Chromatography on Paper

We like to make colors an important part of our lives. That's why manufacturers make products in a variety of colors. Have you ever wondered how these colors are created? We see a myriad of colors all around us, and many of them result from a mixing or blending of other colors.

Colored markers are something we commonly use. A single color of marker may contain many different pigments. You can probably make some guesses as to what colors of pigments are contained in marker colors such as green, orange, and purple. How about black and brown? In this activity you will see for yourself. You may be surprised by your colorful results.

Materials

- several brands and colors of water-soluble markers (Vis-à-Vis® work very well; try to include black, brown, and green)
- coffee filters
- scissors
- 2 glass containers (plastic can be substituted if acetone is not used)
- 2 adhesive labels (or paper and tape to make your own)
- plastic wrap or sandwich bags
- water
- one of the following:
    - rubbing alcohol (70% isopropyl alcohol)
    - acetone-based nail polish remover or hardware product

Safety

If you are using acetone, wear eye protection and avoid extensive or prolonged skin contact or inhalation. In addition, avoid spilling acetone on your clothing or other fabrics.

Getting Ready

Step 1 Squares

Cut two 2-1/2-inch x 2-1/2-inch squares out of the coffee filters. Using an accordion-style fold (so the square will be free standing), fold each square into four or five sections (depending on the number of colors/brands you are testing).

Step 2 Ink dots

Place a different color of ink dot (about 1/2 cm in diameter) on each folded section of one square, about 1 cm from the bottom. Mark the other square in exactly the same sequence. You want to be able to readily compare the squares when you are done. (See Figure 1.)

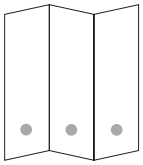

Figure 1: Place a different colored dot on each section.

Step 3 Solvents

Label one container “water” and the other either “isopropyl alcohol” or “acetone,” depending on which one you are using. (Review the safety section about the use of acetone.) Pour about 1/2 cm of each solvent into the appropriately-labeled cup.

Exploration

Step 1 Carefully place a marked paper square (so it is free-standing) in each container. (If the solvent level touches the dots, pour out some of the solvent and prepare another square with ink dots.) Cover the containers loosely with plastic wrap or part of a sandwich bag. What is the purpose of doing this?

Step 2 Observe the squares. Describe what the solvents are doing. What does this indicate about the solvents? What is happening to the ink dots? Explain in terms of attraction.

Step 3 Allow the chromatograms to develop until the solvents are about 1 cm from the tops of the squares. Remove the squares. Use a pencil to write the solvent used on the dry part of each square. Now compare the chromatograms and describe how they are alike or different.

Challenge

What are some of the factors that affect the usefulness of chromatography as a separation method? If a paper chromatogram of a red dye shows a smear of pink, is this conclusive evidence that the dye is a mixture? Explain.

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Concepts

separation of a mixture, chromatography, polarity, capillary action

Expected Student Responses to Exploration

Step 1 To keep the solvent from evaporating as rapidly and/or to keep the solvent vapors inside the cup.

Step 2 (a) The solvents are moving up the paper (the paper acts as a wick).
(b) The solvents are attracted to the paper.
(c) The inks begin to migrate up the paper and separation of colors should be occurring for at least some of them. For example, a dot from a green Vis-à-Vis marker in isopropyl alcohol would be yellow at the bottom and blue at the top. Black and brown markers contain many different pigments, including red, blue, and yellow.
(d) Both the inks and solvents are attracted to the paper and to each other, but to different degrees. The more a color travels with the solvent, the more attracted it is to the solvent than the paper.

Step 3 The water chromatogram will probably have a different color sequence than the isopropyl alcohol (or acetone) chromatograms.

Expected Student Answer to Challenge

Depending on the solvent used, the nature of stationary phase (the paper), and the material being separated, chromatography is often a useful method of separating components of a mixture. A smear of pink from a red dye is inconclusive. Because no distinct separation is noted, it is difficult to conclude much about the nature of this dye.

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