Read the introduction to Hydrogen Balmer Series and Rydberg Constant in your lab manual. Here again we see the duality of light where we will use its wavelike properties with a diffraction grating and use its particle-like properties where photons are emitted at certain quantized energies when excited electrons fall down to lower energy levels in the hydrogen atom.

To find the wavelengths (or energies) of the light emitted from a hydrogen discharge tube, the light will be diffracted so that the individual energies can be separated out. The angle of diffraction will be measured, and using the equation for diffraction, the wavelength of the spectral lines can be found. Recall from the diffraction lab that 
\[ d \sin \theta = m \lambda \] (Eqn. 2, p. 341) where \( d \) is the grating spacing, \( \theta \) is the angle of diffraction, \( m \) is the order (\( m=0,1,2,\ldots \)), and \( \lambda \) is the wavelength. The grating spacing, \( d \), is the inverse of the line density. In the Hydrogen Balmer Series lab you will use a diffraction grating with 300 lines/mm so \( d = 1/300 \) lines/mm=0.003333 mm.

Once the wavelength of the spectral lines is found, the Rydberg constant can be calculated using the known quantum numbers for the hydrogen transitions. The emitted spectral lines that are seen with the hydrogen discharge tube are from transitions of \( n>2 \) to \( n=2 \) quantum levels. These transitions can be seen at the website: [http://hyperphysics.phy-astr.gsu.edu/hbase/hyde.html](http://hyperphysics.phy-astr.gsu.edu/hbase/hyde.html).

**Things to remember during the lab:**

1. The hydrogen discharge tube is powered by high voltage. Do not stick your fingers in the power supply! The tube gets hot! Do not touch the tube, or it will break. If the tube does break, call your GTA over to handle the broken glass.
2. Follow the instructions for setting up the student spectrometer carefully. Initially, the diffraction grating should not be set in the spectrometer.

3. There is a loupe with each student spectrometer that can be used to magnify the Vernier scale to get the angular readings. You can also use your phone camera to take a picture and zoom in on the image to get your readings.

4. Below shows an image of the angle readings off of one of the student spectrometers. It is read by looking to where the 0 line is past as shown with the yellow arrow (arrow at the top of the figure). Shown here the 0 line is a little past 11°. To get fine resolution from the Vernier scale, you then look to see which lines are continuous. Here it is shown with the purple arrow (arrow at the bottom of the figure). This arrow reads 10’. The total reading is 11° 10’ (11 degrees 10 minutes). \( \frac{1}{60}° = 1’ \). So the reading is 11 1/6° or 11.167°

Questions:

1. Do the prelab questions on page 369 of your lab manual.
2. What is the reading of the Vernier scale shown below?

References:
2. http://hyperphysics.phy-astr.gsu.edu/hbase/hyde.html