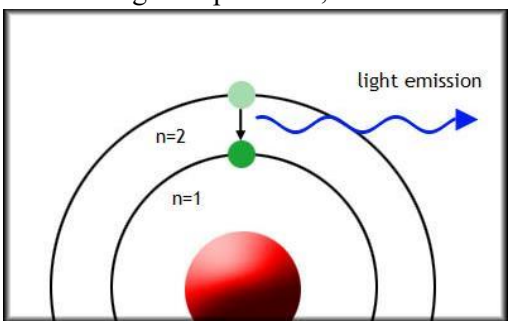
Honors Chemistry Lab #7/8: Flame Tests and Light Inquiry

Background information:

The normal electron configuration of atoms or ions of an element is known as the "ground state." In this most stable energy state, all electrons are in the lowest energy levels available. 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. In this case the electrons were able to get to a higher energy level by absorbing heat energy from the Bunsen burner flame. The element is then said to be in the "excited state." This excited configuration is unstable, and the electrons "fall" back to their normal positions of lower energy (ground state). As the electrons return to their normal levels, 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. The color of this light can be used as a means of identifying the elements involved. Since each atom has a unique arrangement of electrons, each gives a unique color. Such analysis is known as a flame test. To do a flame test on a metallic element, the metal is first dissolved in a solution and the solution is then held in the hot, blue flame of a Bunsen burner. This test works well for metal ions. Many metallic ions exhibit characteristic colors when vaporized in the burner flame. The energy (E) of the emitted by a photon determines the color of light observed in the flame. View the electromagnetic spectrum to see that photons of red light have low energies, while photons of blue light have high energies.



Pre-Lab: You will be using a spectroscope in this lab. You will need to read the entire spectroscope supplement (clickable) prior to conducting the lab. I will then conduct a series of demonstrations for you with various element spectrum tubes. These can be visualized as a chemical fingerprint through the spectroscope. You will need to record your observations for each element I show you and the corresponding wavelength, as viewed through the spectral scope. Lastly, explain why and how these elements exhibit these chemical fingerprints.

Part 1: Flame Tests:

1. Bunsen burners will be lit, and the lights will be off for this part of the lab. Please obtain your PPE and ensure all benches and walkways are clear.
2. Take one of the Q-tips/splinter on table and dip it into the salts in the vials/beakers. Read the labels carefully. Hold the Q-tip/splinter into the nonluminous part of the flame of your Bunsen burner. View the color through a spectroscope and document the estimated wavelength. Do not hold the Q-tip/splinter into the flame for too long or it will catch on fire. Record your observation in your data table.
3. Repeat this process for all substances on the lab benches. Be sure to record your results in a data table. To test for your unknowns, use the vial marked as the unknowns (U1-U4) and the Q-tips/splinter that are placed near your lab station.
4. Wash your hands thoroughly.

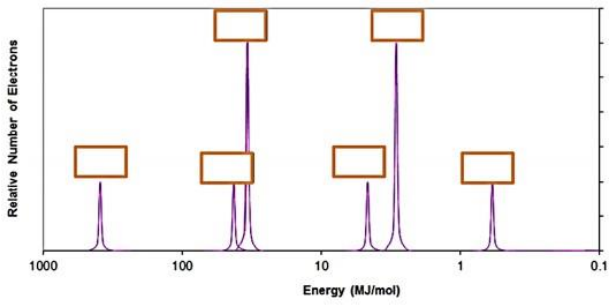
Part 1 Post-Lab:

Q1. How do electrons give off light? Explain thoroughly what happens.

Q2. Why do different elements have different flame test colors?

Q3. Attempt to identify the unknown solutions and briefly justify your identification for each

Q4. Review you notes from Atomic Theory 11 on photoelectron spectroscopy (PES). Identify the subshells and number of electrons for the six peaks represented on the spectrum below. Identify the element.



Part 2: Light Inquiry

Niels Bohr discovered that the energy levels for electrons were quantized, meaning that only certain, specific energy levels were possible. How does an electron move between energy levels? By gaining the right amount of energy, an electron can move, or undergo a transition, from one energy level to the next. We can explain the emission of the light by atoms to give the line spectrum like this: 1) An electron in a high energy level (excited state) undergoes a transition to a low energy level (ground state). 2) In this process, the electron loses energy, which is emitted as a photon (a particle which behaves like a wave. 3) The energy difference between the high energy level and the low energy level is related to the frequency (color) of the emitted light. In part two of this lab, you will explore electron movement, quantization of electrons, and light through the process of inquiry.

Activity 1: Obtain two ~6 cm pieces of clear scotch tape. Fold old back about a 0.5 cm section to make a little tab. Stick the two pieces on a student desk side by side. Vigorously rub and scrape the two pieces of tape. Slowly remove both pieces of tape. Now slowly move the adhesive sides of the tape towards each other. Experiment with various movements of the tape. Repeat if necessary.

Q1. Thoroughly describe your observations. Write an explanation for this phenomenon and be sure to include the movement of electrons in your answer. How could such observations have led to the discovery of sub-atomic particles?

Activity 2: Obtain and inflate a balloon. Next, turn on a fine stream of water at your lab station. Vigorously rub the balloon on your hair. Now hold the balloon near the stream of water. Experiment with various movements of the balloon.

Q2. Draw a schematic diagram that illustrates this phenomenon. Be sure to consider water's polar structure and the orientation of the electrons. How might these observations have contributed to the early research done by scientists like Thomson and Bohr?

Find another group with a balloon and experiment with various configurations of the two balloons. Try holding the balloon to the wall.

Q3. Describe what happened with another group's balloon. What about the wall?

Activity 3: Obtain an electroscope, which is an apparatus used to illustrate electrostatic principles of charging and charge interactions. Experiment with different combinations of cloth and rod materials (or even your balloon) to explore the movement of charge.

Q4. After completing this activity, describe your observations and attempt to explain these phenomena in terms of Coulomb's Law. If needed, review your notes from Atomic Theory 8 for a refresher on the law.

Activity 4: Obtain two wintergreen Lifesavers per group, so that each student has one. The following activity will be conducted in a dark room per teacher instructions.

Q5. Describe your observations. Draw a schematic that shows the movement of electrons and photons. Use the terms light emittance, light absorption, and ground state in your answer. These terms were discussed in a recent podcast.