# CHROMATOGRAPHY

## Teacher Notes

***FOURTH GRADE BACKGROUND***

- The concepts and vocabulary associated with chromatography are brand new
- The students have a general idea about the properties of a material
- The students will have little prior knowledge of atoms and molecules

***PREVIOUS LESSON REVIEW***

- What did you learn last month about magnetism?
- Can you remember all of the kits that we've done? (Classification, Mass Olympics, Length Measurement, Volume, Density, Electricity, Magnetism)
- What was your favorite kit?
- What is a property? This time we'll use the properties of different materials to solve a crime!

***INTRODUCTION***

We learned about the scientific method during the Measurement Olympics, and Chromatography is a great time to review this important idea. Ask the students whether they remember the steps that scientists take when they follow the scientific method. The *scientific method* is how scientists investigate a question they have. Sometimes scientists make discoveries by accident, but more often they develop a plan to test a theory or *hypothesis* they have. This plan is often called a procedure. During the procedure, a scientist collects the results or data from his or her experiments. After thinking a lot about the data, the scientist then makes a conclusion and shares the results of the experiment.

*Chromatography* is a method scientists use to separate and/or analyze complex mixtures. A mixture of various components enters a chromatography process, and the different components are flushed through the system at different rates. As the mixture moves over adsorptive materials, these differential rates of migration provide separation. As the affinity of a molecule for the stationary phase decreases, it will spend less time on a column.

For our chromatography experiment, the students will be acting as CSI agents, trying to determine which of four suspects is the actual criminal. The stationary phase is chromatography paper, while the mobile phase is water. The water moves up the chromatography paper via *capillary action*. While the water moves up the paper, it drags materials that are soluble in water along with it. In this experiment, black inks are spotted onto the paper and the water-soluble *dye* components move up the paper at different rates depending upon their size. The material that is insoluble in water, or the *pigment*, remains at the ink spot. The black ink is comprised of many differently colored dye *molecules*. Each dye molecule consists of a different number and variety of *atoms*. The larger a dye molecule is, the more difficult it is for the water molecules to carry it up the chromatography paper. It is easier for water to carry smaller dye molecules, so they move up the paper more quickly.

In order for the CSI agents to get a crucial piece of evidence for the judge and jury, they need to compare the chromatography spots of the black ink from the poster to the black ink found in the suspects' pens.

***DISCUSSION THOUGHTS***

How do you sort coins?

***VOCABULARY***

- **Scientific Method:** A hypothesis is created, based on observations, and then checked using an experiment
- **Chromatography:** "Color Writing." A method used to separate compounds or molecules
- **Capillary Action**: The wicking of a liquid between two very close surfaces, like fibers in paper
- **Dye**: Dissolvable material that moves with water

- **Pigment**: Non-dissolving particles that don't move with the water front line
- **Molecules**: Matter made up of atoms
- **Atoms**: The smallest part of an element. These combine to form molecules

***ACTIVITIES***

- **Molecular Kids**
  - Have one student act as a small molecule, a few students hold hands to act as a medium sized molecule, and a group of students hold hands to act as a large molecule. Have the students make a hypothesis about which "molecule" will be able to run back and forth across the classroom fastest. Conduct the race (make sure they are careful!). Discuss the results of the race and compare to chromatography.
  - Objective: The students should observe that the smaller a "molecule" is, the quicker it can move. This is the main principle behind liquid chromatography that is used in the poster experiment.
  - Materials: None

- **Chromatography Worksheet**
  - Vocabulary, atoms & molecules, and a practice chromatography analysis are included.
  - Objective: To introduce the concept of chromatography by describing what a molecule is and how they have different shapes and sizes.
  - Materials:
    - 25 Chromatography worksheets

- **Defaced Painting**
  - Before class begins, pass out the four numbered pens to adults in the classroom. ***Please be careful to keep track of the pens- they are not replaceable.*** Each student gets a cup with a little water in the bottom, a rack (stirrer), and a narrow strip marked with an "F" (food coloring). Help the students fold over the strip as indicated on the paper. Hang the strips on the racks so that the strip touches the water while keeping the dye spot out of the water.
  - After talking about the graffiti on the poster and handing out the "Science Experiment" worksheets, the kids will work in pairs. Each pair will get one strip marked "unknown" and another marked "knowns." After removing the "F" strip from their cups, the students should fold the top of each strip and hang them on the racks. The kids will be asked to keep the results to themselves for a group discussion at the end.
  - Objective: The students should get a taste of what chromatography is and use it to solve a crime. The kids should understand why the colors separate and learn about the scientific method.
  - Materials:
    - Disposable:
      - Water
      - 30 paper strips (1") with spotted food dyes (labeled "F")
      - 15 paper strips (1.5") with 4 spotted pen inks (labeled "K")
      - 15 paper strips (1") with spotted culprit pen ink (labeled "U")
    - Re-Useable:
      - 30 plastic cups
      - 30 coffee stirrers
      - 4 numbered black pens (different black inks)
      - 1 art painting with pen markings

***CONCLUDING THOUGHT***

How could you determine what color dyes are in the shell of a brown M&M? What would be your hypothesis? What experimental procedure would you use to test your hypothesis?