**Flame Tests**

**Introduction**

Electrons reside in various energy levels and orbitals. The locations of these electrons are defined by a set of numbers called "quantum numbers." Electron configurations are used to list all the energy levels and orbitals that electrons occupy simultaneously in any given atom. When an element is subjected to high temperatures, some of these electrons become "excited"... they occupy higher energy orbitals. As the electrons fall back to their "ground state" (their normal positioning), the loss of energy can be emitted as light. The color of the light is determined by the amount of energy that is released from such a transition. Visible light increases in energy from red to blue. The mnemonic ROY G BIV is often used to aid students as to the colors in order of increasing energy: red, orange, yellow, green, blue, indigo, and violet. Keep in mind that some energies may be lower than red (infrared), or higher then violet (ultraviolet), and not in the visible spectrum. Therefore, you may not be able to see the energy released from all elements. Since each element has a different number of electrons, each transition from excited state to ground state will be different. This physical property is often used to identify unknown metals. In this lab, we will concentrate on the identification of metals that emit light in the visible spectrum.

**Procedure**

Put on your safety glasses or goggles.

1. Fill your test tube rack with 5 or 6 clean, small test tubes from your lab drawer. Obtain 10-15 drops of a solution in the first test tube. Be sure to label the tube as to its contents. Do the same for the remaining test tubes, using a different solution for each. **Be sure to use a clean dropper each time.** Using the same dropper in a different solution, without cleaning, will contaminate the entire bottle of solution! (Don't forget to put the lid back on the bottle!)

2. Pour 15 mL of 6M hydrochloric acid into a small beaker. (CAUTION: Hydrochloric acid can cause burns. If you spill some acid, it should be neutralized with baking soda before being cleaned up. If your skin comes in contact with the acid, wash the area immediately with lots of cold water, and spray a baking soda solution on the area as well.)

3. Light your Bunsen burner by doing the following: Turn on the gas valve (blue) by turning the valve so that it is perpendicular to the gas pipe. Adjust the gas control (on the very bottom) on the burner so that you can hear a stream of gas flowing through the burner. Pass a match over the top of the burner. Adjust the gas flow so that the flame is a few inches tall. Not enough gas will result in the flame blowing out. Too much gas will result in the flame only lighting while the match is held over the flame, and only the top part of the flame will light. Adjust the air control (the open holes toward the bottom of the burner) so that you get two cones in the flame: a light blue flame inside a dark blue flame. The hottest portion of the flame is near the top point of the inner light blue cone.

4. Obtain a flame test loop from the counter. Clean it by dipping the loop end into the beaker of 6M hydrochloric acid, and heating the loop in the flame of a burner. When placing the loop into the flame, hold the loop by the handle, and tilt the flame tester at an angle. A clean loop should not change the color of the flame. Repeat if necessary.

5. Dip the clean loop into one of the test tubes containing a metal salt solution. Place the loop in the burner flame. Observe and record the color of light produced. Repeat as necessary to accurately determine the color of the light.

6. Repeat the cleaning and burning procedure on each of the remaining solutions.

7. Dip your flame test loop in a few crystals of solid sodium chloride, and test the solid in the flame as before.

8. Wash out the test tubes, and obtain and test any remaining solutions not obtained in step 1. Be sure to test the unknown solution(s) also!

9. After all solutions have been tested, clean the loop one last time. Pour any remaining solutions down the drain. Return your flame test loop to the counter. Do not store it in your lab drawer.

10. Turn the burner off by closing the gas valve first (all the way left or right). Then close the gas control on the burner. Use caution when picking up the hot burner!

11. Clean up all equipment and your area, as described on your cleaning checklist on the back of the equipment list in your drawer. Wash your hands, and return your safety glasses to the storage cabinet. MAKE SURE THE GAS IS TURNED OFF. Return to the classroom.

**Flame test observations**

|  |  |
| --- | --- |
| **Metal salt solution** | **Color of flame** |
| Barium chloride |  |
| Calcium chloride |  |
| Copper II (cupric) chloride |  |
| Lithium nitrate |  |
| Potassium chloride |  |
| Strontium nitrate |  |
| Manganese chloride |  |
| Sodium chloride |  |
| Sodium nitrate |  |
| Sodium nitrite |  |
| Sodium chloride solid |  |
| Unknown "B" |  |
| Unknown "A" |  |

**Analysis questions**

1. Compare the results of unknown "A" with the results from the known solutions. What was the name of the chemical in unknown "A"?

2. What was the name of the chemical in unknown "B"?

3. Did the anion (chloride, nitrate, nitrite) make any difference in the sodium salt solutions?

4. Was solid NaCl any different than in solution?

5. List the metal ions tested in this lab from lowest energy to highest energy.