Electrons and Light: Using Indirect Evidence
Student Activity

Introduction and Historical Context

By the mid-1800s Robert Bunsen and Gustav Kirchhoff had discovered that elements give off distinctive flame colors when their compounds were placed in a burner flame. Bunsen, in fact, developed the Bunsen burner, which produced a transparent flame that did not mask the colors of the flames given off by various elements. Kirchhoff found that if the flames were viewed through a prism or other device that separated the colors, different elements had distinctive color patterns. This discovery led to the development of the spectroscope. The findings of these two scientists provide the historical context for both demonstrations in this section.

By the late 1800s scientists were studying different types of radiation. J. J. Thomson was conducting experiments about the radiation in the cathode-ray tube. Using evidence similar to your observations in the demonstration part of this activity, Thomson advanced the idea that the rays were actually caused by very small particles, which he called "corpuscles." These particles were charged and had a mass very much smaller than the hydrogen atom. Thomson had discovered electrons.

Purpose

The two demonstrations will show you how Thomson, Bunsen, and Kirchhoff used light radiation both to show the existence of electrons in atoms and to show how light can be used to provide evidence for how electrons are structured in atoms. In the lab part of the activity you will learn how light emitted by compounds can be used as evidence about the structure of atoms in those compounds.

Safety

As you do the lab part of the activity, you should wear eye protection and be careful handling the solutions.

Materials and Apparatus

- For the lab portion of the activity you will need
- Small quantities of several solutions
- Wood splints, one for each solution
- Burner and tubing
- Striker (or other means of igniting the burner)
- Eye protection

Pre-Lab Questions

1. Record your observations of the cathode-ray-tube demonstration.
2. What indirect evidence does this demonstration provide for the existence of electrons?
3. Record your observations of the spectrum-tube demonstration.
4. What indirect evidence does this demonstration provide for the existence of electrons?
5. When you observe the results of the demonstration for a second time, how do the bright lines compare with those you observed the first time?

Procedure

1. You and your partner must wear eye protection throughout this procedure.

2. Determine the number of solutions at your lab station.
3. Prepare a two-column table, one column for the name of each solution and the other column for the flame color you observe during the lab. In your table, record the formula for the compounds in the solutions at your station.
4. Ignite your lab burner. Adjust the air supply so that a blue inner cone is produced within the flame.
5. Remove a wood splint from one of the solutions. Briefly place it in the flame at the tip of the blue cone. Observe the color of the flame. Record this color on your table next to the appropriate compound. If you are not certain about the color, dip the wood splint back in the solution and place the wood splint in the flame again. Be sure to replace the wood splint in the correct solution.
6. Repeat step 5 until you have recorded the flame color for all the compounds at your lab station.
7. Compare your results with several other lab groups. Compare the names of the compounds and the flame colors produced.

Post-Lab Questions

1. By comparing your results with the results of other lab groups, identify the ions responsible for the flame colors.
2. As a class, make a list of ions and the characteristic color each one produces in the flame tests.
3. Other students in your class may have used different color words to describe the observed flames. Based on the demonstrations you observed, how could you observe the flame colors so that everyone would get the same results?
4. In one or two sentences explain why each element displays a unique flame color.
5. What element is present in the unknown solution given you by your teacher after the lab?

Extension Question

How could the results of this activity be applied to the production of fireworks?