Flame Test Laboratory Demonstration

Purpose:

In this lab activity, students observe the color produced when different substances are placed in a flame and are taught that each element produces its own distinct spectrum of radiation emission.

Key Concepts:

Ionization
Plasma Formation
Light Emission
Conservation of Energy

Materials & Equipment

Apron or lab coat
Flame Test Lab Kit:

- Six thin wire loops labeled NaCl, LiCl, $SrCl_2$, KCl, $CuCl_2$, and Boric Acid (H_3BO_3); clean the loops in advance with water and heat them with the propane torch. *
- Six 25 ml capacity test tubes (15 cm x 2 cm)
- One test tube rack
- Small bottles of Sodium Chloride (NaCl), Lithium Chloride (LiCl), Strontium Chloride ($SrCl_2$), Potassium Chloride (KCl), Cupric Chloride ($CuCl_2$), and Boric Acid (H_3BO_3).
- Eyedropper

Small propane tank with nozzle
Spark striker, match or butane lighter

Note: It is very important to avoid cross contamination of the compounds, so use only the loop marked for the specific compound with that compound.

Safety Precautions:

Use eye protection, gloves, and apron.
Disposal: Wash test tubes throughly with water.

Procedure:

1. With safety goggles on, place the propane tank on a metal table, open the valve and light the flame.

2. Tell the students that you will test different compounds, each containing a different element.

3. Pour some **sodium chloride** crystals from **bottle A** into a test tube to about 1 cm from the bottom, add 5 drops of water and shake the test tube to form a slurry.

4 Take the wire loop marked **NaCl**, insert it into the test tube containing the salt slurry, and place it into the flame. Tell the students that the flame temperature is 1,225 ºC, causing the salt to melt and ionize. Ask the students to describe the color of the flame.

5. Repeat the demonstration with lithium chloride, strontium chloride, potassium chloride, cupric chloride, and boric acid using the wire loop marked for each compound. Ask the students to describe the color of the flame after each test. *(Note: lithium chloride is deliquescent, so it may exist as a concentrated aqueous solution, but it will work well*).

6. Have the students write the symbol of each element and the color that it produced in the flame.

Flame Tests

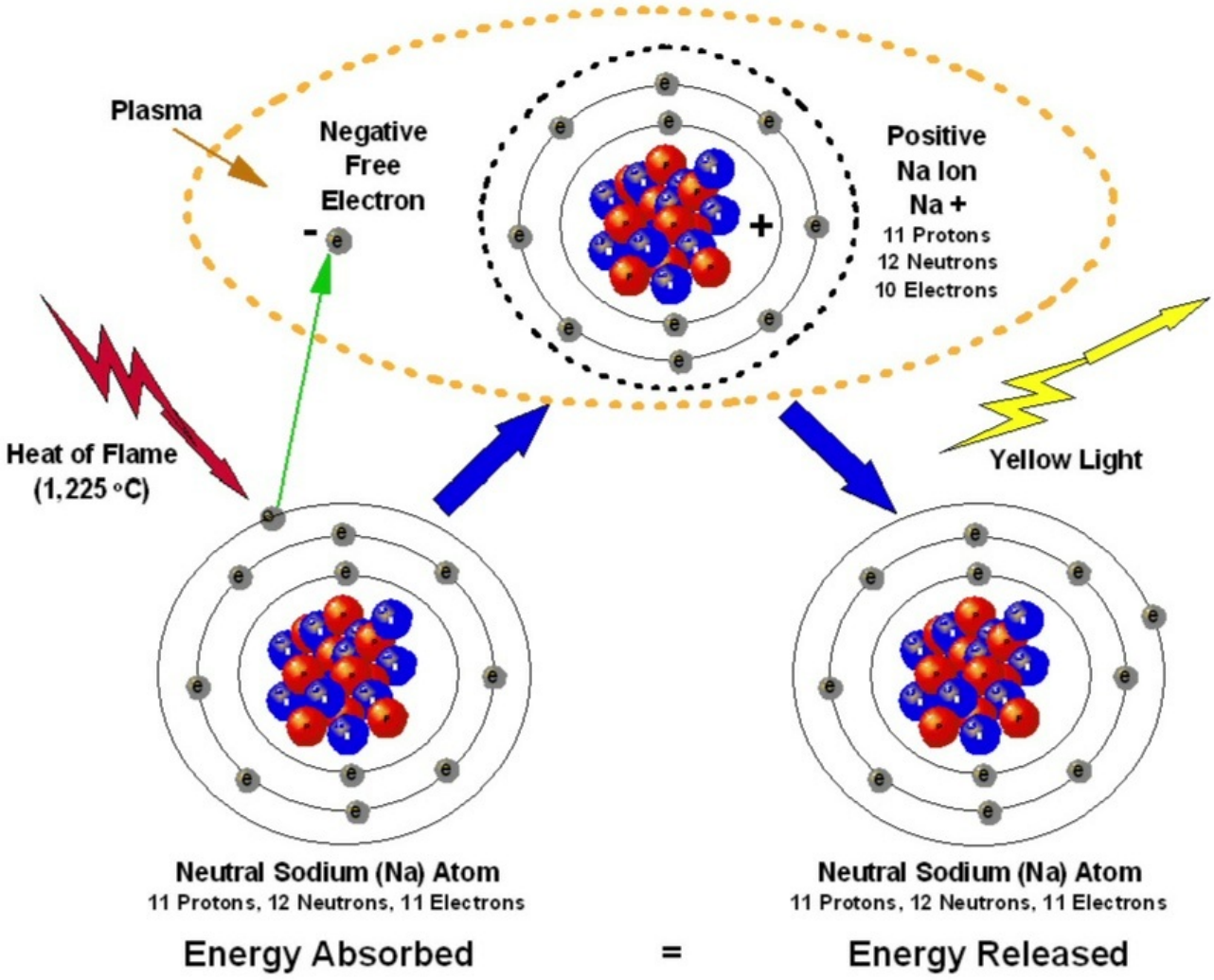
	Sodium	Lithium	Strontium	Potassium	Copper	Boron
Symbol:	Na	Li	Sr	K	Cu	B
Color:	Yellow	Red	Red-Orange	Pale Violet	Blue-Green	Green

Discussion:

Explain what happens when an element is burned in a flame using sodium as an example. The high heat of the flame vaporizes the material and the heat energy causes the sodium atoms to become ionized. This means the electrons are separated from the sodium atoms to produce positive sodium ions and negative electrons in the gaseous state. ***This ionized gas is called a plasma***.

Common examples of this concept are the street lights that we see at night throughout the city. Students will recognize their yellow color. Ask if they can guess the element used in these lights. Explain that it is a glass bulb containing sodium vapor. When an electrical current is passed through the gas, it produces a plasma that glows with a bright yellow light.

The sodium ions recombine with the electrons to form neutral sodium atoms and the heat energy that was absorbed by the atom when it was ionized is then released in the form of light energy. This follows the law of conservation of energy-- ***the heat energy absorbed is equal to the light energy released***. The process takes place very fast -- millions of times per second. The diagram below may be helpful.



Students should be taught that the atom of each element has a unique structure so that the amount of energy absorbed to produce the plasma is different for each element. Thus, the energy released will be different for each element. This explains why sodium produces yellow light, lithium gives red light, strontium produces orange light, and copper emits blue-green light. Scientists use this concept to identify the elements in a sample with very sensitive instruments called spectrometers. Many students are familiar with the televison show CSI where police scientists sometimes show a graph on a screen with various peaks. The police can identify the material by comparing these graphs with the graphs from known materials. The graph below may be helpful.