



# Dye Detective

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Visitors use filter paper and water to analyze six different markers. They use chromatography to separate the dyes in each marker and reveal its signature pattern.

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**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

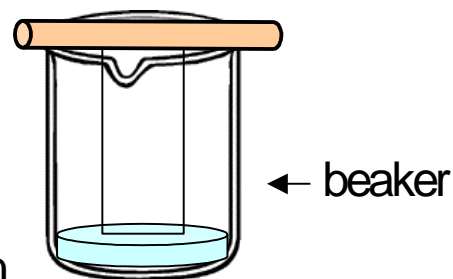
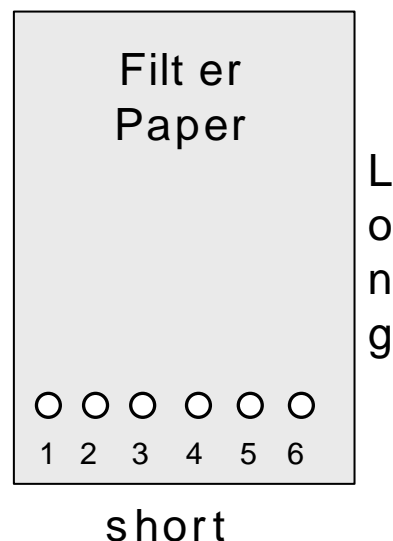
chromatography  
molecule



# Dye Detective

## Procedure:

1. Always wear safety goggles.
2. • Write the numbers 1 through 6 about half an inch from the bottom of a piece of filter paper (as shown on the right).
  - Draw a circle over each number.
3. • Choose six different markers.
  - With one marker, color the spot over the number “1” on the paper. Use the other markers to fill in the other circles on the paper.
4. Add **just enough water** to the beaker to cover the bottom.
5. • 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.)

6. Watch the marker spots as the water climbs up the paper.
7. When you are done, put the paper in the waste cup.



Why did the inks travel different distances on the paper?

Could you identify a specific type of marker using this method?

## A Closer Look:



Most markers and pens contain several different inks. In this experiment, you used paper and water to separate the inks in each marker into a recognizable pattern. This process, known as [chromatography](#), is frequently used by forensic scientists to separate and identify different substances.

How does it work? The molecules of each kind of ink have different sizes, shapes, and charges, so each ink has different chemical properties. Some inks are very attracted to the paper, for instance, while others are more attracted to the water. These differences explain what happens when water moves up the paper. The inks that like water are carried quickly up the paper, while those inks that like paper are slowed down and separated.

A more powerful version of this process, called gas chromatography, uses gas to carry the chemicals instead of paper. With gas chromatography, forensic scientists can separate and identify many, many things, including paint chips, pharmaceuticals, brands of lipstick, food residues, accelerants, and tobacco.



## MATERIALS

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- (with amounts to have on hand)
- one 250-mL squeeze bottle
- filter paper (keep 3 full sheets of 46x57cm filter paper)
- pencils (keep six on hand)
- tray for filter paper and pencils
- various water-soluble markers
- two large plastic beakers
- one 400mL glass beaker
- large clip
- six-inch long dowel,  $\frac{1}{4}$  to  $\frac{1}{2}$  inch diameter

## Setup/Takedown Procedures

### ORIGINAL SETUP

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- Label the 250-mL squeeze bottle “water” in blue
- Label the tray “paper and pencils” in white
- Label one large plastic beaker “pens” in white
- Label one large plastic beaker “waste” in orange
- Label the 400mL glass beaker “beaker” in white

### WEEKLY SETUP

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- Fill the squeeze bottle with water.
- Inventory pens. Replenish if needed.
- Sharpen pencils.
- Cut sheets of filter paper into pieces 2.5inx4in. Check that these papers are not too wide or too long for the beaker. They should just clear the bottom and not touch the sides of the beaker.

- Set out visitor instructions in a Plexiglas holder.
- Check supply of cut filter paper. Replenish if needed.
- Fill beaker labeled “pens” with water soluble pens
- Set out the following items on plastic tray:
  - beaker of pens
  - tray with paper and pencils
  - clip on dowel
  - glass beaker
  - squeeze bottle filled with water
  - labeled waste beaker.

### **DAILY TAKEDOWN**

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- Straighten up all supplies on the tray.
- Recycle used filter paper in recycle bin.

### **WEEKLY TAKEDOWN**

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- Empty the water bottle.
- Return all materials to the tub. Store tub in appropriate cabinet.

## RUNNING SUGGESTIONS

- Watch visitors to make certain they are labeling their filter paper correctly. Many visitors will make their pen marks on the long side of the paper instead of the short side.
- Make certain visitors mark their number and circles with PENCIL and not marker.
- Make certain the level of water in the beaker is high enough to touch the bottom of the paper, but not so high that it reaches the ink marks. Too much water allows the ink to dissolve in the water instead of moving up the paper.
- Visitors may keep their papers if they like.

## EXTENSIONS

- Scientists use chromatography to analyze and identify mixtures. Markers contain various dyes inks to make the different colors of ink. Each dye molecule reacts differently to the paper and water, so travels a different distance on the paper. Each brand of marker uses a different recipe, so the patterns they leave on filter paper are distinct and identifiable.
- Other methods are also used to analyze and separate mixtures. Gas chromatography uses a high temperature, inert gas (usually helium or nitrogen) as the medium for chemicals to travel. Gel electrophoresis, on the other hand, uses agar gel as the medium to separate different lengths of DNA.

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All materials are general household and desk materials. No special precautions are needed.

## **MATERIALS PREP**

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None needed.