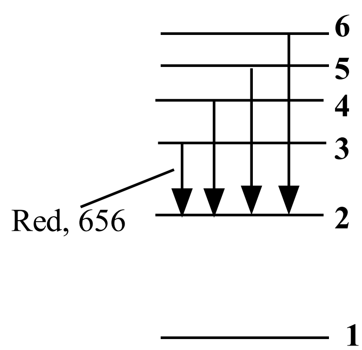
#10 Line Spectra of Elements

Purpose: You will identify elements from their emission line spectra. Before doing this experiment, complete the experiment on wavelength and color.

Introduction:
No calculations are required to do this experiment. You will simply observe the emission from an element and try to match it with a spectrum from the Flinn manual in order to identify the element.

Emission Spectra of Elements
Transitions of electrons from higher to lower electronic energy levels in elements produce emission of light. When energy is supplied to the element, its electrons are excited to higher energy levels. When the electron returns to a lower level, a photon with that energy difference is emitted. The peaks in the emission spectra are very sharp and are known as line spectra. The pattern of lines is different for each element and thus can be used to identify the element. Discovery of a new element is confirmed by the fact that its line spectrum is different from any known element.

Spectrum of Hydrogen
Electrons in atoms of an element occupy distinct energy levels, labeled by integers 1, 2, 3, 4, and so on. The energy level diagram on the right is for the element hydrogen. Bohr was able to predict all of the energy levels for H, using a simple equation where n is the number of the energy level:



$$E_n = -2.18 \times 10^{-18} \text{ Joules}/n^2$$

Transitions from higher energy levels to the 2^{nd} level produce the visible lines that you will see in the H spectrum, such as the intense red line resulting from the transition from 3 to 2. However, this relatively simple model works only for H. The interpretation of the spectra of other elements, even helium, is much more complicated.

Calculating the wavelength
The wavelength of the photon emitted depends on the energy difference, ΔE. Using the Planck equation, the wavelengths in the H spectrum can be found.

$$\Delta E = hc/\lambda \quad \text{and} \quad \lambda = hc/\Delta E$$

The h is Planck's constant, c is the speed of light, and λ is the wavelength.

Apparatus
The gaseous elements are sealed in spectrum tubes, which are housed in power supplies that provide energy through an electric field applied between electrodes at the ends of the tubes. When the power supply is turned on, the electrons in the elements are excited to higher energy levels. Emission occurs. By eye the glow of the element in the tube appears to be one color, like that emitted by mercury lights. Using a diffraction grating, you will be able to see the sharp lines of color that make up the emission spectrum. Like prisms, diffraction gratings divide white light into its component colors.

Procedure
CAUTION: Do not touch the power supply. Your instructor will set up each spectrum tube for you.

1. Obtain one Flinn Emission Spectra Manual for your group. You will return these at the end of the class.

2. You will start by observing a known element, hydrogen. Hold the square of diffraction grating off to either side of the emitted light and you should see a set of lines. You may also see other identical weaker sets of lines. You can ignore those.
Start at the red end of the spectrum and number each line or groups of lines that you see. Record the *colors* of the lines and estimate their wavelengths from the results of the experiment in which you observed the reflection off the piece of chalk. Estimate the *intensities* of each of the lines as best you can, by choosing the most intense line in the spectrum and comparing the rest to that one.
Compare what you see with the emission spectrum of H in the Flinn Emission Spectra Manual.
Note: Intensity of a peak is actually the area under that peak. For very sharp single lines, the peak height is a good indicator of the intensity. When there are many small peaks that are close together, they may appear as one single strong line in the spectrum.

3. Repeat with other unknown elements that your instructor will choose. Record the number of the spectrum tube. Record the colors and intensities of lines and try to identify each of the elements from the spectra in the Flinn manual.

Data and Results (Line Spectra)
Name(s) ____

Spectrum Tube # 1 (Known)   Element: Hydrogen

Number of Line or Groups of Lines	Color	Intensity

Spectrum Tube # ______   Element: _________________

Number of Line or Groups of Lines	Color	Intensity

Spectrum Tube # ______   Element: _________________

Number of Line or Groups of Lines	Color	Intensity

Data and Results 2 (Line Spectra)

Spectrum Tube # _______ Element: __________________

Number of Line or Groups of Lines	Color	Intensity

Spectrum Tube # _______ Element: __________________

Number of Line or Groups of Lines	Color	Intensity

Spectrum Tube # _______ Element: __________________

Number of Line or Groups of Lines	Color	Intensity

Instructor's Guide
(#10 Line Spectra of Elements)

Time: 1 h

Equipment and Materials: per group

Items	**Number**	**Comment**
power supplies	1	for the whole class
spectrum tubes	1 ea	for the whole class; 1 each of H, He, Ne, Hg, Kr, Ar, I, Br, Xe
diffraction grating	1 per student	one square inch for each student
Flinn spectrum manuals	1	

Ideas/ Information
Four of the elements are very easy to identify. We recommend starting with:
H (known) , then He, Hg, and Ne.
H , He and Hg have very sharp peaks that are easy to assign. Ne has broad red, orange and yellow bands and clearly matches the one in the Flinn manual.

Kr is not very intense. N and Argon are much more difficult to see. You could try these after students have identified the others.