Atomic Spectra

Purpose:

To measure the spectra of gas tubes of different elements with spectroscope and identify the energy levels associated with the emission of photons.

Equipment:

Figure 1 shows a schematic of a spectroscope. The diffraction grating inside will separate the different wavelengths of light and superimpose it on a scale. Make sure when you point the spectroscope at the light source you can see the light coming in from the slit.

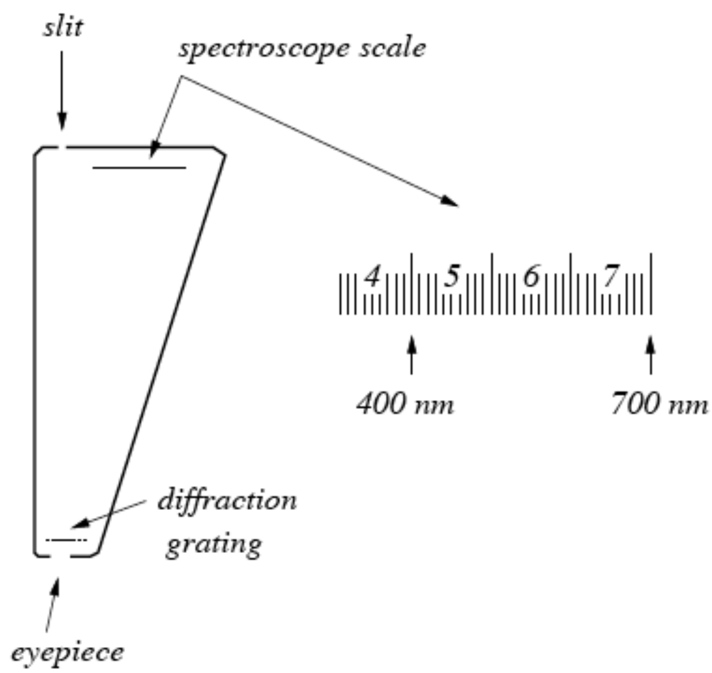

Figure 1

Procedure:

1. Point the spectroscope to the daylight outdoor and observe the spectrum. **Do not point directly at the sun.** Write down the range of the wavelength you observe.

Wavelength: ____________________________ to __________________________________

2. What color has the shortest wavelength? Which has the longest?

3. What is the range of the frequency?

Frequency: _____________________________ to __________________________________

4. Point the spectroscope to the florescent light on the ceiling. Write down all the wavelengths you observe. You should see a pattern similar to Figure 2.

Wavelengths: ____

5. What are the frequencies?

Frequencies: ____

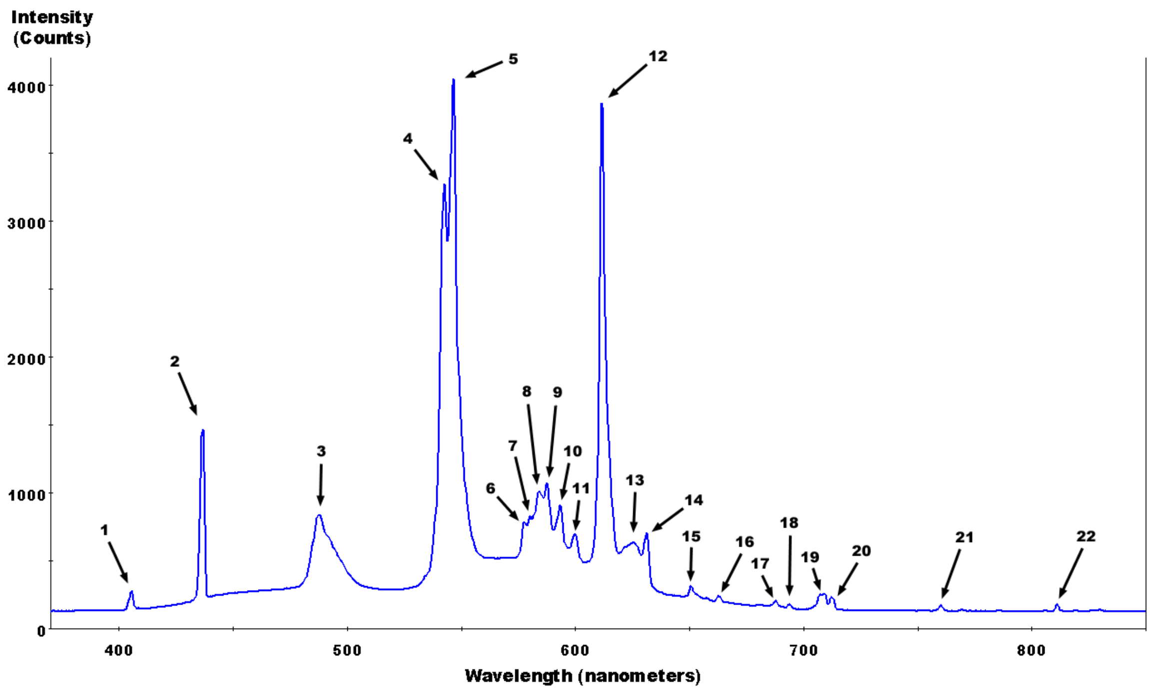

Figure 2: Spectrum of a typical fluorescent light

6. Now point the spectroscope to the hydrogen gas tube. Record the wavelengths you observe in the first column in Table 1. Note that the spectroscope reading is not very accurate, it may be off the actual value by as much as *30nm*.

7. Go to the web site http://physics.nist.gov/PhysRefData/Handbook/element_name.htm , click on hydrogen. Select "Persistent Lines" from the top option, you will see a list of wavelengths of light emitted by hydrogen. Write down in the second column the ones with values closest to your measured λ. Under "Configurations" from the NIST site you will see the initial and the final orbitals from which the electron transitions take place. Write down the initial n (n_i) and the final n (n_f) in the third and fourth column below. For example, the NIST entry "1s, 5p" means $n_i = 5$, $n_f = 1$. Note that in the web site, all the wavelengths are listed in ångström (*Å*), which equals $10^{-10}m$. For example, *600nm=6000Å*.

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Table 1: Hydrogen

Angle θ	Color	m	Measured λ (nm)	Quoted λ (nm)	Percentage Difference	n_i	n_f	Calculated λ (nm)

8. Use the formula $\frac{1}{\lambda} = Z^2 R(\frac{1}{n_f^{\,2}} - \frac{1}{n_i^{\,2}})$, where $R = -\frac{E_1}{hc} = 1.1 \times 10^7 m^{-1}$, Z is the atomic number, to compute λ, and make sure that they are reasonably close for hydrogen. This formula[1], however, will not work well for the other elements.

9. Repeat the same procedure 6 for 3 different elements in the tables below. Make sure you label the element for each table clearly. For these elements, sometimes you have to find the spectral line from the NIST site under "Singly Ionized" because the current ionizes some of the atoms. The listings under "Configurations" are also more complicated because there are more electrons. For example "$5d^{10}(^1S)6s^2$" and "$5d^{10}(^1S)6s6p$" means both n_i and n_f are 6. "$5d^{10}(^1S)6s6p$" and "$5d^{10}(^1S)6s7s$" means n_i =7 and n_f =6.

Table 2: ______________________

Angle θ	Color	m	Measured λ (nm)	Quoted λ (nm)	Percentage Difference	n_i	n_f

[1] This formula is only correct for atoms/ions with only one electron.

Table 3: ______________________

Angle θ	Color	m	Measured λ (nm)	Quoted λ (nm)	Percentage Difference	n_i	n_f

Table 4: ______________________

Angle θ	Color	m	Measured λ (nm)	Quoted λ (nm)	Percentage Difference	n_i	n_f