**Introduction:**People become chemists for many reasons yet the primary draw seems to be the flash and bang. The charm of color changes, rising bubbles and sudden sparks. Then, there are the people that read the following passages and said to themselves “*I want to do THAT.”*

*“Harry took the wand. He felt a sudden warmth in his fingers. He raised the wand above his head, brought it swishing down through the dusty air and a stream of red and gold sparks shot from the end like a firework, throwing dancing spots of light onto the walls.” (Book 1, P 85)*

*“One by one, the Beauxbatons students stepped across the Age Line and dropped their slips of parchment into the blue-white flames. As each name entered the fire, it turned briefly red and emitted sparks.” (Book 4, P 262)*

*“He took a pinch of glittering powder out of the flowerpot, stepped up to the fire, and threw the powder into the flames. With a roar, the fire turned emerald green and rose higher than Fred, who stepped right into it, shouted ‘Diagon Alley!’ and vanished.” (Book 2, P 47)*

*“There was a soft, crackling noise, and a shivering light filled the compartment. Professor Lupin appeared to be holding a handful of flames.” (Book 2, P 83)*

What gives flames and sparks their colors? What makes the Goblet of Fire burn blue? Floo Powder turn emerald green? What do charms and spells consist of? *Magic* some will say. But as a muggle, the answer lies is *chemistry*.

Colored flames and sparks, like those found in fireworks, are produced by the energy released by the atoms when their electrons move from higher to lower energy levels. When elements are heated to high temperatures, they move from a ground state to an excited state. In an ***excited state***, the electrons are in higher energy levels than usual. Atoms do not stay excited for long, their electrons soon fall back to their normal (lower) energy levels, known as the ***ground state***, releasing the previously absorbed energy as a small, discreet package of energy called a ***photon***. When this photon is emitted, it emits a wavelength. When that wavelength falls into the visible portion of the electromagnetic spectrum, we see it as a specific color. The particular colors are dependent on the atoms that are excited, because each element has its own electron arrangement; therefore, as their electrons fall back to their ground state they release energy in distinctive patterns known as an ***emission spectrum***. The observed colors, or spectrum, of the substance is caused by the set of visible wavelengths of light emitted. Since the element emits a unique set of wavelengths, the emission spectra can be used to identify many elements.

One method used to determine the emission spectrum of a substance is called the ***flame test***. Using this method, a small sample of a substance is heated and the characteristic glow of that substance is observed. In this experiment you will perform a flame test on several ***salts*** (they contain a metal bonded to a nonmetal). These salts have first been dissolved in water. Based on your observations, you will develop a reference table which lists the flame color of each metal atom. You will then use this data to identify the famous flames in Harry Potter, our unknown samples. By comparing your observations to the data in your reference table, you will be able to identify the metallic atom present in the unknowns.   
 **Objectives:**

1. To observe and record the emission spectrum of several salts
2. To identify unknown metallic salts
3. To evaluate the flame test as a tool for atom identification

**Equipment and Materials:**

* Test tube rack
* Bunsen Burner
* Inoculating Loop
* Goggles
* Test tubes containing the following solutions:
  + Barium Chloride
  + Sodium Nitrate
  + Calcium Chloride
  + Strontium Nitrate
  + Potassium Nitrate
  + Lithium Nitrate
  + Copper Nitrate
  + Boron Chloride

**Safety:**

* The compounds used in this lab will be irritating to the skin. Avoid contact with eyes. Wash thoroughly with soap and water if any solution comes in contact with your skin.
* Do not leave a lit Bunsen burner unattended. Ensure that you or your lab partner are/is monitoring a lit Bunsen burner by staying at your lab station. Do not turn your back on a lit Bunsen burner.
* Do not touch the end of the wire inoculating loop. This wire gets extremely hot and can cause severe burns. A hot wire can appear no different than a cool wire.

**Procedure:**

1. Put on safety goggles.
2. Use the striker to light the Bunsen burner. Adjust so that the flame is a small blue cone.
3. Flame the inoculating loop until it is bright red to remove any coating on it.
4. Cool the wire, then dip it into the solution (be careful not to cross-contaminate the loops or your colors will not be accurate).
5. Carefully remove the wire from the solution, trying to keep some of the solution in the loops for a better flame test (think about it like you are blowing bubbles as a kid).
6. Immediately put the wire loop into the edge of the flame. Record the overall **color**, **brightness** [bright, average, faint] and **duration** [short, medium, long] of the flame visible to the naked eye.
7. When you are finished with the flame test, turn off the gas jet at your station. Wipe down the table with a damp paper towel.
8. Wash your hands with soap and water.
9. \*After observing the color of each of the known solutions, view the unknowns in clips in Google Classroom.

**Pre-Lab Questions:** *Read the ENTIRE LAB and then answer the following questions. Remember to respond in* ***BLUE.***

1. Briefly describe the difference between the ground state and excited state.
2. How fast do all Electromagnetic Spectrum waves travel?
3. When we excite atoms, they give off certain wavelengths of light that we can see. Are these visible waves the only types of waves given off? Explain your answer.

**Observations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Compound Tested** | **Flame Color**  [be specific] | **Brightness**  [bright, average, faint] | **Duration**  [short, medium, long] |
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**Unknown Identification:**

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| --- | --- | --- |
| **Magic to Identify** | **Color** | **Most Likely Muggle Metal Atom:** |
| Clip #1. Floo Powder Flames |  |  |
| Clip #2. Spell from Dumbledore’s wand when battling Voldemort |  |  |
| Clip #2. Spell when Voldemort conjures a fire snake while battling Dumbledore |  |  |
| Clip #3. The charms used to protect Hogwarts from Voldemort |  |  |
| Clip #4. The Goblet of Fire *before* the names are called |  |  |
| Clip #4. The Goblet of Fire *after* the names are called |  |  |
| Clip #5. Spell from Harry’s wand when battling Voldemort |  |  |

**Post-Lab Questions:** *Use evidence from your lab and your unknowns to answer. Remember to respond in* ***BLUE.***

1. Which metallic ion emitted the light with the greatest energy? (See EM Spectrum Chart)
2. Which metallic ion emitted the light with the least energy? (See EM Spectrum Chart)
3. Consider the compounds used in this lab. How can you be sure the color of the flame is not due to the negative ion?
4. What is the frequency range for the colors you observed? (See EM Spectrum Chart)
5. What color or colors would you expect the following compounds to produce:   
   Potassium chloride:   
   Barium Fluoride:   
   Barium Phosphate:   
   Lithium Chloride:
6. A firework contains copper chloride and strontium sulfate. What two colors will this explosion produce?
7. Rolled newspaper and pinecones were soaked in a solution and then allowed to dry. When the newspaper logs and pinecones were burned in a fireplace, the flame was tinged with blue-ish green and crimson. What metallic ions were present?
8. Is the flame test a good methods for identifying the types of metallic ions in a solution? Why or why not? Use complete sentences and do not abbreviate words.

**Extension:** Go find one of your favorite clips on YouTube (must be school appropriate) that features colored flames/sparks/fireworks. Copy and paste the link to the clip below and identify which metal atom is most likely to have caused it.