Chemistry: Flame test Lab

Names:

Period:

Objective

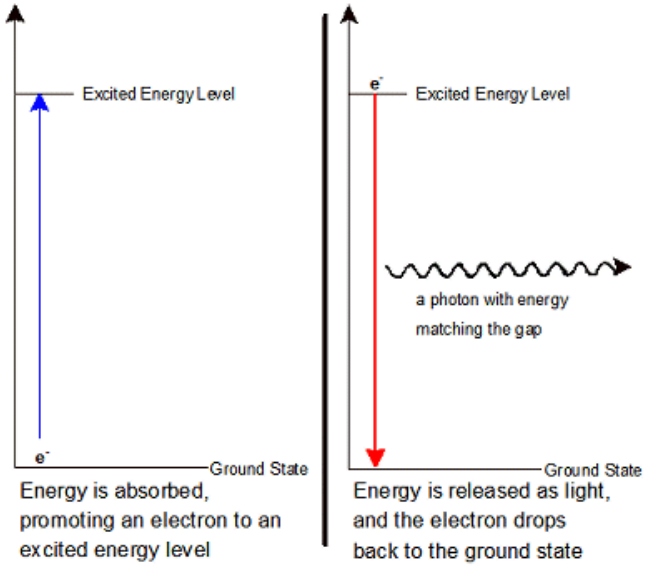
In this lab students will learn about atomic energy levels, emission spectroscopy, and flame tests for element identification.

Background

Energy levels are specific regions around a nucleus where electrons reside, based on defined energies. When an electron is at the lowest possible energy level it said to be in the **ground state.** Electrons can be promoted to a higher-energy electron level by absorbing a photon of just the right amount of energy (quantum) to move it from one energy level to an outer energy level. Atoms can also be heated or energized with electricity which allows electrons to gain energy. An electron in a higher-energy level is said to be in an **excited state**.

Electrons in excited states almost immediately fall back to lower energy states. When electrons lose their energy they do so by emitting a photon (quantum). Photons (quanta) are the smallest unit of electromagnetic radiation. Their energy is directly proportional to the frequency of the light (remember: E = hν). The photons emitted precisely match the energy difference between the excited state and the ground state.

The light produced by energized atoms in the gaseous state can be separated into specific spectra. To observe the spectrum requires the use of a prism, diffraction grating, or spectroscope. Another way to identify specific elements, other than looking at the spectra, is to identify them by their flame test. Salts are ionic compounds which include a metal ion and a non-metal ion. Sodium chloride (NaCl) is the most familiar example of a salt but others include calcium chloride ($CaCl_2$) and copper(II) chloride ($CuCl_2$). In flame tests salts that are dissolved in water are evaporated using a hot flame. In the flame the metal atoms become excited and produce their characteristic spectrum of light. However, since the observer does not use a spectroscope only one color is observed. It turns out that many metals produce a unique single color under these conditions. This ability of metal atoms to produce these colors is used to create various colors in fireworks.



Materials

7 small test tubes -- inoculation loop -- Bunsen burner -- distilled water -- metal salts solutions -- unknown metal salt solution

Safety

- $CuCl_2$ (Copper(II) Chloride) is highly toxic by ingestion; avoid contact with eyes, skin and mucus membranes.
- LiCl (Lithium Chloride) is moderately toxic by ingestion; avoid contact with eyes, skin and mucus membranes.

Procedure

1. Label all nine of your test tubes, one for the water rinse and the remainder for each salt.
2. Collect a small sample (about 1 mL) of each of the known metal salt solutions.
3. Obtain an inoculation loop for your group.
4. Clean the inoculation loop by swirling it gently in the distilled water. Then, once you light the burner, heat the loop until it glows red hot. This step removes any ions clinging to the loop from previous experiments.
5. Light and adjust your Bunsen burner. Be sure to clean your loop carefully. **Do not leave the loop in the flame too long as it can cause the loop to degrade and break.**
6. To do a flame test with each metal salt get a film of the solution of a salt inside the loop and bring it into the hottest part of the flame. If this produces poor color then try the edge of the burner flame. Repeat the dip into the salt solution as often as necessary to see the flame test color. Be sure not to over-heat the loop.

7. Carefully note the color of each metal salt when it is put in the flame. Use the chart below to estimate the approximate wavelength of the color you see. Use the Representative Wavelength values. Record all data in the table you made earlier.
8. Clean the inoculation loop using distilled water and heat each time you change from one metal salt to another. Failing to do so will result in mixed flame test colors. Again, do not over heat the loop.
9. Perform a flame test for the unknown metal salt solution and record the appropriate data in the data table.

Color	**Representative Wavelength (nm)**	**Wavelength Region (nm)**
Violet	420	400 - 440
Blue	455	440 - 470
Blue-green	480	470 - 490
Green	525	490 - 560
Yellow-green	565	560 - 570
Yellow	580	570 - 585
Orange	620	585 - 630
Red	660	630 - 700

Chemistry: Flame lab data sheet

Names:
Period

Data Table:

Name of salt	Formula of salt	Metal Ion	Color of Flame	Approx. Wavelength (nm)	Approx. Wavelength (m)

Questions

1. Why do different metals have different characteristic flame test colors?

2. Most salts contain a metal and a non-metal. Look at the compounds we tested and determine whether it is the metal or the non-metal that is responsible for the color produced in the flame test for that salt. How can you be sure your answer is correct?

3. What colors did the unknown produce in the flame? What metal ion is present in the unknown?

4. Why do the chemicals have to be heated in the flame before the colored light is emitted?

5. Could flame tests be useful in determining identities of metals in a mixture of two or more salts? If so, what problems might arise? If not, why not? *Explain* your answer.

6. Which method is better for precisely identifying elements: examining the full spectrum using a spectroscope or using a flame test? Use your experience in the lab with both of these methods in answering this question. Justify your answer.