Methyl Alcohol Flame Tests

Safe Laboratory Practices

FLINN SCIENTIFIC CHEM FAX!

Introduction

Demonstrate the characteristic emission spectra of metal ions with a flame test that is large enough for an entire classroom to observe. Please review essential information for working safely with methyl alcohol.

Concepts

- Flame test emission spectra
- Bohr model of atom

Materials

Copper(II) chloride, $CuCl_2$, 5 g

Lithium chloride, LiCl, 5 g

Methyl alcohol, CH_3OH, 30 mL

Potassium chloride, KCl, 5 g

Sodium chloride, NaCl, 5 g

Strontium chloride, $SrCl_2{\cdot}6H_2O$, 5 g

Beaker, 600-mL

Butane or piezo safety lighter

Petri dishes, borosilicate glass, Pyrex®, 5

Safety shield (optional)

Safety Precautions

This activity requires the use of hazardous components and, if performed improperly, has the potential for hazardous reactions. Please visit the Flinn website (www.flinnsci.com) and type in AP9303safetyvid to view a special safety video, *How To Safely Perform Flame Tests with Methyl Alcohol.* Please also review the following Safety Precautions section and relevant Material Safety Data Sheets before beginning this activity.

Several accidents have occurred recently involving methyl alcohol. Please remember that methyl alcohol is extremely flammable, has a very low flash point, and burns with an almost invisible flame. A spark, flame, or a small amount of heat will easily ignite methyl alcohol. Once burning, methyl alcohol fires are difficult to notice due to the almost transparent nature of the flames. To prevent accidents, make sure there are no flames, sparks, or electrical equipment near the methyl alcohol. Always recap the methyl alcohol bottle after adding the alcohol to the Petri dishes, and remove the bottle from the demonstration area. Never add methyl alcohol to a hot container. Immediately clean up any methyl alcohol spills. Methyl alcohol is also toxic by ingestion and inhalation. Ingestion of only a small amount may cause blindness.

When performing the Oooh! Aaah! Style Flame Test demonstration, the following safety tips will help prevent an accident:

- Use only borosilicate glass (e.g., Pyrex®) Petri dishes. Do not use watch glasses—the methyl alcohol can easily spill out and spread the fire. Inspect the Petri dish and do not use if the Petri dish has any cracks or chips.
- Never add additional methyl alcohol to the Petri dish after starting or performing the demonstration. Once the first Petri dish containing methyl alcohol has been lit, never add more methyl alcohol to any of the Petri dishes since you now have an ignition source. Methyl alcohol vapors can travel very quickly, ignite, and quickly flash back to the methyl alcohol bottle.
- Perform the demonstration in a well-ventilated area. If the laboratory is not well-ventilated and the methyl alcohol sits in the Petri dish for a few minutes, methyl alcohol vapors can accumulate and lead to a small flash fire. It is best to add the methyl alcohol, cap the methyl alcohol container, remove the methyl alcohol container from the area, and then light the Petri dishes.
- Do not immediately repeat the experiment. Never add additional methyl alcohol to a Petri dish until it has completely cooled to room temperature. The heat from the Petri dish or salts can ignite the methyl alcohol.
- Be sure to perform the demonstration on a flame-resistant surface and remove all combustible materials from the demonstration area. We recommend placing each dish on a heat-resistant ceramic fiber square.
- Make sure the Petri dishes are at least three inches apart to prevent the fire from jumping from one dish to another.
- Be sure that the methyl alcohol fire is completely extinguished after the demonstration is complete.

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- Have Petri dish covers or large beakers nearby so the flame can be easily extinguished by covering the fire, if necessary.
- Have a fire extinguisher readily available.
- Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. All persons viewing the demonstration should also wear goggles.
- For best results, perform all demonstrations involving flames or explosions behind a safety shield.

By following these safety tips, the *Oooh! Aaah! Style Flame Tests* can be performed safely and provide an exciting and easy method for teaching the emission spectra of metal ions.

Preparation

Remove all flammable materials from the demonstration area. The demonstration must be done on a heat-resistant surface. Practice lighting and extinguishing the methyl alcohol.

Procedure

1. Place five Petri dishes in a row in front of your class.
2. Add about 5–7 g of sodium chloride to one Petri dish. Repeat this step, adding 5–7 g each of the other four metal chlorides to separate Petri dishes.
3. Use a Beral pipet to add 7–10 mL of methyl alcohol into each Petri dish.
4. Place the cap on the methyl alcohol bottle and remove the bottle from the demonstration area!
5. Turn down the lights, light the alcohol/salt mixture in each dish, and observe the flame test colors.
6. Extinguish the flames with the Petri dish covers or with 600-mL beakers.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The methyl alcohol in the Petri dishes should be burned until the flames are extinguished or allowed to evaporate to dryness. The solid chlorides may be placed in the trash according to Flinn Suggested Disposal Method #26a.

Tips

- All flames will start out blue in color or invisible but will change to the colors characteristic of the metal salts as they dissolve and the methyl alcohol burns off (strontium = orange, sodium = yellow, potassium = violet or purple, lithium = red, copper = green). When the flame burns out, *do not* add more methyl alcohol and relight. Wait until each salt has burned itself out and the Petri dish has completely cooled before repeating the demo.
- As an extension, have your students do flame tests using aqueous solutions or metal salts. Prepare 1.0 M aqueous solutions of the metal salts you want to test. Students then dip cotton swabs into the solutions, and hold the swabs in a Bunsen burner flame. Alternately, wooden splints can be soaked in the salt solutions overnight and then held in the flame to display the vivid colors.
- You can also do flame tests with barium chloride, calcium chloride, and cesium chloride to show their characteristic colors.
- The copper(II) chloride will begin to burn after a few minutes. Be sure to thoroughly extinguish this fire.

Discussion

You and your students will notice that each metal salt emits a distinctive color of light. When the light of any of these flame tests is passed through a prism or viewed through a diffraction grating, a spectrum is formed that contains only a few colors at specific wavelengths, including the colors seen in the original flame.

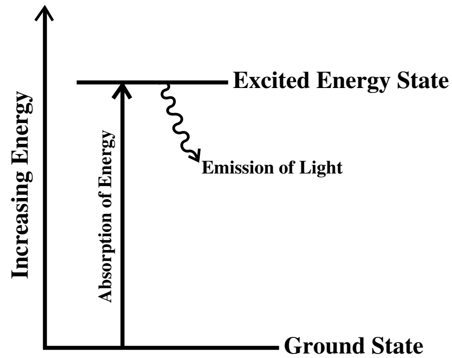

Figure 1.

Results

Metal Ion	Flame Color
Cu^{2+}	green
Li^{+}	bright red
K^{+}	violet
Na^{+}	yellow
Sr^{2+}	red–orange

If an element or compound is placed in solution and the solution is burned, the atoms will absorb energy and promote electrons to higher energy levels. This process is sometimes called "exciting" the electrons. As the excited electrons return to their normal or "ground" state, energy is emitted in the form of electromagnetic radiation. Simply stated: if an electron is excited via heat, that electron will become excited and emit light as it returns to its ground (non-excited) state (see Figure 1).

Sample Emission Line Spectra

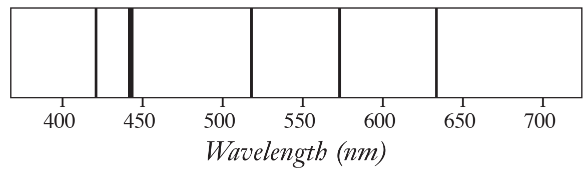

Figure 2.

Every element emits a characteristic wavelength of light. Just as a fingerprint is unique to each person, the color of light emitted after excitation of an element is unique to that element. Only a few elements give off a characteristic light in the visible region of the spectrum. The visible region of the spectrum is that which is visible to the human eye (400–700 nm). For most elements, the characteristic color is detectable only in the ultraviolet or infrared region of the spectrum. The spectrum produced from exciting one element contains only specific wavelengths and is called a line spectrum (see Figure 2). The lines are due to electrons in different excited states returning to lower energy ground states. Since each element has a specific group of electrons and energy levels, the wavelengths given off by the falling electrons can be used to identify an element.

The emission of a characteristic color (electromagnetic radiation) as the excited electron returns to its ground state has provided remarkable tools to the analyst in the form of analytical instrumentation (e.g., emission spectrophotometer, quantometer, flame spectrophotometer, etc.). In a crude way, this activity replicates the process used in these very sophisticated instruments. The very specialized instruments enable the analyst to detect:

- What is present? (Qualitative Analysis)
- How much is present? (Quantitative Analysis)

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, interactions of energy and matter

Answers to Worksheet Questions

1. Name the metal ion present in each Petri dish and the flame color it produced.

Petri Dish 1 – *The ion present was sodium,* Na^{+}*. It produced a yellow flame.*

Petri Dish 2 – *The ion present was strontium,* Sr^{2+}*. It produced a red-orange flame.*

Petri Dish 3 – *The ion present was copper,* Cu^{2+}*. It produced a green flame.*

Petri Dish 4 – *The ion present was lithium,* Li^{+}*. It produced a bright red flame.*

Petri Dish 5 – *The ion present was potassium, K^+. It produced a violet flame.*

2. When an element or compound is placed in a burning solution, the atoms absorb energy and promote electrons to "excited" energy levels, which are different from their normal ground state. Explain how this creates colored light.

An excited electron must eventually return to its ground state. When it does so, it emits a form of energy, light.

3. What is the name for the spectrum of specific wavelengths produced by exciting an element?

The spectrum of wavelengths for each excited element is called a line spectrum.

4. Why is this spectrum different for every element?

The spectrum differs from element to element because each element has a particular group of electrons and energy levels. Therefore, the wavelengths of light are different because the energy states the element has electrons falling from and to are different.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Methyl Alcohol Flame Test* activity, presented by Irene Cesa, is available in *Flame Tests* and in *Safe Labortory Practices*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Methyl Alcohol Flame Test* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Oooh! Aaah! Style Flame Tests—Chemical Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP9303	Oooh! Aaah! Style Flame Tests—Chemical Demonstration Kit
GP3019	Petri Dishes, Borosilicate Glass, 100 × 15 mm, Pkg. of 6
AP1244	Ceramic Squares, 5" × 5" × 1⁄8", Pkg. of 12
SE261	Safety Shield, 36" × 24"
C0212	Copper(II) Chloride
L0095	Lithium Chloride
M0054	Methyl Alcohol
P0183	Potassium Chloride
S0357	Strontium Chloride
S0061	Sodium Chloride

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Methyl Alcohol Flame Test

Discussion Questions

1. Name the metal ion present in each Petri dish and the flame color it produced.

   Petri Dish 1 –

   Petri Dish 2 –

   Petri Dish 3 –

   Petri Dish 4 –

   Petri Dish 5 –

2. When an element or compound is placed in a burning solution, the atoms absorb energy and promote electrons to "excited" energy levels, which are different from their normal ground state. Explain how this creates colored light.

3. What is the name for the spectrum of specific wavelengths produced by exciting an element?

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