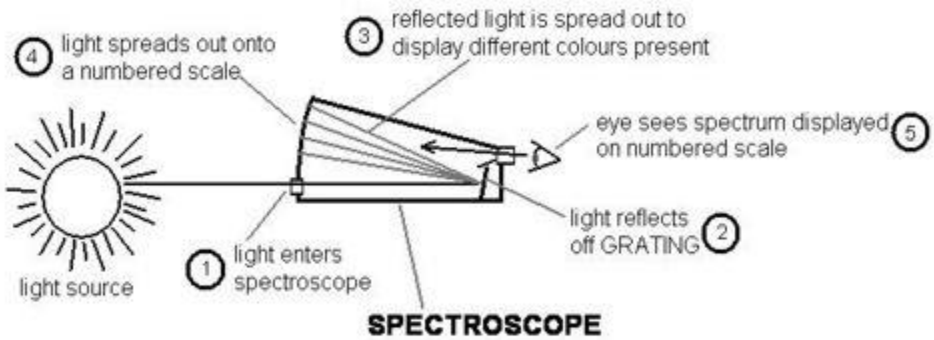
ATOMIC SPECTRA

Purpose: You will observe spectra from several different light sources and compare them.

Background: Everyone has seen the rainbows that form when the atmospheric conditions are right or when light shines through an angled piece of glass. The scientific term for such rainbows is spectra (singular spectrum, plural spectra). In this lab we will use spectroscopes to analyze light from different sources. A spectroscope (Figure 1) is a device that has 2 holes, a ruler, and a special grating. Light goes in one hole, bounces off the grating, is displayed against a ruler, and you look in the other hole to see it.



Read the section in our textbook about Bohr's theory of the hydrogen atom before lab, including the parts about continuous spectra and line spectra. Continuous spectra are produced when light is given off as a sample is heated. However, when light is given off because the electrons around an atom get excited, the electrons only have certain allowed energy values they can move between (different orbitals). The light separates into specific bands, with gaps in between. This series of bands is called a line spectrum. The bands emitted are unique to a specific element, so spectroscopy can be used to identify elements (as in determining the chemical composition of distant stars) or to quantify elements (like measuring how much lead is on a child's toy).

The energy of a photon is related to the frequency by $E = h\nu$, where ν is "nu", the symbol for frequency, not to be confused with velocity. Frequency is inversely proportional to wavelength (λ), as given by $\nu\lambda = c$. When using these equations, be careful to keep track of units. The speed of light is usually given in meters, and wavelengths are usually measured in nanometers, so you have to convert between them.

To get useful data from your spectroscope, you need to calibrate it by measuring something for which the accepted values are well known. Creating a reference between values from a particular instrument and known values is called making a calibration curve. This is somewhat misleading because calibration curves are almost always straight lines. You can then use the equation of the trendline to relate your measured values (ruler readings in cm) to meaningful values (wavelengths in nm). We will use the Hg lamp to create the calibration curve and then use this curve to find wavelengths for the other emission sources.

Procedure: This is what you need to write down. Work in pairs.

Each of you should try looking through the spectroscope, and then whoever is more comfortable with it should take all the readings. The order you observe does not matter, as long as you look at all seven samples (3 lamps, 3 salts, 1 candle). You need to record numbers for the positions of any lines but not continuous spectra.

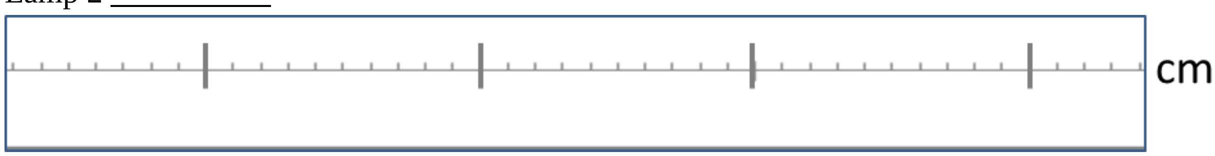
1. Familiarize yourself with the spectroscope. The ruler should be on the left. Depending on the spectroscope your group has, the units on the ruler may increase from left to right or decrease from left to right. Be sure to note which type of ruler you have. Line the light source up exactly with the slit on the right. Hold the box steady and move your eye to get the spectrum to line up above the ruler. You may see other reflections to the side or below the ruler, ignore them.

2. Look at the mercury lamp (the name of the gas in each lamp is written on the top of the enclosure). There are 4 strong emission lines, although the violet one is not intense so you may not be able to see it in our lab conditions. Record the position of the lines as accurately as possible. Look back at the first chapter of our textbook if you don't remember the precision to record when using a ruler (or ruled scale). Use these lines as your calibration data in the report form.

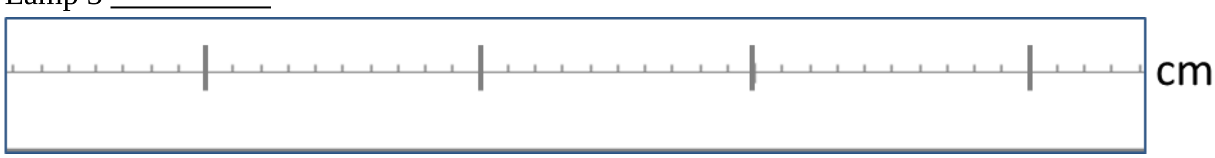
Color	Known wavelength (nm)	Observed position (cm)
Violet	404	
blue	436	
Green	546	
Yellow	580	

3. View two other gas tubes. Sketch the spectra, and record the color and position in cm of any lines observed. Use the sample rulers shown below to record your data. Be sure to indicate whether your ruler's units increase from left to right or decrease from left to right.

Lamp 2 ___________

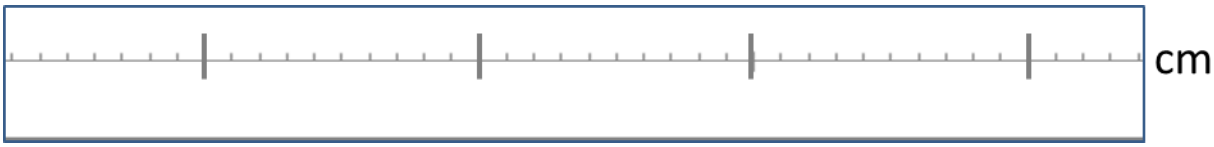


Lamp 3 ___________



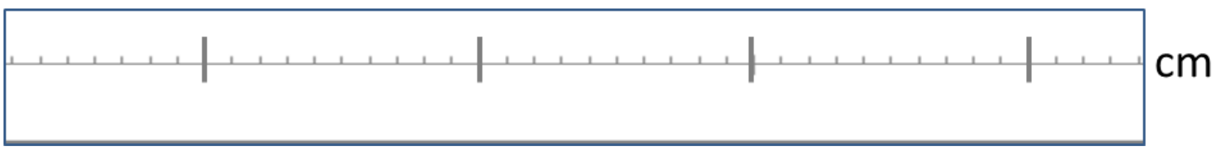
4. View the emission spectrum from the sodium salt. Line the spectroscope up with the flame from the Bunsen burner. Then have your partner dip the wire in the salt and burn the quantity of salt that sticks to the wire. Do <u>NOT</u> pour salt on the burner, scoop salt onto a loop in the wire, or try in any other way to burn a large sample. Sketch the spectrum, and record the color and position in cm of any lines observed. Record observations of the flame without the spectroscope.

   Na Salt

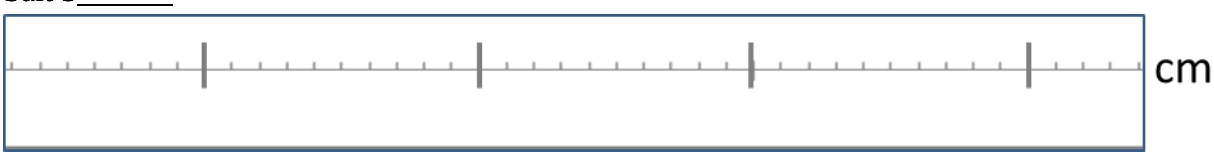
   

5. View 2 other salts using the same technique. Keep each wire and Bunsen burner with the appropriate salt to prevent contamination. Sketch the spectra, and record the color and position in cm of any lines observed.

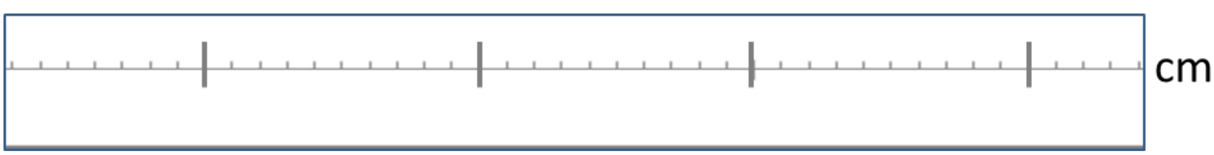
   Salt 2 ______

   Salt 3______

6. View the spectrum from a candle. Sketch the spectrum, and record the color and position in cm of any lines observed.

After completing the procedure but before leaving lab, write in your notebook a brief statement (two to three sentences) on the quality and reasonableness of the data you collected. Note what you might do differently if you performed the lab again.