**Ink Chromatography Lab**

**Background**

"Like dissolves like" is an expression used by chemists to show the interaction of molecules due to different polarity. Polar substances WILL dissolve in Polar substances and Non-polar substances WILL dissolve in nonpolar substances. Compounds are rarely entirely polar or non-polar, and can have different degrees of polarity. In chromatography, we use these slight differences in polarity to separate compounds in mixtures. Different molecules exert different forces of attraction on each other, resulting in different solubility within different solvents. These solubility differences make it possible to separate mixtures into their separate components.

Paper chromatography is a method that is used to separate out materials from a mixture. A solvent such as alcohol or water is used to dissolve the components of a mixture. The solvent travels up the paper by capillary action. The particles of solute that are dissolved in the solvent are carried up the paper along with the solvent. The particles of solute will be separated according to solubility as they are carried up the paper; the soluble particles travel faster and will end up at the top, while the less soluble will travel more slowly and will be seen at the bottom. The pattern on the chromatography paper is called a chromatograph.

Ink is a liquid or semi-liquid material used for writing, printing or drawing. Chemists view it as a colloidal system of fine pigment particles dispersed in a solvent.[[1]](#endnote-1) The pigment may or may not be colored, and the solvent may be aqueous or organic.  The earliest black writing inks, developed before 2500BC, were suspensions of carbon, usually lampblack, in water stabilized with a natural gum or materials like egg albumen. Modern ink formulations are rather more complex. In addition to the pigment, they contain many other ingredients in varying levels. Although all black inks may look the same, they may be quite different in composition. The compositions are generally proprietary and are well guided secrets for different companies. We will use this process of chromatography to examine the differences between several different inks. The special chromatography paper is spotted with each ink and placed in a container with the solvent. The water moves up the paper by capillary action carrying the soluble portions of the ink. The more soluble the compound is in the mobile phase, the further it moves up the paper. In the end, you should have a series of spots for each ink, representing individual components of the ink. In this activity, students with use six solvents to separate different black inks into their different components.

**Pre-Lab Questions**

Answer on a separate sheet of paper and turn in at the beginning of lab.

1. How does molecular structure and polarity relate to the separation of molecules in thin layer chromatography?
2. Chromatography relies on two phases, stationary and mobile. The separation of a mixture is based on a difference in the degree of attraction between the components and the stationary and mobile phases. In this lab, what is the stationary phase and what is the mobile phase?
3. What solvents will you use in this lab?
4. Why do you not want the ink spots to dip below the baseline and into the solvent?
5. What is Rf? What does it measure?

**Purpose**

To examine the differences in the composition between different black inks.

**Safety Precautions**

Be careful not to stain clothing or hands. Do not breathe solvent fumes.

**Procedures**

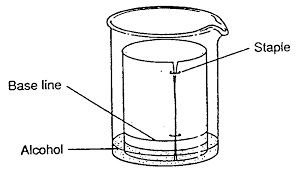
1. Obtain six 10cm X 10 cm pieces of chromatography paper. Using a PENCIL, mark a straight line 1 - 1.5 cm from the bottom of the paper. Make small pencil dots on the line spaced 1.0cm apart, starting at 1.5 cm from edge. Label on top of paper 1-8 and the mobile phase
2. On the first dot, spot with the pen labeled #1. Keep the spot as small as possible. Let it dry for a few seconds, and re-spot.
3. Repeat step 2 with pens/markers labeled #2-8.
4. Prepare your mobile phase. Make NaCl solutions of following concentrations: 1%, 2%, 4% and 8%. You will be using DI H2O as universal solvent and 50% isopropanol for non polar solutes.
5. Pour 10.0 mL of these solutions in 400mL beakers. Seal with parafilm and allow to sit for 15 minutes to “saturate” the air with water vapor (time permitting).
6. Shape the paper into a cylinder so that the dye spots facing out. Place 2 staples to secure the cylinder shape, but DO NOT overlap the end of the paper. Leave a small gap so the edges do not quite meet (Figure 1).

Figure 1: Stapled paper forming a cylinder. Notice that the staples leave a small gap between the ends of the paper.

1. Place the filter paper in the beaker with your mobile phase in it. Your spots need to be above the solvent level. If they look like they will be below the level, empty some of your solvent out. Be careful to not let the paper touch the sides of the beaker. Replace the parafilm so the solvent doesn’t evaporate out.
2. Let the mobile phase move up the paper until it reaches about 2 cm from the top. This should take about 20 minutes.
3. Take your filter paper out of the beaker and pull the paper apart to lay flat. Immediately, use your pencil to mark where your solvent level reached. Outline the spots that the dyes formed. If you wait to do this, the dyes will spread out and give you poor results.
4. Let the paper dry on the bench top. Measure the total distance the solvent moved by measuring from the point of origin to the place where you marked with the pencil. You will need this for your Rf calculations.
5. Measure the distance your spots traveled. Use the center of the darkest area in each spot and the point of origin. Calculate your Rf values for each of the dyes on the data sheet.
6. Repeat for every solvent

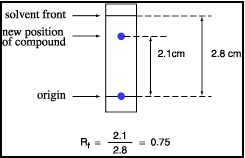
**Data and Calculation**

Example data table

Distance traveled by different components of CraZ Art Black Ink (cm)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Color of spot | 8% NaCl | | 4% NaCl | | 2% NaCl | | 1% NaCl | | DI Water | | 50% Isopropanol | |
|  | Spot | Solvent | Spot | Solvent | Spot | Solvent | Spot | Solvent | Spot | Solvent | Spot | Solvent |
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Rf Calculations

1. Measure the distance from the baseline to the tip of each spot for each ink pen. There may be several spots for each of your pens, so you may have several measurements to make for each ink. Enter measurements, with units, into Data Tables for each pen, making sure you keep track of which black ink goes in which Data Table.
2. For each pen, measure the distance from the baseline to the solvent front. If the solvent moved uniformly up the chromatography paper, this distance may be the same for all pens. But sometimes the solvent does not move so uniformly up the paper, such that the solvent front is a little farther along for some inks than others.
3. Calculate Rf for each spot: Rf = distance to solvent front distance to spot If a particular spot runs all the way to the edge of the solvent front, it would have an Rf = 1, such as the leading spot in pens #1,4,6,7 and 8 in the figure below, left. Otherwise (if the spot does not advance all the way to the solvent front), if will have an Rf less than one.

Example data table

Rf values for different components of Cra Z Art Marker

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Color of spot | 8% NaCl | 4% NaCl | 2% NaCl | 1% NaCl | DI Water | 50% Isopropanol |
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Post-Lab Questions

1. How similar is the composition of the various inks? Do they seem to contain the same dyes/pigments? Could a very good chromatogram be used like a fingerprint to identify a particular ink? Why or why not?
2. Which ink had the most polar components? How do you know?
3. Which ink had the most non-polar components? How do you know?
4. How might your chromatograms look different if you had run these same four inks in a non-polar solvent such as carbon tetrachloride or hexane?

1. Royal Chemical Society [↑](#endnote-ref-1)