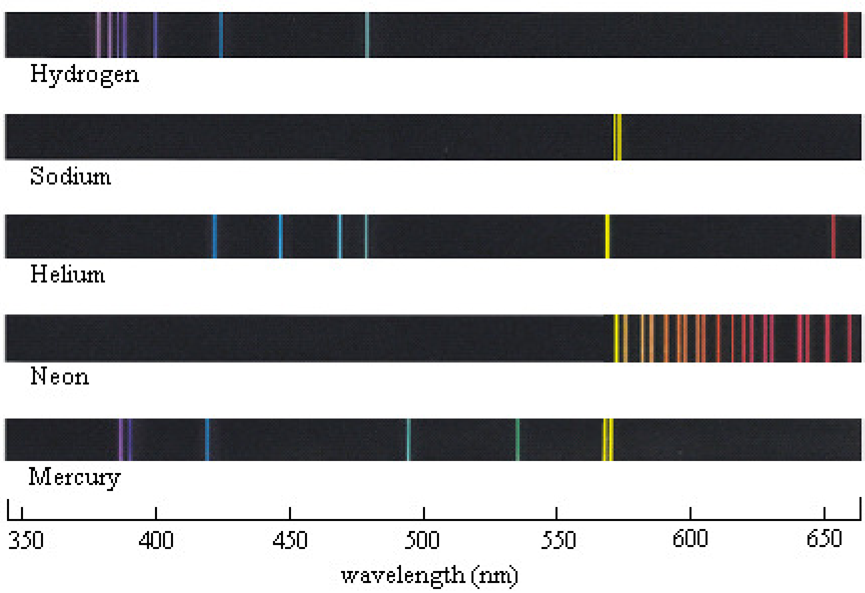
When a gas in a discharged tube is excited it emits light with characteristic frequencies. This light is produced when electrons in specific orbitals drop to lower orbitals and as a result emit a photon of a particular energy. Einstein showed the frequency of the photons was proportional to their energy. Thus only certain frequencies of light are emitted from the gases, depending on the nature of their orbitals. These frequencies are called the emission spectrum of the atom. Thus each atom has its own unique fingerprint that can be used to identify it. The emission spectrum can be observed by looking at the light from the discharge tube through a diffraction grating. The diffraction grating causes the light to separate into its component colors. By measuring the angle of diffraction it is possible to identify the wavelength of each spectral line The emission spectra from a few elements are shown below:



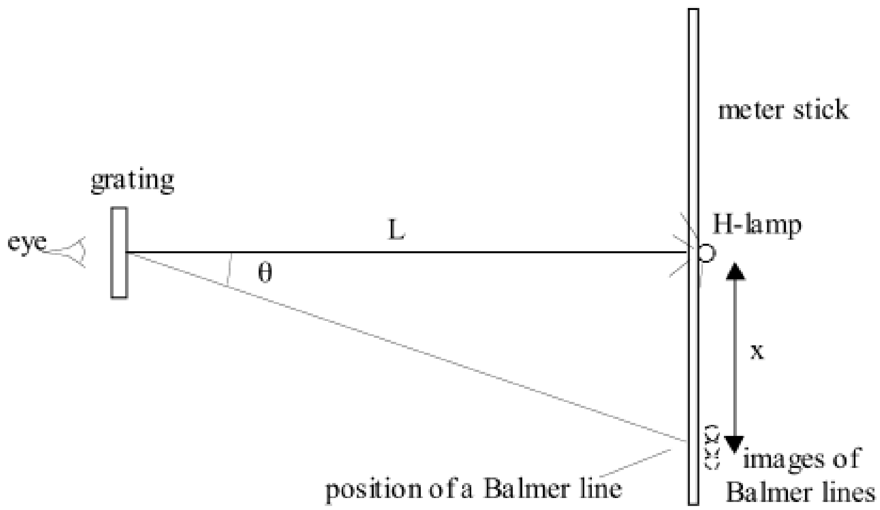
Bohr's model of the atom provides a good explanation for the emission spectrum of hydrogen. The visible part of the spectrum of hydrogen is called the Balmer series, named after a Swiss highschool teacher who observed them. This series comes from the emission of light due to electrons that drop from higher energy levels down to the second energy level. The wavelengths of the emitted photons fit the pattern:

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

Where *R,* the Rydberg constant, is 1.0973×10^{7} m^{-1} and *n* is the energy level (n=3,4,5), with *n*=3 corresponding to the red light, *n*=4 to the blue light and *n*=5 corresponding to violet light. (Other parts of the spectrum may also be visible).

Procedure:

1. Obtain a hydrogen discharge tube, place it in the lamp and turn it on.
2. Observe the tube through the diffraction grating and look for the images of the Balmer lines on the left or right of the tube corresponding to the different parts of the spectrum.
3. Measure the distance of the of the grating from the screen and the positions of the lines in the spectrum, Use these results to find the wavelengths of each line using the formula $d \sin\theta = m\lambda$, where d is the separation of the grating lines and m is the order. You will probably only see the m=1 lines.



4. Record the wavelengths of each part of the brightest fringes of light and use graphical analysis to test the Rydberg formula and measure the Rydberg constant.
5. Obtain the three mystery discharge tubes labeled A,B and C. By observing the spectrum through the diffraction grating try to identify the element by comparing the spectrum to those shown at the start of the lab.