Ms. Randall
Regents Chemistry
Lab Activity: Electron Energies and the bright line spectrum

Background: As shown in the flame test experiment, elements will often color the flame of a Bunsen burner when they are heated. A major emphasis in chemistry was to study and explain why these colors were produced. Using a prism, chemists were able to separate the colored flame into individual colored bands. Any theory concerning the structure of the atom would have to explain these colors and the fact that for any element the colors were always the same. This "emission" spectrum of an atom could be used to identify any element since each element had a unique spectrum.

Examination of the bright line spectrum of hydrogen reveals 4 colored lines: red, blue-green, blue, and violet. These lines represent t characteristic amounts of energy emitted when excited electrons return to lower energy levels. The existence of line spectra indicates that the energy of an electron can only be changed by its movement from one discreet energy level to another. These changes in energy are quantized (restricted to certain values). The conclusion is that the electrons in an atom have definite, distinctive energies.

Objective: To relate lines in an atomic spectrum to the changes in energy that occurs with an electron.

Pre-Lab:
According to the Bohr model, where are electrons located in an atom?

Materials:
Gas tubes, power source, diffraction glasses, calculators

Procedure: Draw lines indicating the presence of each color spectrum in the gases listed below

Sample	Spectrum
Helium	R O Y G B V
Neon	R O Y G B V
Argon	R O Y G B V
Krypton	R O Y G B V
Xenon	R O Y G B V
Mercury	R O Y G B V
Nitrogen	R O Y G B V
Hydrogen	R O Y G B V

Analysis:

Study the spectrum of the hydrogen atom.

1. The red line represents a wavelength of 656 nm, the blue-green line represents a wavelength of 486 nm, and the violet line represents a wavelength of 434 nm. Using the information that 1 m = 1 x 10^9 nm, convert each of these wavelengths from nanometers to meters. *Hint: just divide the value in nm by* 1x10^9. *You should get very small numbers.*

   Red light = _____ m

   Blue-green light = _____ m

   Violet light = _____ m

2. Calculate the frequency of each color of light using this equation:

   Frequency = $\frac{\text{speed of light}}{\text{wavelength}}$ speed of light = 3 x 10^8 m

   Frequency of red light _____ Hz

   Frequency of blue-green light _____ Hz

   Frequency of violet light _____ Hz

3. Calculate the energy of each color of light using the equation $E = h\nu$, where h = Planck's constant (6.626 x 10^{-34} J s) and ν is the frequency of the light.

   Energy of red light _____ J

   Energy of blue-green light _____ J

   Energy of violet light _____ J

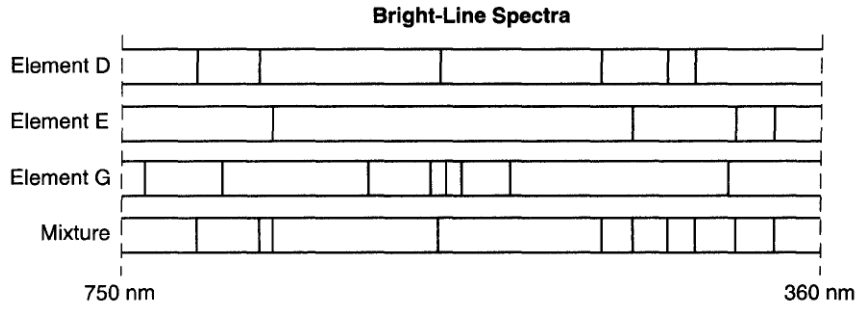
Ms. Randall
Regents Chemistry
<u>Lab Conclusion:</u> Electron Energies in the Hydrogen Atom

1. Write a paragraph summarizing what you have learned about the scientific concept of the lab from doing the lab. Back up your statement with details from your lab experience.

2. Which statement describes the relative energy of the electrons in the shells of a calcium atom?

A) An electron in the first shell has more energy than an electron in the second shell.
B) An electron in the first shell has the same amount of energy as an electron in the second shell.
C) An electron in the third shell has more energy than an electron in the second shell.
D) An electron in the third shell has less energy than an electron in the second shell.

3. Given the bright-line spectra of three elements and the spectrum of a mixture formed from at least two of these elements:



Which elements are present in this mixture?

A) *E* and *D*, only B) *E* and *G*, only C) *D* and *G*, only D) *D*, *E*, and *G*

4. The bright-line spectrum of sodium is produced when energy is

A) absorbed as electrons move from higher to lower electron shells
B) absorbed as electrons move from lower to higher electron shells
C) released as electrons move from higher to lower electron shells
D) released as electrons move from lower to higher electron shells

5. Base your answer to the following question on the following information.

In a laboratory, a glass tube is filled with hydrogen gas at a very low pressure. When a scientist applies a high voltage between metal electrodes in the tube, light is emitted. The scientist analyzes the light with a spectroscope and observes four distinct spectral lines. The table below gives the color, frequency, and energy for each of the four spectral lines. The unit for frequency is hertz, Hz.

Visible Spectrum of Hydrogen

Color	Frequency ($\times 10^{14}$ Hz)	Energy ($\times 10^{-19}$ J)
red	4.6	3.0
blue green	6.2	4.1
blue	6.9	4.6
violet	7.3	4.8

Explain, in terms of subatomic particles and energy states, why light is emitted by the hydrogen gas.