

Introduction

It is suspected that a rival company producing felt tip pens is stealing ideas for new colour from primary colour, a leading felt tip pen manufacturer. The company requires proof before it starts making allegations and requires you to devise a test to determine whether the colours have been stolen. Somebody on the inside of the rival company has supplied the company with same prototype from the rival company for you to test whether the rival felt tip pen manufacturer is stealing ideas for new colours from the other company.

Aim

The aim of this coursework is to find if the rival company is stealing the other company's new idea. To determine if they have stolen new ideas for a new felt tip, I will perform simple tests however effective (paper chromatography and thin layer chromatography). I will reform tests on the prototype and the company's felt tip to see any similarities.

Paper chromatography

Paper chromatography is one method for testing the purity of compounds and identifying substances. Paper chromatography is a useful technique because it is relatively quick and requires small quantities of material.

Paper chromatography is an analytical technique for separating and identifying compounds that are or can be colored, especially pigments. This method has been largely replaced by thin layer chromatography, however it is still a powerful teaching tool.



Separations in paper chromatography involve the same ideology as those in thin layer chromatography. In paper chromatography, like thin layer chromatography, substances are distributed between a stationary phase and a mobile phase. The stationary phase is usually a piece of high quality filter paper. The mobile phase is a developing solution that travels up the stationary phase, carrying the samples with it. Components of the sample will separate on the stationary phase according to how strongly they adsorb to the stationary phase versus and how much they dissolve in the mobile phase.

The purpose of this experiment is to observe how chromatography can be used to separate mixtures of chemical substances, in this case separate felt tip pen. Chromatography serves mainly as a tool for the examination and separation of mixtures of chemical substances. Chromatography is using a flow of solvent or gas to cause the components of a mixture to migrate differently from a narrow starting point in a specific medium, in the case of this experiment, paper. It is used for the purification and separation of various substances. A chromatographically pure substance is the result of the separation. Because cleansing of substances is required

to determine their properties, chromatography is an essential tool in the sciences concerned with chemical substances and their reactions.

Chromatography is also used to compare and describe chemical substances. The chromatographic progression of substances is related to their atomic and molecular structures. A change in a chemical substance produced by a chemical or biological reaction often alters the solubility and migration rate. With this knowledge, alterations or changes can be detected in the substance.

In all chromatographic separations, there is an important relationship between the solvent, the chromatography paper, and the mixture. For a particular mixture, the solvent and the paper must be chosen so the solubility is reversible and be selective for the works of the mixture. The main requirement, though, of the solvent is the mixture needing to be separated. The absorbent paper used must also absorb the components of the mixtures selectively and reversibly. For the separation of a mixture, the substances making up the mixture must be evenly dispersed in a solution, a vapor. Once all of the above criteria have been met, chromatography can be a simple tool for separating and comparing chemical mixtures.

Because molecules in ink and other mixtures have different characteristics (such as size and solubility), they travel at different speeds when pulled along a piece of paper by a solvent (in this case, water). For example, black ink contains several colours. When the water flows through a word written in black, the molecules of each one of the colours behave differently, resulting in a sort of “rainbow” effect. Many common inks are water soluble and spread apart into the component dyes using water as a solvent. If the ink you are testing does not spread out using water, it may be “permanent” ink. In such cases, you will have to use a different solvent.

Method

The first step of the method is to bend a paper clip so that it is straight with a hook at one end. Push the straight end of the paper clip into a pencil. Next, you hang a thin strip of filter paper on the hooked end of the paper clip. Insert the paper strip into the beaker. The paper should not touch the sides of the beakers and should almost touch the bottom of the beaker. Now you will remove the paper strip from the beaker.

Pour same water into the beaker and in the second one pour same iodine. The water will act as a solvent. Put the filter paper back into the beakers with the bottom of the paper in the water and the base line above it. Observe what happens as the liquid travels up the paper. Record the changes you see. When the solvent has reached the solvent front, remove the paper from the beakers. Measure how far the solvent travelled for both of the papers, before the strip dries. Finally, let the strip dry on the desk. With the ruler, measure the distance from the starting point to the top edge of each colour. Record this data in a data table. Calculate the R_f for each colour by dividing the distance the colour travelled by the distance the solvent travelled.

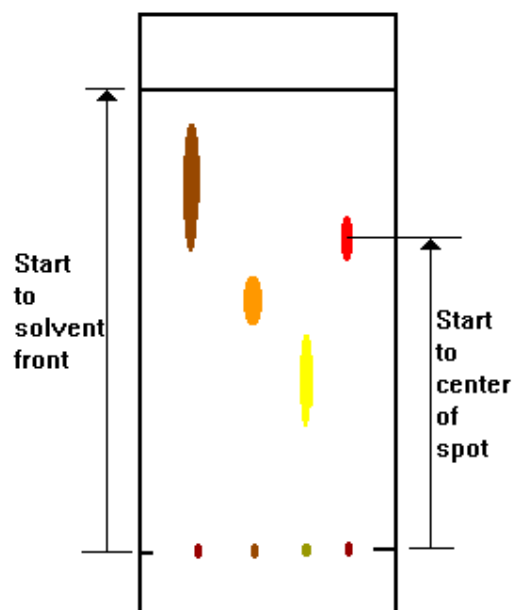
Apparatus

- Beaker

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- Paper
- Felt tips
- Water
- Ruler
- Pencil

Diagram



(Note: R_f values often depend on the temperature, solvent, and type of paper used in the experiment; the most effective way to identify a compound is to spot known substances next to unknown substances on the same chromatogram.)

Problems faced when doing this coursework:

The problems that I faced was that when I was doing the experiment, once I put in the paper the beaker the beaker came very floppy so I had to hold it till the experiment so over. The other problem was that the spot size was not all the same and may have given as same uneven results.

Results for paper chromatography

The R_f value for each spot should be calculated. R_f stands for "ratio of fronts" and is characteristic for any given compound. Hence, known R_f values can be compared to those of unknown substances to aid in their identifications.

$$R_f = \frac{\text{Distance from start to center of substance spot}}{\text{Distance from start to solvent front}}$$

This is the first set of results that I got from the first felt tip that I used and the colours that I used are:

Brown gave	Distance travelled by solvent	Distance travelled by colour	R_f values
BLUE	6 cm	6 cm	1
RED	6 cm	5.7 cm	0.95
YELLOW	6 cm	4.8 cm	0.8

Blue gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Blue	6 cm	5.9 cm	0.983

Yellow gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Yellow	6 cm	5.1 cm	0.83

This is second set of results that I got from the prototype felt tip and this is the colour that I used:

Brown gave	Distance travelled by solvent	Distance travelled by colour	R_f values
BLUE	7.8 cm	7.8 cm	1
RED	7.8 cm	7.6 cm	0.97
YELLOW	7.8 cm	7.2 cm	0.92

Blue gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Blue	7.8 cm	7.8 cm	1

Purple	7.8 cm	7.4 cm	0.94
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Yellow gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Yellow	7.8 cm	7.4 cm	0.94

Thin layer chromatography

Thin-Layer Chromatography (TLC) is a simple and inexpensive technique that is often used to judge the purity of a synthesized compound or to indicate the extent of progress of a chemical reaction. In this technique, a small quantity of a solution of the mixture to be analyzed is deposited as a small spot on a TLC plate, which consists of a thin layer of silica gel (SiO_2) or aluminum (Al_2O_3) coated on a glass or plastic sheet. The plate constitutes the stationary phase. The sheet is then placed in a chamber containing a small amount of solvent, which is the mobile phase. The solvent gradually moves up the plate via capillary action, and it carries the deposited substances along with it at different rates. The desired result is that each component of the deposited mixture is moved a different distance up the plate by the solvent. The components then appear as a series of spots at different locations up the plate. Substances can be identified from their so-called R_f values. The R_f value for a substance is the ratio of the distance that the substance travels to the distance that the solvent travels up the plate.



Before attempting to apply TLC to the challenging problem of separating and identifying the felt tips, it is advisable to learn and practice the technique by applying it to mixtures that are easily visualized and separated. Inks provide an ideal practice vehicle for TLC because they normally contain several coloured components that separate nicely in common solvents such as water. Spotting the plate is also easy: it may be done simply by making a VERY small mark on the plate with the tip of a pen, just above the pencil line drawn across the bottom edge of the plate. Inks are of different types and colours, of course. Some are washable (water-soluble), others are permanent. Different types require different solvents for development. Common sources of ink are ballpoint pens, felt-tip markers, and roller ball pens. Bottled ink is still available for people using fountain pens. You should select inks from at least 2 different sources available in the lab and should find a solvent or mixture of solvents that separates each ink into its component colours.

I will be an assigned two-ink sample to examine as well as I will carry out two experiments, one with the prototype that has been provide and one from the company itself to spot any simulates. The process is similar to paper chromatography with the advantage of faster runs, better separations, and the choice between different stationary phases. Because of its simplicity and speed TLC is often used for monitoring chemical reactions and for the qualitative analysis of reaction products.

Method

Into your first developing beaker, pour same water in the beaker. Holding the top end of the spotted plate, lower the plate into the beaker. Allow the bottom of the plate to rest on the bottom of the beaker, with the top of the plate leaning against the sidewall of the beaker. NOTE: IT IS VERY IMPORTANT THAT THE START LINE AND SPOTS BE ABOVE THE LEVEL OF SOLVENT. Monitor the movement of solvent up the plate. When solvent has advanced to the top pencil line (solvent front), remove the plate from the beaker, and allow all solvent to evaporate. Use a pencil to outline each observed spot on the plate, preserving the shape of the spot.

If water did not effect a separation of the ink into components, try another solvent. If you found that the ink moved along with or close to the solvent front, try a less polar solvent. If you found that the ink did not move at all with water, try a more polar solvent (e.g., ethanol). Your goal is to cleanly separate each of your ink samples into its constituents, each constituent producing a single TLC spot. Be aware that some inks contain only one component!

Apparatus

- Beaker
- TLC
- Felt tips
- Water
- Ruler
- Pencil

Diagram

Problems faced when doing this coursework:

Over-large Spots If the initial spot are large, then components with similar R_f values may not be resolved because their spots will be so large that they will overlap considerably and may appear to be one large spot. Small initial spots, on the other hand, maximize the potential of complete separation of components.

Uneven Advance of Solvent Front. A common problem in TLC is uneven advance of solvent along the plate. Instead of a straight line, the solvent front may appear to bow either up or down in the centre. Uneven advance of solvent leads to uneven advance of substance spots, and inaccurate R_f values result. A frequent cause of uneven solvent that does not have a flat bottom. Glass bottles usually have bottoms that curve upward from the edges to the centre. If the bottom of the TLC plate is placed on this curved surface, the shape of the solvent advance line may mirror the shape of the container bottom. It is therefore important to use flat-bottomed developing tanks in TLC. A bowed solvent front may also result if too little developing solvent is placed in the chamber; if the plate is cut improperly, so that the sides are not exactly perpendicular to the bottom edge; and if the slide is excessively tilted in the chamber. Care in choosing and using a developing chamber is the best defence against curved solvent fronts.

$$R_f = \frac{\text{Distance from start to center of substance spot}}{\text{Distance from start to solvent front}}$$

Results

This is my result I got from the thin layer chromatography using the felt tip

Brown gave	Distance travelled by solvent	Distance travelled by colour	R_f values
BLUE	4.5 cm	4.5 cm	1
RED	4.5 cm	4.3 cm	0.95
YELLOW	4.5 cm	4 cm	0.88

Blue gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Dark blue	4.5 cm	3.9 cm	0.86
Yellow	4.5 cm	4.1 cm	0.91

Yellow gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Yellow	4.5 cm	4.5 cm	1

This the second result I got from the thin layer chromatography using the prototype felt tips

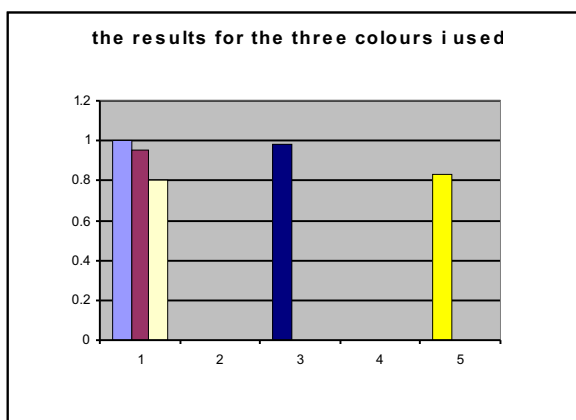
Brown gave	Distance travelled by solvent	Distance travelled by colour	R_f values
BLUE	4.7 cm	4.7 cm	1
RED	4.7cm	4 cm	0.85
YELLOW	4.7cm	4.3 cm	0.91

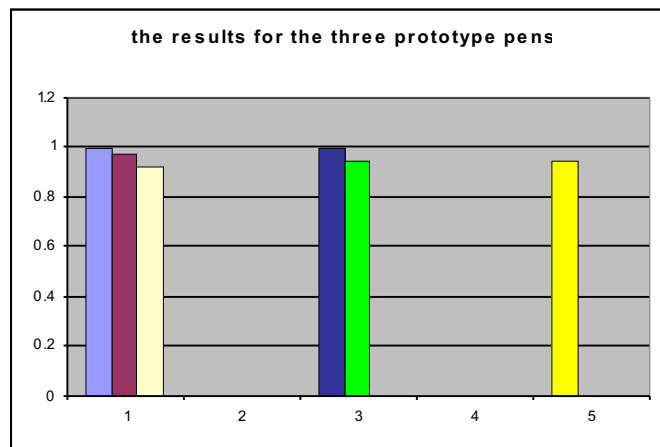
Blue gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Dark blue	4.7 cm	3.9 cm	0.82
Yellow	4.7cm	4.1 cm	0.86

Yellow gave	Distance travelled by solvent	Distance travelled by colour	R_f values
Yellow	4.7cm	3.8 cm	0.80

Conclusion

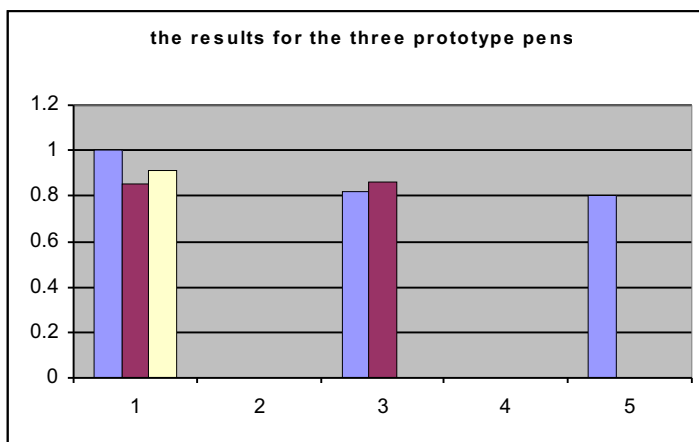
This is result that I got for my paper chromatography. The first graph shows the results of the company's pen and the second graph shows the results of the prototype pen. In addition I can see that there are no similarities between the two pens, which indicates that the rival company has stolen their idea for a new primary colour. However, the results that I got may not have been as accurate as it should have which could have given me a different result and a more accurate result to. Furthermore the other problems that I faced were due to the paper I used and the water I used. Firstly the paper I used in the to two experiments were not the same size which meant that the ink was not able to travel at the same speed, also the solvent front was not at the same measurement which meant that for one of the inks the water would have reached the it first. Secondly, the water that was used in the beakers was not measured so we had two different volume of water in the two beakers, which once again meant that the results might not have been as accurate as it should have been.

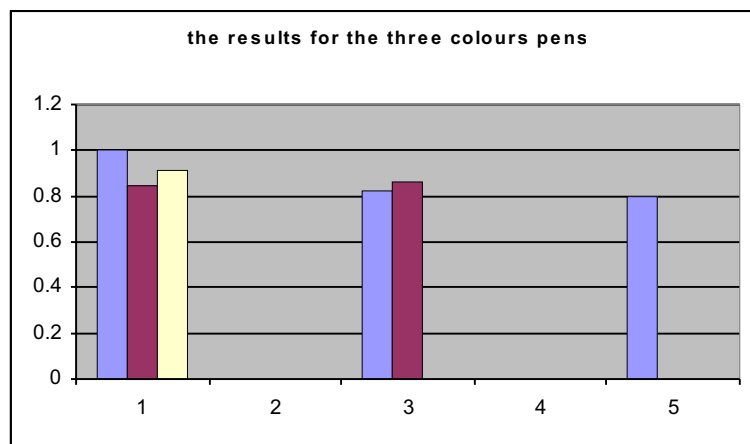




Thin layer chromatography

The first graph shows the results that I got for the pen the company used and the second graph shows the results that I got for the prototype pen, which is from the rival company. After comparing the two graphs I can see that the thin layer chromatography has given a more accurate and I can distinguish that the two results are very corresponding. Thin layer chromatography has given me a more reliable result, which I can say know that the two pens are very identical and say that the rival company has stolen the other company's idea for a new primary colour. In addition, even I used different volume of water I have got an accurate result because TLC was the same size for the two tests I did and also the solvent front was the same measurement, which meant that the water reacted the ink nearly the same time.





In conclusion I can say that by analysing the paper chromatography graphs and the thin layer chromatography graphs I articulate that the rival company has stolen their idea for a new primary colour.

Risk assessment

Glass equipment

Beakers: when doing this you will be using three to four beakers and for safety reasons you should not be walking around with the beakers and also make sure that the beaker doesn't roll down the table.

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