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Chemistry 1

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**Effect of solvents on Paper Chromatography**

# Introduction

Chromatography is a technique for separating the components of a mixture by using a mobile phase (a moving fluid stream) and a stationary phase.[[1]](#endnote-1)

Paper chromatography, an easy and direct way of chromatography, is a technique for separating dissolved chemical substances by taking advantage of their different rates of migration across sheets of paper. It is an inexpensive but powerful analytical tool that requires very small quantities of material.[[2]](#endnote-2)

In the experiment, we are given: (1) a sample of paper chromatography result of a pen found at the scene of a crime, (2) three suspected pens (labelled A, B and C), one of which is the murderer’s. We need to identify which is that pen and catch the murderer.

The **goal** of this experiment is to identify whether Pen B is the pen we are looking for by using the method of paper chromatography. During the experiment, water was first used as the solvent to dissolve the ink of Pen B, but the ink was not separated at all. Thus, **hypothesis** was made that the ink of Pen B maybe non-polar substance and thus can only be dissolved in non-polar solvent instead of polar substances like water during the process of paper chromatography. The reason of that hypothesis is that nonpolar substances don’t interact with water, a polar substance, and stay separated.[[3]](#endnote-3) They can only form solutions with other non-polar substances[[4]](#endnote-4) or amphipathic matter like ethanol, which contains both polar particles and non-polar particles[[5]](#endnote-5).

# Methods

### Controls and replication

**Controlled variables:**

* The water temperature
* The same components of the ink
* The size of the ink spot
* The mass of solvent used in each trial
* The length of the part of filter paper immersed in the solvent
* The shape and size of the filter paper

**Replication:**

Use solvent of different concentration of ethanol to exam the effect of solvent on paper chromatography.

This experiment is divided into three trials: distilled water, 3:1 water: ethanol, 1:1 water: ethanol.

### Experimental Design

**Materials**:

* Several pieces of filter paper
* A marker to test (Sample B)
* A ruler
* A pencil
* Water
* ethanol
* A beaker
* Tape
* A pair of scissors
* A dropper
* Glass stirring rod

**Procedure：**

1. Gather all the materials
2. Cut the filter paper into three pieces. Obtain the middle part and cut the bottom of the paper sharp
3. Draw a straight line 1 cm above the bottom across the paper by using the ruler and the pencil.
4. Draw a small dot with Pen B on the straight line.
5. Cut a piece of tape and stick the dotted filter paper on a pencil.
6. Hung the pencil on the beaker.
7. Use a dropper to add water into the beaker from the rim of the cup until the water reaches the bottom of the filter paper (the spot must stay above the water so that the experiment will work well).
8. Observe the water soaks up the filter paper until it reached the top of the paper.
9. Take the filter paper down the beaker gently and lay it until it dries.
10. Wash the beaker and add a solvent of 1:3 for ethanol and water into the beaker and hung a new dotted filter paper on the beaker.
11. Repeat step 8 and 9
12. Replace the beaker with another one that has a solvent of 1:1 for ethanol and water and repeat step 8 and 9.
13. Collect all the filter papers.

# Results

Figure 1: with solvent water



Figure 2: with solvent 1:3 ethanol and water



Figure 3: with solvent 1:1 ethanol and water



According to these three experiments, the ink became increasingly easily spread as more ethanol was added, and it can be concluded that the ink is non-polar and thus can be dissolved in the amphipathic ethanol for paper chromatography.

# Analysis

### Conclusion and Support

In this experiment, the aim was to identify whether Pen B is identical to the sample, and it is hypothesized that the ink of Pen B is non-polar substance so it can only be dissolved in non-polar or amphipathic solvent.

After performing the experiment and doing several trials, it was confirmed that Pen B is not the murderer’s and that the hypothesis is reasonable. Although the data is not that precise and there are limitations due to the limited class time and imperfect procedures, the overall difference between the effect of solvent is significant, leading to the conclusion that even though polar solvent cannot be used for paper chromatograph, components of non-polar substances can be separated using non-polar substances or amphipathic substances, which include both polar and non-polar particles.

### Limitations

The experiment may not be that well-founded because of the limited trials and the inaccurate measurement as a result of the limited time in class.

Moreover, Trial 3 was not that successful because the solvent only still soaks up half way of the paper after around 40min, and thus the components cannot be completely separated. The reason for that may be relatively quick evaporation of ethanol in the solvent and because the ethanol kept evaporating at high speed, it was hard for the solvent to move upward.

Thirdly, the last procedure of drying the filter paper was not did properly, causing the colors that had been separated to spread all over and mix together again.

But these limitations can be minimized by (1) use a cover on top of the beaker to prevent the loss of ethanol, (2) directly take out the filter paper as soon as the water reaches the top of it, hang it up and let it dry naturally in the air.

### Significance

The experiment not only shows that chromatography is applied to a wide range of areas, but also confirmed that “like dissolves like”.

For future study, it is really interesting to keep on investigating the effect of different solvents with different concentrations on paper chromatography and the deeper reason behind that kind of phenomena.

1. URL: <https://www.britannica.com/science/chromatography>

   Website Title: Encyclopædia Britannica

   Article Title: Chromatography

   Date Published: November 17, 2016

   Date Accessed: October 06, 2018 [↑](#endnote-ref-1)
2. URL: <https://www.britannica.com/science/paper-chromatography>

   Website Title: Encyclopædia Britannica

   Article Title: Paper chromatography

   Date Published: June 01, 2018

   Date Accessed: October 06, 2018 [↑](#endnote-ref-2)
3. Book Title: Biology

   [Chapter 2.2 Water](https://cnx.org/contents/GFy_h8cu@9.85:pPjfgsd4@9/Water)

   Book Publisher: OpenStax, Rice University

   Publication Year: 2016

   Date Accessed: October 06, 2018 [↑](#endnote-ref-3)
4. URL: [https://www.school-for-champions.com/chemistry/polar\_molecules.htm#.W7ehq2j7TD5](https://www.school-for-champions.com/chemistry/polar_molecules.htm%23.W7ehq2j7TD5)

   Website Title: Three Lever Classes by Ron Kurtus - Succeed in Understanding Machines: School for Champions

   Article Title: Polar and Non-Polar Molecules

   Date published: September 19,2016

   Date Accessed: October 06, 2018 [↑](#endnote-ref-4)
5. URL: <https://sciencing.com/info-12066577-alcohol-dissolve-oil.html>

   Website Title: Sciencing

   Article Title: How Does Alcohol Dissolve Oil?

   Date Published: January 09, 2018

   Date Accessed: October 06, 2018 [↑](#endnote-ref-5)