

# AP/IB Chemistry

## Ink Chromatography Lab

### Background

In general, a polar compound is soluble in a polar solvent, and a non-polar compound is soluble in a non-polar solvent. Compounds are rarely entirely polar or non-polar, though, 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 solubilities within different solvents. These solubility differences make it possible to separate mixtures into their separate components. Inks are often a mixture of different compounds.

Although all black inks may look the same, they may be quite different in composition. 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 will use two 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  $R_f$ ? 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 a 7 cm length of chromatography paper. Using a **PENCIL**, mark a straight line 1 - 1.5 cm from the bottom of the paper. Evenly space four small pencil dots on the line (don't get the dots too close to the edges OR too close to each other) and label them 1, 2, 3 & 4.
2. On the first dot, spot with the pen labeled #1. Keep the spot as small as possible. (If your spot is too small, let it dry for a few seconds, and re-spot if necessary. This probably will not be necessary, however.)

3. Repeat step 2 with pens/markers labeled #2, 3, 4.
4. Put water in the developing container to a depth of about 1 cm. Seal with parafilm and allow to sit for 15 minutes to “saturate” the air with water vapor (time permitting).
5. Place chromatography paper in the container *being careful not to let the baseline (with the dots) dip below the water line*. Also do not allow paper to touch container. You will need to be creative. Shut the container.
6. Watch the solvent front on the paper. When it is near the top of the container, remove the paper and *mark the furthest edge with a straight line across, using a PENCIL*. Be sure to mark this edge – it’s important for your calculations!
7. Allow your chromatography paper to dry.
8. Repeat steps 1 – 7 using isopropanol (instead of water) as a solvent in a second chamber.

**Data Table for \_\_\_\_\_ Black Ink in Water**

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to <b>Water</b> Front	R <sub>f</sub>

**Data Table for \_\_\_\_\_ Black Ink in Water**

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to <b>Water</b> Front	R <sub>f</sub>

**Data Table for \_\_\_\_\_ Black Ink in Water**

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to <b>Water</b> Front	R <sub>f</sub>

Data Table for \_\_\_\_\_ Black Ink in Water

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to Water Front	R <sub>f</sub>

Data Table for \_\_\_\_\_ Black Ink in Isopropanol

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to Isopropanol Front	R <sub>f</sub>

Data Table for \_\_\_\_\_ Black Ink in Isopropanol

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to Isopropanol Front	R <sub>f</sub>

Data Table for \_\_\_\_\_ Black Ink in Isopropanol

Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to Isopropanol Front	R <sub>f</sub>

Data Table for \_\_\_\_\_ Black Ink in Isopropanol

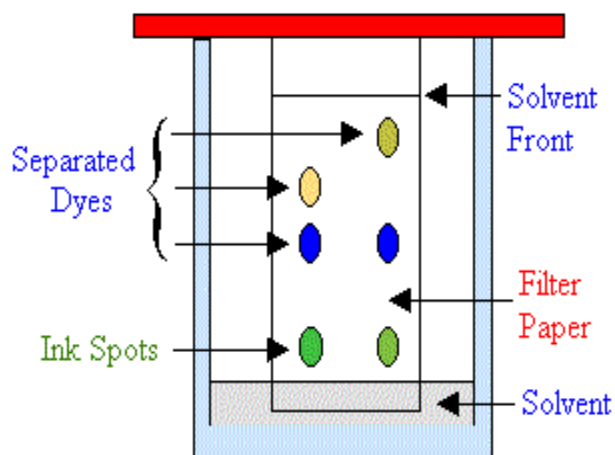
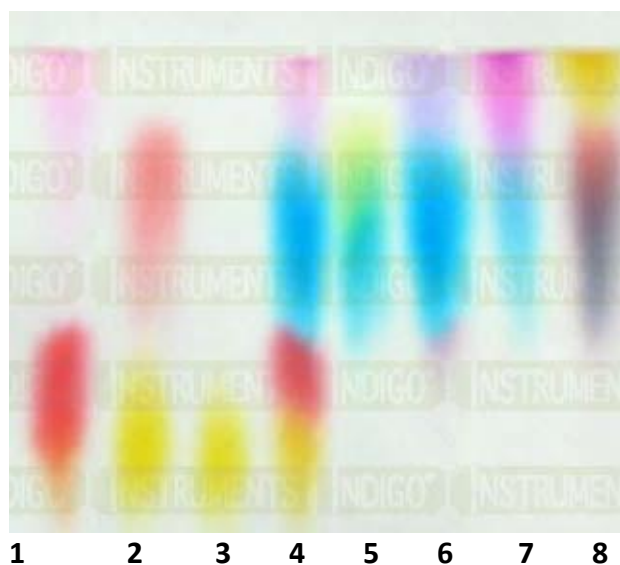
Color of Spot	Distance from Baseline to Tip of Spot	Distance from Baseline to Isopropanol Front	R <sub>f</sub>

## 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 four inks (see the figure below), so you may have several measurements to make for each ink. Enter measurements, *with units*, into Data Tables 1-4, 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  $R_f$  for each spot: 
$$R_f = \frac{\text{distance to spot}}{\text{distance to solvent front}}$$

If a particular spot runs all the way to the edge of the solvent front, it would have an  $R_f = 1$ , 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), it will have an  $R_f$  less than one.



## 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?