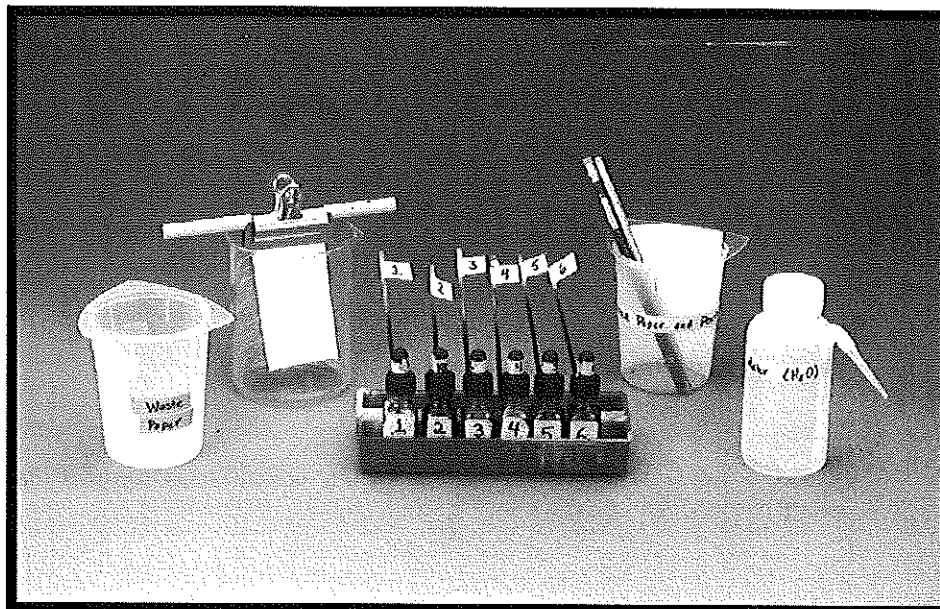


Dye Detective

Visitors use filter paper and water to test six dyes. They place spots of the different dyes at the bottom of a piece of filter paper and label them "1" through "6." They then hang the filter paper so that it just touches the water in the bottom of the beaker. They observe the color spots as the water travels up the filter paper.



OBJECTIVES:

Visitors learn about paper chromatography as a technique to separate and identify different molecules based on their sizes.

SCIENCE TOPICS

Chromatography
Properties of Molecules

PROCESS SKILLS

Observing
Inferring
Comparing/Contrasting
Interpreting Data

VOCABULARY

Biochemistry
Chromatography
Molecule

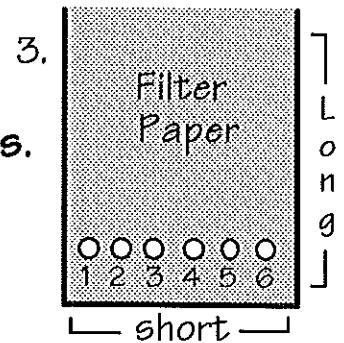


Dye Detective

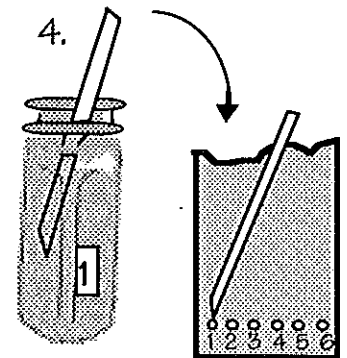
Procedure:

1. Always wear safety goggles.
2. Empty the glass beaker. Dry your hands and the counter.

3. • Draw 6 dots about a half inch from the bottom of a piece of filter paper (as shown).
• Write the numbers 1 through 6 below the dots.

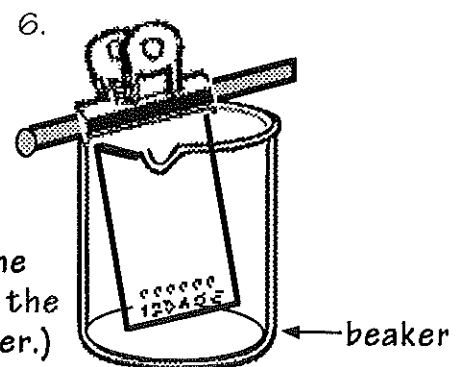


4. • Use the stick from bottle 1 to make a spot of dye on dot 1.
• Repeat this step with bottles 2-6 to make 6 different colored spots on the paper.



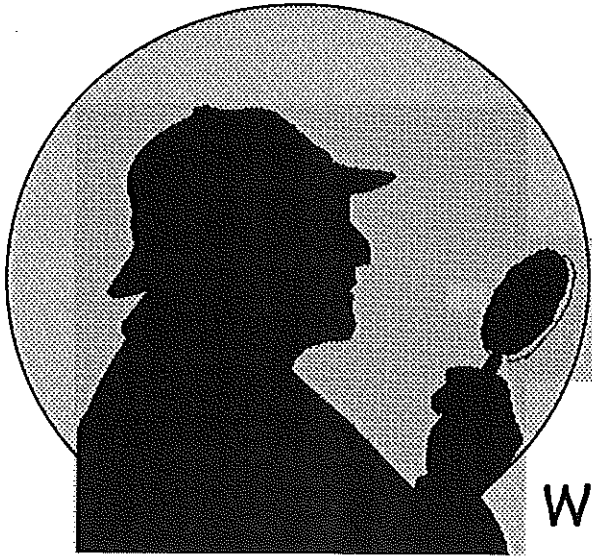
5. Add just enough water to the beaker to cover the bottom.

6. • Attach the paper to the clip on the round stick.
• Hang the paper inside the beaker as shown in the picture. The bottom edge of the paper should barely touch the water in the beaker.



(If the water in the beaker does not reach the bottom of the paper, remove the paper and add just enough water to wet the very bottom edge of the paper when it hangs into the beaker.)

7. Watch the dye spots as the water climbs up the paper.
8. When you are done, put the paper in the waste beaker.



Why did the dyes travel different distances on the paper?

What happened to dye number 6?

A Closer Look:

Each dye is made of molecules of different size, shape, and color. In this experiment, the dye molecules were carried along with the water as it traveled up the paper. This process, known as paper chromatography, is frequently used by biochemists to separate and identify different molecules.

Because smaller molecules move faster than larger molecules, they travel farther up the paper. Some dyes have a single kind of molecule; others are a mixture of different molecules. For example, dye number 6 is a mixture of three dyes (numbers 1, 2, and 4).

Dyes can be separated and compared to other dyes of known composition to identify their components. A similar process might be used in a police lab to identify the dye on a scrap of cloth found at a crime scene .

MATERIALS

See *Materials Prep*
for more details

(with amounts to have on hand)

- Six glass dropper bottles
- Six wooden skewers (6 inches long, flat at one end)
- Eosin Y (keep 1 g on hand)
- Crystal violet (keep 1 g on hand)
- Phenol red (keep 1 g on hand)
- Bromphenol blue (keep 1 g on hand)
- Methylene blue (keep 1 g on hand)
- One bottle tray to hold six dropper bottles
- One 250-ml squeeze bottle
- Filter paper (always have 3 full sheets of 46 x 57 cm filter paper on hand) (available from Central Scientific, 1-800-262-3626)
- Pencils (keep six on hand)
- One medium plastic beaker
- One large plastic beaker
- One 400-ml glass beaker
- One large clip
- Six-inch-long dowel, 1/4- to 1/2- inch diameter

Setup/Takedown Procedures**ORIGINAL SETUP**

- Label the six glass dropper bottles "1" through "6."
- Use label tape to attach flags to the skewer ends (opposite the flat ends) and label them "1" through "6."
- Label the 250-ml squeeze bottle "Water (H₂O)."
- Label the medium plastic beaker "Filter Paper and Pencils."
- Label the large plastic beaker "Waste Beaker."

WEEKLY SETUP

- Always have at least 1/2 of a dropper bottle of each solution on hand; make new solution if needed.
- Fill the labeled 250-ml squeeze bottle with water.

- Cut 100 rectangular pieces of filter paper, 2.5 x 4 inches. Check that these papers are not too wide or long for the beaker (they should just clear the bottom and not touch the sides of the beaker). Use the scraps to make strips for "Build a Battery" (Unit 2).

DAILY SETUP



- Set out the visitor instructions in a Plexiglas holder.
- Remove the droppers from each dropper bottle and place the skewer with the respective number into each bottle. Make sure each bottle is at least $\frac{1}{4}$ full.
- Attach the large clip around the center of the dowel (see the picture on the public copy).
- Keep the filter paper, the large clip, and the dowel somewhat separate from the rest of the supplies.
- Set out the following items on a plastic tray:
 - Six dyes in the bottle tray (the tray is red)
 - Two sharp pencils
 - One clip with the dowel
 - One 400-ml glass beaker
 - The labeled beaker filled with filter paper and pencils
 - The labeled squeeze bottle filled with water
 - The labeled waste beaker

DAILY TAKEDOWN

- At the end of the day, remove the skewers from the bottles.
- TIGHTLY SCREW THE CAPS ONTO THE DYE BOTTLES.
- Rinse the skewers and return them to the tub for reuse.
- Return the remaining equipment to the tub.
- Throw away the used pieces of filter paper.
- Tightly cap the water bottle and store it in an upright position.

WEEKLY TAKEDOWN

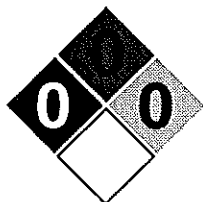
- Sponge out the tub and clean off the other equipment.
- Store all bottles tightly capped.
- Return the tray to general storage.

**RUNNING SUGGESTIONS**

- ◇ It is important that the filter paper remain dry until the moment in the experiment when water is added to the beaker.
- ◇ Remind visitors to dry their hands and to set the filter paper on a dry spot on the bench.
- ◇ Visitors may keep their papers if they like.
- ◇ Circular filter paper can also be used. Cut them into 2.5-in. by 4-in. rectangles. Save the scraps for the Unit 2 experiment, "Build a Battery."

**EXTENSIONS**

This technique is often used in biotechnology labs to separate and identify different biological compounds. Another separation technique illustrated in the lab is electrophoresis. Ask the visitors to compare the methods.

SAFETY & DISPOSAL

No special precautions are needed; follow standard lab safety procedures.

MATERIALS PREP

To prepare the solutions in the bottles:

- Mix one or two match-head-sized scoops of each dry crystal with 10 ml of dH₂O (deionized water) to form a richly colored solution, as follows:
 - Solution 1: Eosin Y
 - Solution 2: Crystal violet
 - Solution 3: Phenol red
 - Solution 4: Bromphenol blue
 - Solution 5: Methylene blue
- Prepare Solution 6 by mixing equal parts of Solutions 1, 2, and 4.