Introduction

By placing atoms of a metal into a flame, electrons can be induced to absorb energy and jump to an excited energy state, a quantum jump. They then return to their ground state by emitting a photon of light (the law of conservation of energy indicates that the photon emitted will contain the same amount of energy as that absorbed in the quantum jump). The amount of energy in the photon determines its color; red for the lowest energy of visible light, increasing energy through the rainbow of orange, yellow, green, blue, indigo, and finally violet for the highest energy of visible light. Photons outside the visible spectrum may also be emitted, but we cannot see them.

The arrangement of electrons in an atom determines the sizes of the quantum jumps, and thus the energy and colors of the collection of photons emitted, known as emission spectrum. In this way the emission spectrum serves as a "fingerprint" of the element to which the atoms belong. We can view the emission spectrum of colors all at once with the naked eye. It will appear to be one color, which we will carefully describe.

A flame test is a procedure used to test quantitatively for the presence of certain metals in a chemical compounds. When the compound to be studied is excited by heating it in a flame, the metal ions will begin to emit light. Based on the emission spectrum of the element, the compound will turn the flame a characteristic color.

In this lab, we will record the flame test color of several metals by making solutions of salts, or ionic compounds, of those metals then igniting them with a burner. We will observe the separate colors of the emission spectra, as the solution burns.

Background:

The electrons in an atom occupy different energy levels, as you know. When all of the electrons are at the lowest possible energy level they are said to be in the ground state. Electrons do not always stay in the ground state. Sometimes they can be promoted to a higher-energy electron shell. This can happen in two ways. First, the electron can absorb a photon of just the right amount of energy to move it from one quantum shell to another. Second, when atoms are heated their electrons can gain energy from the heat. This promotes them to the higher-energy shell. When an electron is in a higher-energy shell it is said to be in an excited state.

Electrons in excited states do not usually stay in them for very long. When electrons lose their energy they do so by emitting a photon of light. Photons are particles with energy but no mass. Their energy is directly proportional to the frequency of the light (remember: $E=hf$). The photons emitted precisely match the quantum energy difference between the excited state and the ground state. For different elements the spacing between the ground state and the higher energy levels is different. This gives rise to a way to uniquely identify elements based on their spectrum. A spectrum is the scientific name for a rainbow: light broken into the different wavelengths that make it up.

Pre lab Questions:

What color of light is the lowest in energy?

What color of light is the highest in energy?

What color of light has the highest frequency?

What color of light has the lowest frequency?

How are electrons "excited"?

What does it mean when the electrons are "excited"?

Name: ______________________________ Date: ________

Period: __________

Lab: Flame Tests

<u>Discussion:</u> When atoms or ions in the ground state are heated to high temperatures, some electrons may absorb enough energy to allow them to "jump" to higher energy levels. These excited state electrons are unstable and they will "fall" back to their normal positions of lower energy. As the electrons return to the ground state, the energy that was absorbed is emitted in the form of electromagnetic energy. Some of this energy may be in the form of visible light.

<u>I. Objective:</u> To observe the characteristic colors produced by certain metallic ions when vaporized in a flame; and to identify an unknown metallic ion by means of its flame test.

<u>II. Materials and Equipment:</u>

1. wooden splints
2. 7 different ions solutions
3. Bunsen burner
4. Beaker with

<u>III. Procedure:</u>

1. Put on safety goggles.
2. Fill a beaker half way with water to depose of used wooden splints.
3. Set up Bunsen burner. Take NiCr wire and dip into
4. ~~Take a wooden split of~~ the metallic ion solutions insert into flame. Record the color produced by the ion.
5. Repeat for all ions.
6. When you have finished testing your eight metallic ion solutions, obtain a sample of an unknown solution. Perform a flame test and identify the metallic ions present by the color of the flame.
7. Clean up your Lab bench.

① what is an ion?

② How can electrons move to higher energy levels?

<u>IV. Data:</u>

Metallic Ion	Color in Flame
Mg^{+2}	
Na^{+1}	
K^{+1}	
Li^{+1}	
Ca^{+2}	
Sr^{+2}	
Cu^{+2}	
Ba^{+2}	
Unknown	

The emission of color, is this endothermic or exothermic? Explain your answer.

V. Conclusion Questions:

1. What inaccuracies may be involved in using flame tests for identification purposes? Explain at least 2 plausible inaccuracies.

2. The characteristic bright-line spectrum (color) of an element is produced when
   A. electrons are emitted by the nucleus as beta particles
   B. electrons move to higher energy levels
   C. electrons are gained by an atom
   D. electrons fall back to lower energy levels

3. Define the following terms:

   A. Ground state

   B. Excited state

   C. Quanta

Conclusion- Explain what happened during the lab. Where have you seen these ions before?