Electronic Transitions

**HIGH SCHOOL**

**Green Chemistry & Sustainable Science**

*Written by Helene Nameth and Carolyn Wojicik, 2010 Summer Workshop Participants*

**Teacher Background Information:**

This lesson replaces traditionally used flame test activities which and used nitrate salts of sodium, potassium, lithium, strontium, calcium, barium and copper (II) as well as sodium chloride. The redesigned lab includes acetate salts of sodium chloride, sodium acetate, and potassium acetate.

**Safety Information:**

* All three solutions are considered minor skin irritants
* If they come in contact with eyes, flush for 15 minutes

**Educational Goal:** Students will understand…

* That as elements (and compounds) absorb energy the energy causes electronic transitions
* That the energy absorbed is released from metals as visible light
* That the energy absorbed/released is of specific energies dependent upon the element (electronic configuration) involved

**Student Objectives:** Students will …

* Recognize flame tests are a qualitative test for a metal cation.
* Understand that energy absorbed as light can be emitted by atoms.
* Relate the ‘colors’ of light to its wavelength and energy.
* Practice Lab Safety

**Materials:** (per lab group ~3 students)

* 1mL 0.1M sodium acetate solution
* 1mL 0.1 M sodium chloride solution
* 1mL 0.1M potassium acetate solution
* 3 test tubes
* 6 wooden splints
* Striker
* Bunsen Burner

**Time Required:** One 45 minute class period

**Standards Met:** NGSS

**HS-PS1-2.** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns in chemical properties.

**HS-PS2-6.** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of the designed materials.

**Green chemistry principles addressed:** Pollution Prevention ¤ Design for Degradation ¤ Inherently Safer Chemicals for Accident Prevention

**Teacher Prep:**

* Prepare 0.1 M solution of sodium acetate (NaC2H3O2, MW: 82.03 g/mol)

Hint: To prepare 50 mL solution of 0.1 M sodium acetate, dissolve 4.10 g NaC2H3O2 in 50 mL of water

* Prepare 0.1 M solution of sodium chloride (NaCl, MW: 58.44 g/mol)

Hint: To prepare 50 mL solution of 0.1 M sodium chloride, dissolve 2.92 g NaCl in 50 mL of water

* Prepare 0.1 M solution of potassium acetate (KC2H3O2, MW: 98.15 g/mol).

Hint: To prepare 50 mL solution of 0.1 M potassium acetate, dissolve 4.91 g KC2H3O2 in 50 mL of water

**Keys for Success:** Resources for instruction and student practice.

* After instruction about light and electron arrangement, the teacher will show video about fireworks colors and elements involved. The American Chemical Society has a video clip called The Chemistry of Fireworks that is available on YouTube.
* Have students use the student sheet to perform the Flame Test Procedure
* The website, <https://phet.colorado.edu> also provides a virtual lab using gas discharge tubes that can be used to illustrate this concept. This can be used at the end to show what is occurring at the atomic level.

**Disposal Information:** All solutions may be flushed with water down the drain.**Electronic Transistions Student Lab**

**Problem:**

When different salts are exposed to the energy of the flame, what response will occur? Will this response occur because of the cation or the anion?

**Procedure:**

1. Place two labeled wooden splints in each tube of salt solution.
2. Light the Bunsen burner.
3. Take the wooden splint soaked in the sodium acetate solution and hold it in the flame. Observe the color of the flame and record it in the Data Table. Put the splint back into the solution if it dries out. Use this splint only for this solution. Return the splint to the proper test tube when you have finished.
4. Repeat step three for sodium nitrate (chloride) and potassium acetate.
5. Extinguish the flame.
6. Wash your hands thoroughly.

**Data:**

|  |  |
| --- | --- |
| Compound | Color of Flame |
| Sodium acetate |  |
| Sodium nitrate (chloride) |  |
| Potassium acetate |  |

**Questions:**

1. Why do solutions of sodium acetate and sodium chloride impart the same color to the flame?
2. What difficulty might be encountered with the use of flame tests for identification?
3. Using reference materials, describe the colors that would be seen for the following compounds:
   1. Lithium chloride
   2. Copper (II) nitrate
   3. Barium acetate
   4. Calcium nitrate
   5. Strontium chloride
4. Barium and copper produce colors very different from the metals in this lab. Considering Green Chemistry Principles, why are sodium and potassium salts included in this lab, but strontium and barium salts are not?

**Teacher’s Guide to Questions**

1. **Is flame coloration a test for the cation or the anion?**

The cation.

1. **Why do solutions of sodium acetate and sodium chloride impart the same color to the flame?** Both contain the metal (cation) sodium
2. **What difficulty might be encountered with the use of flame tests for identification?**

As a qualitative test, it is possible two metals will impart similar colors to the flame. The differences may be difficult to recognize or describe. Also, since this is not a test for the anion, it cannot differentiate between two different compounds containing the same metal.

1. **Using reference materials, describe the colors that would be seen for the following compounds:**
   1. **Lithium chloride:** Red
   2. **Copper (II) nitrate:** Green
   3. **Barium acetate:** Yellow Green
   4. **Calcium nitrate:** Orange/Red
   5. **Strontium chloride:** Crimson
2. **Barium and copper produce colors very different from the metals in this lab. Considering Green Chemistry Principles, why are sodium and potassium salts included in this lab, but strontium and barium salts are not?**

Although strontium and barium impart color to the flame, they are much more toxic than sodium and potassium. They are heavier metals, and are more damaging to humans and the environment.