

Paper Chromatography

Equipment

You will need a 600 mL beaker, a 50 mL graduated cylinder, 4 Expo Wet Erase markers, each a different color, three different food colors, three capillary tubes, a pencil, a ruler, a piece of chromatography paper, and a piece of plastic wrap.

Chemicals

You will need about 25 mL of ~70% isopropanol.

Introduction

In this experiment we will use the fact that "like dissolves like". What this means is that a polar substance would rather dissolve in a polar substance than in a non-polar substance, and a non-polar substance would rather dissolve in another non-polar substance than in a polar substance.

For example, alcohol (ethanol) which is polar would rather dissolve in water, which is also polar, than in oil which is non-polar.

The markers and food coloring that you will use in this experiment get their colors from one or more pigments (molecules). These pigments generally have different polarities.

We will use this fact to separate these pigments from each other, and to determine which color pigments are in each marker and food coloring.

In paper chromatography one or more samples is spotted on special paper, chromatography paper.

The paper is then placed in a developing chamber (a beaker) with a solvent in it.

The solvent is pulled up the paper, just as water is pulled into a paper towel.

As the solvent passes the sample it tries to pull the sample with it. However, the paper is trying to hang on to the sample. There is a

tug-of-war for the sample.

If the solvent has a stronger attraction for a pigment in the sample it will pull the pigment with it.

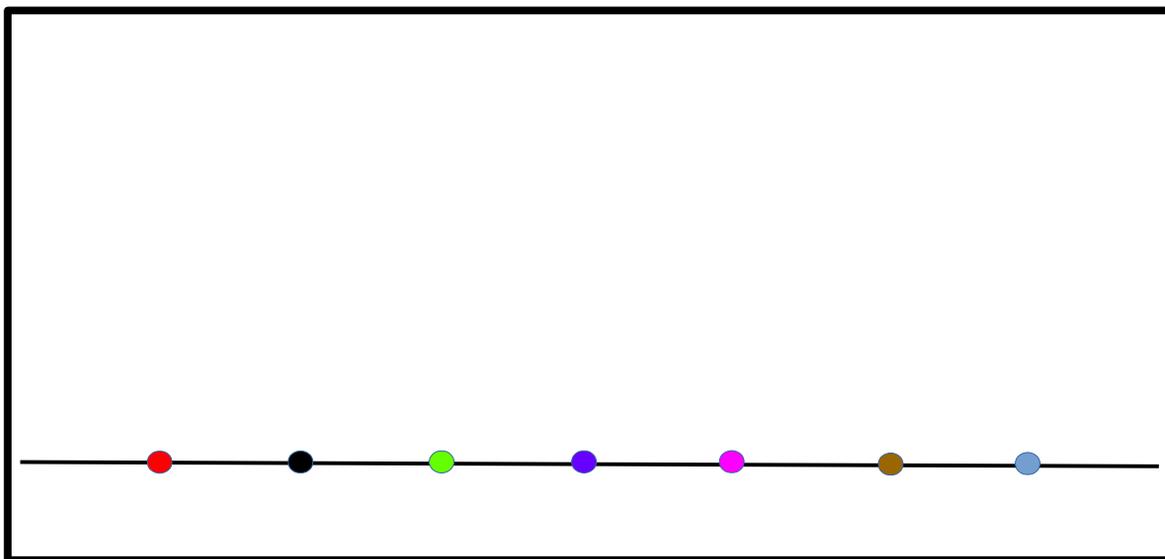
If the paper has a stronger attraction for a pigment it will hold onto that pigment.

The closer the polarity of the solvent is to the polarity of a pigment the stronger an attraction the solvent has for that pigment.

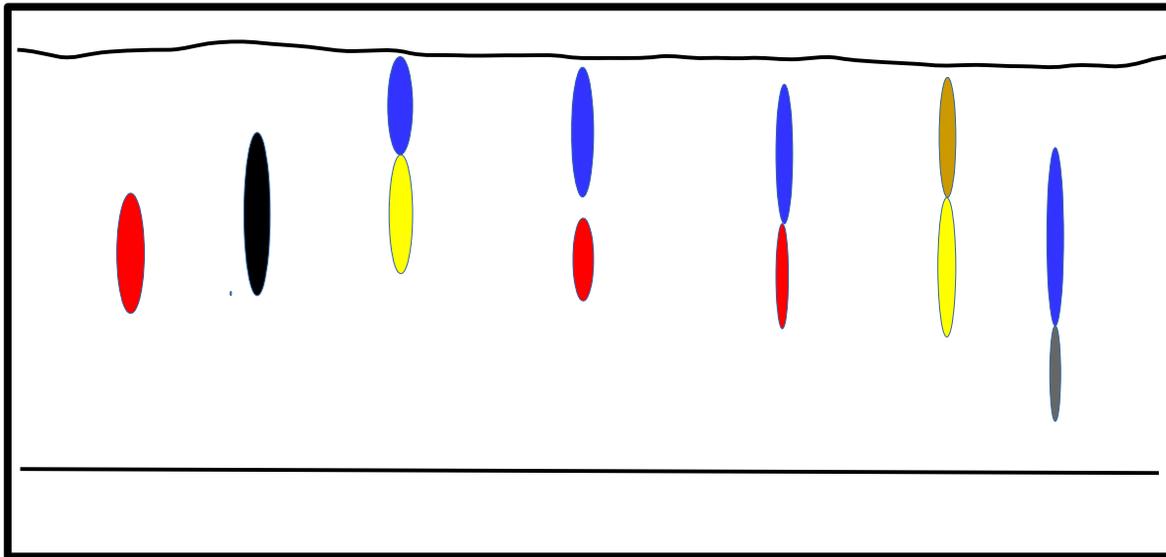
The closer the polarity of the paper is to the polarity of a pigment the stronger an attraction the paper has for that pigment.

As the solvent travels up the paper the sample is separated into it's individual pigments because each pigment has a different polarity, and will be more or less attracted to the paper (an solvent) than another pigment.

The paper would look something like this before it is placed in the developing chamber.



And after the solvent has traveled up the paper most of the way it might look like this.



This is just an example, the colors are not accurate. Each color represents a pigment. The pigments are separated from each other due to their different polarities.

The line at the top is the solvent front. That is, how far the solvent traveled up the paper before it was removed from the developing chamber.

The ratio of how far a pigment travels up a paper to how far the solvent traveled is called its R_f number.

$$R_f = \frac{\text{Distance to middle of spot}}{\text{Distance to solvent front}} \quad (\text{Equation 1})$$

Each distance is measured from the line on which the samples were spotted, not the bottom of the paper.

Procedure

- 1.) Cut a piece of chromatography in half. You should end up with a piece that is about 4 or 5 inches high and about twice that in width.
- 2.) Using a pencil (NOT A PEN!) and a ruler draw a straight line horizontally about 2 cm from the bottom of the paper.

3.) Using the pencil make 7 marks on the line, spaced out approximately evenly. No mark should be closer than about 2 centimeters to an edge of the paper.

4.) Using pencil, label the spots beneath the line you drew in the following order from left to right:

1. Red Expo
2. Blue Expo
3. Green Expo
4. Black Expo
5. Pink Food Color
6. Black Food Color
7. Green Food Color

5.) With the Expo markers make a small mark on the line where you made the pencil mark. The mark should be 1 – 2 millimeters in diameter.

6.) Using a different capillary tube (you can do a different color on each end of a capillary tube) for each different color make a similar mark at the appropriate places with each food color.

7.) Staple the ends of the chromatography paper together so that it forms a cylinder with the spots on the outside of the cylinder. **MAKE SURE THE ENDS ARE NOT TOUCHING!**

8.) Measure about 25 mL of ~70% isopropanol with your graduated cylinder and pour it into a clean 600 mL beaker.

9.) Place the spotted chromatography paper into the beaker with the isopropanol in it, the end closest to the spots down. **MAKE SURE THE PAPER DOES NOT TOUCH THE SIDES OF THE BEAKER!**

MAKE SURE THE SOLVENT DOES NOT TOUCH THE SPOTS!

10.) Cover the beaker with plastic wrap, sealing it so that the vapors can not get out.

11.) When the solvent front (the top of the wet area) gets to within 1 or 2 cm from the top of the paper remove the paper, with pencil trace the top of the solvent front, and let the paper dry. This will likely take about 1 hour.

12.) When the paper is dry, remove the staples and lay the paper flat. Measure the distance from the bottom line to the solvent front. Record this in your data section (**A1**). Make sure to use units and the correct number of significant figures.

13.) Measure the distance from the bottom line to the center of each spot. For some of the marks you made there will be more than one spot, and for some there will only be one spot. Measure all of them. Record these in (**A2**), using units and the correct number of significant figures.

14.) Calculate R_f for each spot. Show all of your work, include units and significant figures.

NAME: _____

SECTION: _____

Data and Analysis**Data:**

Distance from bottom line to solvent front: _____ (A1)

Record the distance, in cm, from the bottom line to each spot (A2)

Distance to Each Spot (cm)

Color	1	2	3	4	5	6	7

Analysis:

1.) Calculate the R_f for each spot. Show all of your work, including units and significant figures, below, neatly. Record your results in the following table.

WORK

R_f's

Color	1	2	3	4	5	6	7

2.) The more polar a pigment is, the greater it's R_f (in this experiment). For each mark that you started with (1-7), in the following table state which color pigment was most polar and which was least polar. If there was only 1 color pigment, say "1 pigment".

POLARITY

Color	1	2	3	4	5	6	7
Most Polar							
Least Polar							

3.) Based on their R_f's do you think that the food coloring uses the same pigments for each color as the Expo markers? If they do, the R_f's should be close.

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