# Flame Test Demonstration and Activity: Al DeGennaro

# Teacher's Guide

## Goals

- To learn about electronic states through flame tests
- To relate the chemistry of atomic structures to cases from everyday life

## The Demonstration and Activity

In this lesson, students get a feeling for the relationship between color and electronic states by observing a flame test demonstration. They learn about useful applications for classroom chemistry and practice scientific thinking and reasoning skills.

## Materials for Each Group

- A Bunsen burner
- Matches
- Solutions of different metal ions: sodium chloride, lithium chloride, calcium chloride, barium chloride, strontium chloride, copper chloride and potassium chloride
- Wooden splints soaked in the solutions

## SAFETY

Wear safety goggles at all times during the demonstration.

When working with fire, have a fire extinguisher nearby, remove all flammable and explosive chemicals away, tie your hair back and be careful.

## Lecture Notes

I am going to show you evidence of excited states in atoms. Remember that I told you I could use either electricity or flame? So I will do it by flame, using a Bunsen burner.

What I want you to do during the demonstration is to keep track of the colors that you're seeing.

Put a wooden splint soaked with the metal salt solution into the flame.

Sodium chloride is first: I want you to think about the colors of the spectrum in the Roy G. Biv (abbreviation for: red, orange, yellow, green, blue, indigo, violet). What color would you call that? Orange.

Lithium chloride is next. What color is this? Red. It will give you the borderline.

Calcium chloride is orange, but it is not the same orange as before, so we want to change. Maybe we will make the sodium yellow-orange and this plain orange?

You could actually use this, to figure out which atoms there are in a chemical. So, if I mix these (solutions) up, and ask you what this is, you will know what it was because you recorded the color.

This is what the chemists do. They measure every element that they can think of and they publish it all in books: these are the colors that belong to this element, and so on.

And so, a chemist can figure out if there is an unknown. They say, "What is this stuff? I want to know what it is." They can check it with a flame and see what colors come out, and then, they can figure out what it is.

Here is the task for the day. This is a simulation of the real thing. First of all, if there is an accident, somebody usually sues somebody. Also, what a lot of people are not aware of is that judges, and jury, have to address other people who are experts, called "expert witnesses."

So you are going to play the role of the expert witnesses. This lady is suing a company, a chemicals company. And you are going to explain to the judge whether the witness is right or wrong.

Because the judge has to decide whether this lady deserves the four million dollars, or is wrong. That's what you have got to decide.

For five minutes, carry on a discussion about the case with your colleagues at the table.

## Teaching Tips From Mr. DeGennaro

I had to think of something that would at least make it seem useful. They are interested in lawsuits and they are interested in explosions.

Astronomers and people who observe explosions, can tell what blew up, by the spectra of the elements which are coming off. Satellites can tell whether it was a construction explosion, whether it was a chemical weapon, and so on. And it's not that hard, all they have to do is look at the colors of light.

It's related to the same thing that they say—that you don't really understand things until you teach them. Well, you don't really understand things until you verbalize it. And I am sure that for some kids, telling the story will be more effective. But I just can't listen to 80 stories, so I ask them to write it out.

I'd say that everybody verbalized to me that the worker was wrong, but to compose a coherent thought and put it on paper really cements the learning for most of the kids.

## Students' Products

"We are given this prompt which says that we have been contacted by the State of Maryland. A lawsuit is going on against a chemical company, and a worker who was injured in an explosion claims that unsafe conditions near a Potassium Chloride tank resulted in an explosion, and she's suing the company for four million dollars."

Dear state officials,

As a chemical expert working on this case, I look only at the facts. In this case, the facts show that the worker is wrong, in thinking that potassium chloride tank exploded.

The witnesses recall seeing a bright, green flash. These positions conflict. I saw an experiment with the colors of burning elements. Some of the elements tested included potassium chloride and copper chloride.

Each type of atom has a different amount of space between its orbitals. This requires more or less energy for the electrons to make the jump. Different amounts of energy produce different colors of light when they pass through an electron. Thus each different chemical element produces different colors of light when receiving a surge of energy. Witnesses to the explosion at the Useful Chemical Company, report seeing a bright green flash of light as the explosion occurred. Potassium chloride, the chemical in question, does not produce a green flash of light when it receives a surge of energy.

## References: Links

http://www.fbi.gov/hq/lab/handbook/examelem.htm
From the FBI Handbook, a discussion of elemental analysis.

## References: Readings

McKelvy, G.M. (1998) "Flame Tests That Are Portable, Storable, and Easy To Use," *Journal of Chemical Education,* Vol. 75, No. 1, pp: 55-56.