**Flame Test Lab**

* **Question:** “How does light reveal the behavior of electrons in an atom?”
* **Introduction:** By placing atoms of a metal into a flame, electrons can be induced to jump to an excited energy state, a **quantum** jump. They then return to their ground state by emitting a **photon** of light. The amount of energy in the **photon** determines its color. Remember that **ROY G. BIV** gives us colors of **Visible light** (**Balmer series**) in order from least energetic to most. (Red, Orange, Yellow, Green, Blue, Indigo, Violet). Photons of energy can be emitted for other transitions outside the visible range, however we will not see them in this lab. (**Ultraviolet - Lyman series**, **Infrared – Paschen series**).

The arrangement of electrons in an atom determines the sizes of the quantum jumps and thus the energies and colors of the collection of photons emitted, known as **emission spectrum.** This spectrum of an element is as individual as a fingerprint. Astronomers, for example, can analyze the various spectra in the light coming from stars and determine what elements are present millions of miles away!!

One method used to demonstrate the emission spectrum of a substance is the flame test. Using this method, a small amount of a substance is heated and the characteristic glow of the substance is observed. In this experiment you will perform a flame test on several metallic salts. Based on your observations, you will develop a reference table which lists the flame color for each metal ion. You will then perform a flame test on an unknown substance. By comparing your observations to the data in your reference table, you will be able to identify the metal ion in the unknown substance.

|  |  |  |
| --- | --- | --- |
| **Metal Ion** | **Flame Color** | **Estimated Wavelength (nm)** |
| barium, Ba+ |  |  |
| calcium, Ca+ |  |  |
| copper, Cu2+ |  |  |
| potassium, K+ |  |  |
| sodium, Na+ |  |  |
| strontium, Sr2+ |  |  |
| lithium, Li+ |  |  |
| *unknown #­­****\_\_\_*** |  | **Unknown identity \_\_\_\_\_\_\_\_\_\_** |
| Sodium & Potassium, Na+ + K+ |  |
|  | **Flame Color with Cobalt Glass** |
| Sodium & Potassium, Na+ + K+ |  |
| sodium, Na+ |  |
| potassium, K+ |  |

* **Safety:** Goggles, gloves, aprons and closed-toed shoes are required. Many metal ions are toxic. Assume all that you are working with are toxic. Follow all safety procedures for the laboratory burner. Be careful with the cobalt glass as the edges may be sharp.

**Data Table**

*(Copy into your lab notebook before lab day.)*

* **Procedure:** *(*✓ *each of the steps as you complete them.)*
* 1. Fill a small beaker half way with water and keep in close proximity to your Bunsen burner. Students will utilize this water to extinguish the wooden splints in the event they begin to burn.
* 2. You have at your lab station a test tube rack holding several test tubes containing metal ion solutions. Place one wooden splint into each solution except for sodium, potassium and the sodium & potassium mixture – in these place two (2) wooden splints.
* 3. Allow splints to soak for at least one minute to ensure proper adsorption of metal ions.
* 4. Write down your unknown # on your data table.
* 5. Light your Bunsen burner.
* 6. You are now ready to test your metal ions. Place the barium ion-soaked wooden splint into the flame. Your goal is to see the color of the metal ion flame, not catch the wooden splint on fire.
* 7. Observe the color of the flame and estimate the wavelength using the Visible Light Spectrum Card.
* 8. Record the color and estimated wavelength on your data table.
* 9. When finished, place the wooden splint into the beaker of water.
* 10. Repeat steps 6 -9 for the remaining solutions. Use only ONE of the wooden splints in the solutions that contain 2 splints at this time.
* 11. When finished with your unknown, **identify the metal ion in your unknown.**
* 12. You should still have a wooden splint in the sodium, potassium and the sodium & potassium mixture. Repeat the procedure but observe the color by looking through a piece of cobalt glass.
* 13. If needed, repeat any test with a new, clean wooden splint.
* 14. When finished, turn off your Bunsen burner. Throw the used wooden splints into the trash. Dump the beaker water into the sink. Sponge down your lab bench and then wash your hands.
* **Calculations:**

Using the *Speed of Light Equation,* c = λν , and your estimated wavelength calculate the **frequency** of each of your flame colors for barium, calcium, copper, potassium, sodium, strontium & lithium.

* **Conclusion:**

“*Using the Speed of Light Equation, c = λν , and the estimated wavelength, the frequency of each of the flame colors was calculated to be: barium \_\_\_\_\_ calcium\_\_\_\_\_ copper\_\_\_\_\_ potassium \_\_\_\_\_ sodium \_\_\_\_\_ strontium \_\_\_\_\_ lithium \_\_\_\_\_.”*

EXTRA CREDIT: What is the purpose of the cobalt blue glass? Why is only the purple color of the potassium seen through the cobalt glass?