Chemistry I
Flame Test Lab

**Introduction:** In this lab you will explore the different colors and spectra that are produced when an element’s electrons are excited and then return to the ground state. You will use the colors and spectra to identify the different substances and to determine wavelength, frequency, and energy of the photon emitted by several elements.

**Safety Precautions:**

You will be using heat in the form of an open flame from the Bunsen burner. You will be dipping Q-tips into an alcohol-based solution. Do NOT touch the top of the splint directly on top of the burner. DO extinguish the Q-tip in the beaker of water. Do NOT throw it in the sink. DO be as descriptive as possible with the color you observe as you will have to assign wavelengths afterwards. DO tie back your long hair.

**Pre-lab Questions:**

1. Define the terms emission and absorption?
2. What are the units and variables for frequency, wavelength and energy?
3. What is a photon?
4. Research **the colors for three of the following groups** of cations when exposed to flame:
   a. potassium, rubidium, cesium compounds   g. antimony and ammonium compounds
   b. copper chloride, lead, arsenic, selenium   h. zinc
   c. copper bromide   i. sodium compounds
   d. thallium, tellurium   j. lithium
   e. barium, molybdenum, borate compounds   k. strontium
   f. phosphates with sulfuric acid   l. calcium
5. What is the difference between copper bromide and copper chloride solutions when exposed to the flame test?

**Procedure:**

1. Be sure that your burner is adjusted to provide a sharp cone that is not too high. Also note that your flame should be as colorless as possible.
2. Obtain a set of salt/ethanol solutions and a few Q-tips. Be careful not to mix up the solutions.
3. Test a solution of pure ethanol. This will serve as your control.
4. Choose a cation solution to test by placing the Q-tip in the flame. Note the color of the flame.
5. Continue with the remaining known cation solutions. The order of these solutions is not specific.
6. Once you have observed all the known ions, you will observe the three unknown cation solutions. Write the code of the unknown in your data table. These unknown were made from different compounds than the first set but contain the same ions.
7. Take two different Q-tips and dip them into two different solutions (your pick). Put these two Q-tips into the solution at the same time. Write your observations in the space provided in the Data section.
8. Once you have completed the color column in your data table, shut off your burner and throw all of the Q-tips into the trash can. Rinse out the waste beaker and return to the drying racks.
9. Clean up your lab area.
10. Use the visible light spectrum in your textbook, or on the internet, to assign wavelengths to all colors that you observed. Make an assumption as to what wavelength is being observed.
11. Use the wavelength to calculate the frequency and the energy of one photon of each of these ions.
### Experimental Data and Results:

<table>
<thead>
<tr>
<th>Cation Solution</th>
<th>Color of flame (Be descriptive)</th>
<th>λ (m)</th>
<th>ν (Hz)</th>
<th>E (Joules)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca&lt;sup&gt;2+&lt;/sup&gt;</td>
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<td>Cu&lt;sup&gt;2+&lt;/sup&gt;</td>
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<td>Li&lt;sup&gt;+&lt;/sup&gt;</td>
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<td>Unknown #1</td>
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<tr>
<td>Unknown #2</td>
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<tr>
<td>Unknown #3</td>
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Observations of two Q-tips in the flame:

**Identity of Cation Unknowns:**

#1 _____________ #2 _____________ #3 _____________

Unknown Codes:  #1 _____________ #2 _____________ #3 _____________

**Calculations:** On a separate sheet of paper, show how you calculated both the frequency and the energy for calcium and copper.

**Post-Lab Questions:** Answer in complete sentences on a separate sheet of paper.

1. Explain subatomically (in terms of the particles found in atoms) why you are observing luminescence (colored light released) when you hold the soaked Q-tip in the flame.
2. Explain why different elements produced different colored flames.
3. What colors did you see when you held two elements in the flame at once. Explain why this would be similar or different to their individual effects.
4. If you wanted to produce a fireworks display where one rocket would produce first a faint-green, then violet, and then yellow colored burst, what three chemical salts would you use in your rocket?
5. Which of the elements that you observed produced the light with the most energy? What does this tell you about its movement with respect to the nucleus?
6. Identify at least three shortcomings of using a flame test to identify a compound. Suggest alternatives (hypothesize) to correct these shortcomings and to correctly identify the compound.