Name: Block: 1

Partners Name: Exp Date: February 3, 2014 Due Date: February 7, 2014

Thin Layer Chromatography

Question Statement: Are all black markers a mixture of dyes and do all black markers contain the same dye(s)?

Prior Knowledge:

- TLC- Thin layer chromatography is a chromatography technique that functions in separating mixtures that aren't easily evaporated or are considered non-volatile. It can be used to monitor the progress of a reaction and to identify compounds that exist within a mixture. Thin layer chromatography can also be useful for determining the purity of a substance. This technique typically is performed on a sheet of paper that is specially used in TLC. This layer is known as the stationary phase, and after that sample being analyzed has been applied on the plate, a solvent is selected. This is known as the mobile phase. The solvent will be drawn up the plate by a capillary action, but each component of the mixture has different affinities (attractions) to the mobile phase. This results in the mixtures moving up the TLC plate at different rates, and later separation of the mixtures is achieved.
  Source: The background information from the Thin Layer Chromatography Lab handout given out in class (class notes).
- R_f Value- R_f values are used to identify the compounds that have been separated within a mixture. These values are used to describe the position of the spots seen on a chromatogram in thin layer chromatography. To figure out these values, the distance the sample travels and the distance that the solvent front travels needs to be recorded. The distance the sample travels is divided by the distance that the solvent front travels to give the R_f values. These values can be matched with known compounds to identify the components within a mixture. A similar match doesn't prove that the compounds are the same, but it suggests that they are.
  Source: The background information from the Thin Layer Chromatography Lab handout given out in class (class notes).

Evaluation/ Hypothesis:

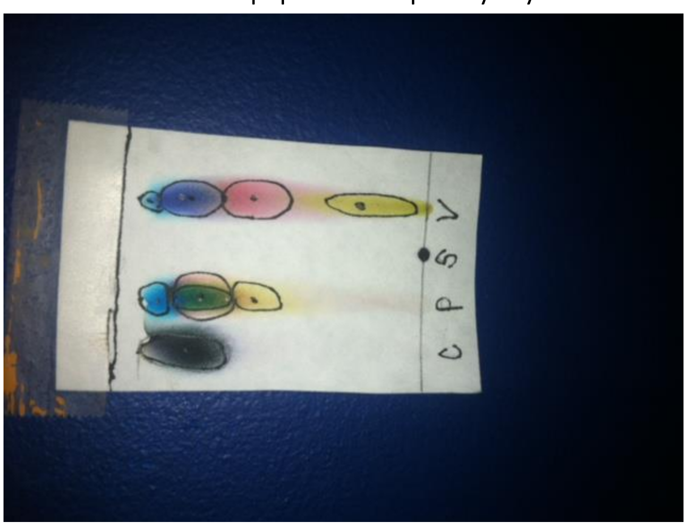
If one dot is made per black marker on the thin layer chromatography paper used in the experiment, then the thin layer chromatography paper at the end of the experiment will show that the markers are a mixture of different dyes/ components because there are different types of black markers and for this reason different components are going to be put into the different markers which aren't always going to be the same dye(s).

Materials:

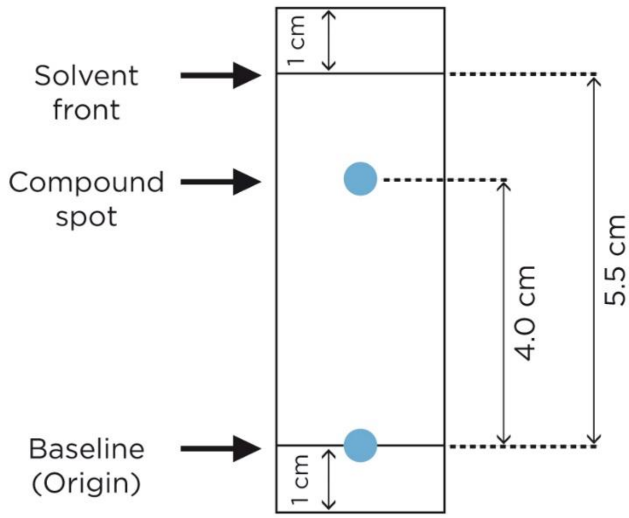
TLC Paper	Pencil	Ruler	4 Brands of Markers (Crayola, Prang, Sharpie, and Vis-à-vis)
Tape	250 ml Beaker	Water	Black Light

Procedure/Method:

1. Begin the experiment by getting the ruler and measuring one centimeter from the bottom of the TLC paper. Draw a straight line all the way across the TLC paper using pencil from this point.
2. Get the four different brands of markers and make a dot for each marker on the TLC paper on the pencil line. There should be four different dots of the same size. It would be helpful to place each dot in alphabetical order of the first initial of the brand of markers.
3. Attach the TLC paper to a pencil using tape.
4. Get the 250 ml beaker and fill it with water below the one centimeter mark on the TLC paper. The water shouldn't be above or on the pencil line, but it should be below it.
5. Carefully place the TLC paper into the chamber. Allow the solvent to move up the TLC paper within one centimeter of the top of the sheet.
6. Remove the TLC paper from the chamber.
7. Using pencil, mark where the solvent ended.
8. Allow for the TLC paper to completely dry.



Source: http://www.chemguide.co.uk/analysis/chromatography/thinlayer.html



Source:
http://www.silicycle.com/products/thin-layer-chromatography-tlc-plates/siliaplate-2

Data/Evidence/Observations:

- **Brand of Marker: Crayola**

Sample Color(s)/ Component(s)	Distance Sample(s) Traveled	Distance Solvent Traveled	Rf Calculations	Rf Value(s)
Black	45 mm.	60 mm.	45mm./60mm.	0.75 mm.

- **Brand of Marker: Prang**

Sample Color(s)/ Component(s)	Distance Sample(s) Traveled	Distance Solvent Traveled	Rf Calculations	Rf Value(s)
Yellow	30 mm.	60 mm.	30mm./60mm.	0.50 mm.
Green	45 mm.	60 mm.	45mm./60mm.	0.75 mm.
Blue	55 mm.	60 mm.	55mm./60mm.	0.9166666667 mm.
Red	45 mm.	60 mm.	45mm./60mm.	0.75 mm.

- **Brand of Marker: Sharpie**

Sample Color(s)/ Component(s)	Distance Sample(s) Traveled	Distance Solvent Traveled	Rf Calculations	Rf Value(s)
Black	0 mm.	60 mm.	0mm./60mm.	0 mm.

- **Brand of Marker: Vis-à-vis**

Sample Color(s)/ Component(s)	Distance Sample(s) Traveled	Distance Solvent Traveled	Rf Calculations	Rf Value(s)
Blue	55 mm.	60 mm.	55mm./60cm.	0.9166666667 mm.
Purple	50 mm.	60 mm.	50mm./60mm.	_ 0.83mm. / 0.83333333 mm./ 5/6mm.
Red	35 mm.	60 mm.	35mm./60mm.	_ 0.583mm./ 0.58333333 mm./ 3.5/6mm.
Yellow	15 mm.	60 mm.	15mm./60mm.	0.25 mm.

Analysis:

<u>Rf Value</u>= Distance Sample Traveled/ Distance Solvent Front Travels

<u>Rf Values</u>

Crayola:

- Black Component: 45mm. /60mm. = 0.75 mm.

Prang:

- Yellow Component: 30mm. /60mm. = 0.50 mm.
- Green Component: 45mm. /60mm. = 0.75 mm.
- Blue Component: 55mm. /60mm. = 0.9166666667 mm.
- Red Component: 45mm. /60mm. = 0.75 mm.

Sharpie:

- Black Component: 0mm. /60mm. = 0 mm.

Vis-à-vis:

- Blue Component: 55mm. /60mm. = 0.9166666667 mm.
- Purple Component: 50cm. /60mm. = 0.8333 mm. / (5/6 mm.)
- Red Component: 35mm. /60mm. = 0.583333333 mm. / (3.5/6 mm.)
- Yellow Component: 15mm. /60mm. = 0.25 mm.

Thin layer chromatography was used to identify the different components within four different brands of black markers by using Rf values in this experiment. The Rf values include the distance that the sample/component traveled and the distance that the solvent front traveled. The distance that the solvent (water) moved was measured in millimeters and it came out to travel 60 mm. The visible components on the TLC paper were circled and eventually were marked in their centers. The TLC paper was then placed under a black light to identify any unseen components, and then these components were circled and their centers were marked also. The distance was measured between the pencil line and the middle of each component of each marker in millimeters. Crayola had one component which was black. It traveled 45 millimeters, and since the solvent only traveled 60 mm., its Rf value came out to be 0.75 mm. The next brand for black markers used in this experiment was Prang. Prang had four different components. The yellow component traveled 30 mm., the green component traveled 45 mm., the blue component traveled 55 mm., and the red component traveled 45 mm. Since the solvent traveled 60 mm., the Rf values were 0.5 mm. for yellow, 0.75 mm. for green, 0.916667 mm. for blue, and for red it was 0.75 mm. In the Sharpie brand, only one component was identified. This component was black and didn't travel, instead it stayed on the pencil line. Its Rf value was 0mm. The last brand of marker was Vis-à-vis which had four identified components. They were blue, purple, red, and yellow. The blue component had an Rf of 0.916666667 mm. because it traveled 55 mm. The purple component had an Rf of 0.83333 mm. / (5/6mm.) because it traveled 50 mm., the red component traveled 35 mm. and had an Rf of 0.5833333 mm. / (3.5/6mm.), and yellow had an Rf of 0.25 mm. because it traveled 15 mm. The Rf values are used to identify the compounds within a given mixture, and in this case, the Rf values are used to identify the compounds within the four different brands of black markers.

Evaluation/Trouble Shooting/ Error Analysis:

The experiment was successful in its attempt to show the components/compounds within the mixtures of the black markers. The number of components/dyes within each black marker are clearly identified and their Rf values can be calculated because the samples, as well as the solvent front, traveled. During the experiment, several possible errors could have been made. The first possible error is how the dots from each brand of marker could have been misplaced and not put onto the pencil line that is placed one centimeter above the bottom of the TLC paper. The source of this problem is a human error. This happens if the human/person placing the dots onto the TLC paper isn't carefully placing them on the pencil line. This could allow for the dyes and components of each brand of marker to not travel at its fullest distance. It could also allow for all components to not be visibly seen on the TLC paper. Because of this, it may not be clearly known by the end of the experiment how many components/dyes each maker brand is composed of and what components make up the markers. To improve this, the dots could be correctly and carefully placed onto or slightly below the pencil line as long as each dot is placed at the same height from the bottom of the TLC paper.

Another possible error could be size of the dot placed onto the pencil line. Each dot from each brand of marker placed onto the pencil line was meant to be all the same size. If one were to be larger than the other, then this would allow for the components to be larger, be released quicker, and they'd be scattered and could possibly move onto other components of the other brands of markers, and this would create for a mess. The source of this error is a human and also the size of the tip of each marker brand since they are different sizes. One marker tip could be larger than the other which would create a larger dot than the other brands of markers. To improve this, it would be a more effective technique to make sure that the size of each dot made by each marker brand was the same. The diameter of each dot could be measured to be positive that the sizes of the dots are equal to each other or at an almost equal size. This way the error could be prevented.

Concluding Argument/Conclusion/Reflection:

TLC is known as thin layer chromatography. It is a technique used to separate mixtures that can't be separated as effectively with any other method of separation. It identifies the components and compounds within a given mixture and can be used to compare and contrast the components within one mixture from the components within another mixture. Thin layer chromatography is important and useful to chemists because it allows them to recognize that not all mixtures are made up of the same components/compounds. It also allows chemists to identify what components are within a given mixture so that they can learn how to possibly replicate the given mixture or create alternatives for the mixture. TLC is also useful to chemists since it gives them the ability to know what components to combine together to create a specific mixture while using a method of separation that isn't as harmful as other methods of separation may be.

By the end of the experiment it is clearly proven that, based on the chromatogram in the experiment, that not all black markers contain only one dye and that not all black markers use the same dye(s). The first question to be answered was whether or not all black markers contain merely one dye. Crayola was one brand of black marker used in the experiment. When the solvent moved up the TLC paper, the component of the dot made from the Crayola black marker was released. There was only one component in the Crayola marker which was black. The brand Prang was also used during the experiment. When its components were released, there were four components. They were yellow, green, blue, and red, which are all different from the dye seen in Crayola. There were four components seen in Prang whereas there was only one seen in Crayola. In the Sharpie brand one component was identified which was black. The final brand of black marker used in the experiment was Vis-à-vis. There were four components of Vis-à-vis which were blue, purple, red, and yellow. Because there was more than one dye in Prang and Vis-à-vis, not all black markers contain only one dye and this supports the hypothesis which states that not all black markers contain one dye.

The second part of the question to be answered was whether or not all brands of black markers use the same dye(s). From the black markers used in this experiment, it is proven that not all black markers use the same components/dyes. Crayola's only component was black and it moved 45 mm. away from the pencil line. The Sharpie brand was also composed of a black component, but it stayed where it was. If they were the same dyes, then they would have had the same Rf value. They didn't have the same Rf value because the Rf value of Crayola's black component was 0.75 mm. whereas the Rf value of Sharpie's black component was 0 mm. Further evidence to support how not all black markers use the same components or dyes is how Prang showed yellow, green, blue, and red components which isn't the same as the one black component seen in both Crayola and Sharpie. The fourth brand of black marker, Vis-à-vis, also contained different components. It had a blue, purple, red, and yellow component. The components that were the same color in both Vis-à-vis and Prang were mainly not the same though since they didn't have the same Rf values. The blue in both marker brands contained the same Rf values, but the yellow in Prang had an Rf value of 0.5 mm. whereas the yellow in Vis-à-vis had an Rf value of 0.25 mm. The different Rf values of the same components and the different Rf values of the different components between the four black marker brands used in the experiment support the hypothesis of how not all black markers contain only one dye and how they don't all use the same dye(s).

Post Lab Question (1):

1. **What is different about the typical Sharpie marker? How could you change the experiment to see if the black used in the "Sharpie" brand of marker is made of more than one dye?**

   What is different about the typical Sharpie marker is that it only contains one component/dye. This dye is black and when a dot made by this marker is used in TLC, the sample/dot doesn't move or change shape whereas the other components mainly do. It is composed of only a black dye whereas other brands of black markers may be composed of more than one dye that isn't only black including the Prang brand of marker which contains the dyes yellow, green, blue, and red. This experiment could be changed to see if the black used in the "Sharpie" brand of marker is made of more than one dye by placing the dots for each brand of marker lower than the one centimeter mark above the TLC paper. This way, the solvent will reach the dot made by the Sharpie quicker and in a fuller form which will allow for the components of the black in the Sharpie marker to be identified once they are released. To change this experiment, the solvent could also be changed. Instead of using water, another solvent can be used that would allow for the components of the black in the Sharpie marker to be seen. For example, instead of using water, a substance such as alcohol could be used. This way the components of the black in the Sharpie marker can move and be released in a more efficient manner than when water is used as the solvent.

Post Lab Question (2):

2. **Why should chemists use a black light to observe the chromatogram?**

Chemists should always use a black light to observe a chromatogram to identify any undetected components on the chromatogram. Once the mixtures have been placed onto the TLC paper and their components have been released and moved along with the solvent, visible components can be identified. Even though this is true, not all components in a mixture on TLC paper will be visible. Some will be unable to be in seen in some mixtures. A dye/component may not be able to be visibly seen on TLC paper even though it's there. Certain color dyes from a mixture may not show up on a TLC paper also. Therefore, chemists should always use a black light when observing a chromatogram so that they don't miss any component(s) from the mixture(s). If several components were unseen from the mixtures then this could cause the results of the experiment using the TLC paper to be incorrect and unreliable.