Line Spectra and the Bohr Model

Introduction:

A spectrum is composed of the different wavelengths that make up some source of radiation. These wavelengths give off a rainbow of colors, and when all colors are present, this is called a continuous spectrum. However, not all radiation sources give off a continuous spectrum. Different gases emit different colors of light, with each color representing one wavelength. This emission of specific wavelengths is called a **line spectrum.**

Gathering the frequency and wavelength of hydrogen from its line spectrum, the **Bohr Model** can be used to calculate the energies corresponding to the orbits for the electron in the hydrogen atom. The equation for the Bohr Model can be found on page 215 of your textbook.

In this lab, you will examine line spectra of both gases and salts in order to identify the specific element they correspond to. You will also calculate the energy transmission of hydrogen using the Bohr Model. In addition you will be using the diffraction of a laser to determine the wavelength of light coming from the laser.

Part 1: Identifying Gases Using Line Spectra

For this part of the lab, you will be using the RSpec Explorer software to identify gases based on their line spectra.

1. The RSpec Explorer camera, software and all of the tabs you need should already be open for you. The camera should already be calibrated.
2. In order to observe the gas, place a tube in the machine and turn it on using the switch on the right side. ALWAYS hold the gas tubes using a paper towel; they may be hot. To switch gas tubes, ALWAYS turn the machine off first. Gas tubes are labeled with a number.
3. Using the Elements tab, you can reveal the line spectra of several elements. Match the correct element with the graph of the line spectra of the gas in the tube. Write your answers below. If you need to see the graph more closely, you can click on the graph and scroll up and down.

Gas #1:

Gas #2:

Gas #3:

Gas #4:

Part 2: Identifying Cations Using Line Spectra

For this part of the lab, you will be burning salts and identifying the cations using their line spectra.

1. There are 5 unknown salts in cups labeled with numbers. A bunsen burner is also set up for you. Turn the flame on. Please wear eye protection for this portion of the lab.
2. Scoop a decent amount of one of the salts onto a wooden stick. When you hold the wooden stick over the flame, the salt will burn. You can observe the line spectrum of the cation using a diffractor. Draw the line spectrum you see.
3. If you need to do Step 2 again in order to see the line spectrum again, you may do so.
4. Below is a link to the periodic table of elements. When you click on an element, it will show that element’s line spectrum. Match the correct element to each unknown cation. It will be one of these 10 elements: Sodium, Barium, Magnesium, Iron, Calcium, Zinc, Strontium, Potassium, Lithium, Copper.

<http://chemistry.bd.psu.edu/jircitano/periodic4.html>

Cation #1:

Cation #2:

Cation #3:

Cation #4:

Cation #5:

Part 3: Calculating the Energy Transmission of Hydrogen Using the Bohr Model

For this part of the lab, the teacher will display the line spectrum for hydrogen on the board. Using wavelength and frequency, calculate the energy transmission in order to determine which transition between energy levels is responsible for each spectral line you see. Calculate values of all the transitions from the first five energy levels to energy level 1,2, and 3 and determine which transmission relates to each spectral line and where the other transitions should be found.

5 to 1:

4 to 1:

3 to 1:

2 to 1:

5 to 2:

4 to 2:

3 to 2:

5 to 3:

4 to 3:

Part 4: Calculating Wavelength Using Diffraction

For this part of the lab, you will be using a diffractor to calculate the wavelength of a laser. Please do not look directly into the laser. You will be using the equations below to calculate wavelength:

1. The laser and diffractor should already be set up for you. Please do not move the laser or the diffractor, as this will mess up your calculations.
2. n stands for the energy level. Since our diffractor only diffracts one energy level, n will just be one for this particular example.
3. d in the first equation stands for the distance between diffraction gratings on the diffractor. This will be provided for you. This is often given in lines per millimeter, but for our purposes we will want this converted to distance in meters.
4. Θ stands for the angle between the diffractor and the 2 dots you are using.
5. h stands for the distance between the 2 dots.
6. d in the second equation stands for the distance from the diffractor to the center dot.

If you are confused, here is a youtube video that may help.

<https://www.youtube.com/watch?v=TlkVtpzPTdU>