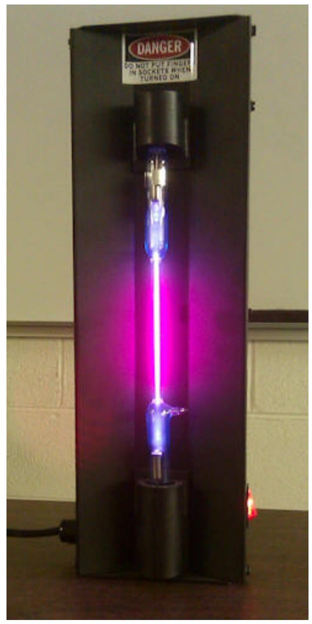
The Hydrogen Spectrum

The equation for the wavelength λ of light *emitted* by Hydrogen is called the Rydberg equation, where R is the "Rydberg" constant, and n1 and n2 are positive integers 1, 2, 3, … etc.

$$\frac{1}{\lambda} = R\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right),$$

Electrons jump from the initial level identified by the integer n_1 to a final level identified by the integer n_2. The loss/gain in electron energy E is accounted for by one photon of light emitted/absorbed with the distinct frequency $f = c / \lambda$, via Planck's formula $E = hf$.



The pinkish glow of a Hydrogen discharge lamp is a mixture of colors and wavelengths. Watch the Panopto video.

Looking to either side you will see this pinkish glow separated into distinct spectral lines corresponding to the N=1 (first–order) diffraction spectrum. Even further to the side, you may also be able to see some of these colors repeated in the N = 2 (2^{nd}-order) diffraction pattern. The colors in each order N are the same light emitted by the atom but diffracted by different angles through the grating.

1. Sketch the location and label the color of all the thin spectral lines that you can see (some may be quite faint). Do not include any smeared out colors – that is due to background light from the computer screen holding the camera that filmed the video.

2 Use the simulation **https://ophysics.com/m1.html** to discover all of the electron transitions that *emit* colored (visible) light. Note: if the emitted photon is shown as black, that signifies ultraviolet or infra red light, not a visible color!

3. Using data from the simulation, copy and complete the following table. You should have a value for R for each color. Obtain a final result as an average with an uncertainty. Take caution to get the correct unit for R !

Color	**Wavelength λ**	**Initial level n_1**	**Final level n_2**	**Rydberg constant R**
				$R_{av} \pm \Delta R$

Remember: As a rule of thumb, round uncertainty to one significant figure, then use same number of decimal places and same power of 10 for the average that you have for the uncertainty.

Is your result for R consistent with the known precise value R = 109,737 cm^{-1} ? How do you define "consistent"?