

Black Magic (Color Chromatography)

With a paper towel, a black marker, and a cup of water, discover the secret colors hidden in black ink. Explore capillary action--how the water moves up the paper--and chromatography--how different elements of the ink are carried along at different rates, allowing you to see that black ink is actually made up of many different colors.

What Do I Need?

- absorbent paper (paper towel or coffee filter)
- scissors
- black marker (water-based)
- water
- cup or mug

What Do I Do?

- 1.** Cut a strip of the paper towel or coffee filter. Make it about 2 inches (5 cm) wide and 5 to 6 inches (13 - 15 cm) long.
- 2.** With the black marker, draw a line across the strip, 1 to 2 inches (2 - 5 cm) up from and parallel to the bottom.
- 3.** Put some water in the cup - enough to cover the bottom.
- 4.** Place one end of the paper strip (the one with the black mark closest to that end) in the cup, then fold the other end of the strip over the cup's edge so the strip doesn't fall in. Make sure the bottom of the strip is in the water, but that the black mark is not in the water.
- 5.** Watch as the water flows up the paper. When it reaches the black line, you'll start to see some different colors moving up the paper strip.
- 6.** Leave the paper in the water until the colors go all the way to the top edge. How many colors can you see?
- 7.** If you have another black marker, draw a line on a clean, dry coffee filter or paper towel. Put the paper in some fresh water. Does this

marker make colors different from

the first one?

What's Going On?

How does Color Chromatography work? Why do some black inks separate into many colors on a wet coffee filter?

Most nonpermanent markers use inks that are made of colored pigments and water. On a coffee filter, the water in the ink carries the pigment onto the paper. When the ink dries, the pigment remains on the paper.

When you dip the paper in water, the dried pigments dissolve. As the water travels up the paper (by capillary action), it carries the pigments along with it. Different-colored pigments are carried along at different rates; some travel farther and faster than others. How fast each pigment travels depends on the size of the pigment molecule and on how strongly the pigment is attracted to the paper. Since the water carries the different pigments at different rates, the black ink separates to reveal the colors that were mixed to make it.

In this experiment, you're using a technique called chromatography. The name comes from the Greek words *chroma* and *graph* for "color writing." The technique was developed in 1901 by Russian botanist Mikhail Tsvet. He used it for separating the pigments that made up plant dyes.

There are many different types of chromatography. In all of them, a gas or liquid (like the water in your experiment) flows through a stationary substance (like your coffee filter). Since different ingredients in a mixture are carried along at different rates, they end up in different places. By examining where all the ingredients ended up, scientists can figure out what was combined to make the mixture.

Chromatography is one of the most valuable techniques biochemists have for separating mixtures. It can be used to determine the ingredients that make up a particular flavor or scent, to analyze the components of pollutants, to find traces of drugs in urine, and to separate blood proteins in various species of animals (a technique that's used to determine evolutionary relationships).

Why does mixing many colors of ink make black?

Ink and paint get their colors by absorbing some of the colors in white light and reflecting others. Green ink looks green because it reflects the green part of white light and absorbs all the other colors. Red ink looks red because it reflects red light and absorbs all the other colors. When you mix green, red, blue, and yellow ink, each ink that you add absorbs more light. That leaves less light to reflect to your eye. Since the mixture absorbs light of many colors and reflects very little, you end up with black.