CheMystery!

CHROMATOGRAPHY LAB (with Coffee Filter Paper)

The case of the missing Chemistry teacher.

INTRODUCTION:
Upon entering your chemistry class you are told by the school police officer that Mr. Beals, your chemistry teacher, has gone missing. It appears to be an abduction! Some of your classmates cheer (which is rude, by the way) and others cry (which is weird, by the way) and others (you) decide to take action and see if you can solve this CheMystery! The police officer mentions that there was a ransom note left at Mr. Beals desk and that they have several suspects in the school (it appears Mr. Beals may have some frenemies amongst the staff!). Upon analysis of the situation, you ask the police officer if you can collect a pen from each of the suspect's desks so you can compare it with the ransom note. He agrees, reluctantly. You collect pens, each the same color as the ransom note. Then, you put science to work…

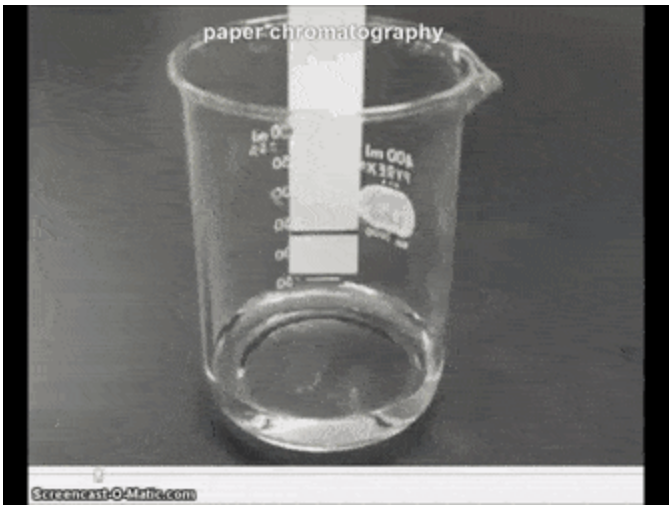
You notice that the ransom note is written in black ink which means you can probably solve this CheMystery using a chemistry technique called "Chromatography". Black ink is not actually "black" it is a mixture of several different colors of dyes and every pen manufacturer uses a

different combination of colors to make their own black ink. All of these colors are mixed together so they absorb most of the light that shines on them, therefore they don't reflect any colors back to your eyes (your eyes/brain tell you that this color is black). You rationalize that if you can get the ink to separate into the different colors that it is made of, you can then test ransom note ink and the ink from several teachers' pens and see which pen matches the colors on the chromatography paper from the ransom note. Yay for science!

SAFETY CONCERNS:
Read the procedure and identify the safety concerns

BACKGROUND:
Read the information below and write the definition for each of the **bold** words in the Background section of your lab notebook.:

Chromatography means "color writing". **Chromatography** involves the separation of mixtures into individual color components. Using this technique, the components of a **mixture** in a liquid medium are separated. The pigment is placed on chromatography paper 1 or 2 cm from the bottom. The separation occurs when the chromatography paper absorbs a liquid that acts as a **solvent**. The solvent wicks up the paper via **capillary action** and attaches to the different pigments and carries the various colors in ink up the paper. The pigments are separated on the paper and show up as colored streaks because some pigments are held more tightly to the paper (via intermolecular forces) than others. The pigments that are the least attracted to the paper will travel to the top. The pattern of separated components on the paper is called a **chromatogram**.



PRE-LAB QUESTIONS:

1. There are no pre-lab questions for this lab! Yay for science!

MATERIALS:

Coffee Filter
Distilled Water
250 ml beaker
Pencil
Scissors and Ruler
Piece of Ransom note with a dot of ink
Timer (chromebook)

CAUTION: [If you are using any solvent other than water, beware of the following] Chromatography solvents are flammable and toxic. Have no open flames; maintain good ventilation; avoid inhaling fumes.

PROCEDURE:

PART 1: RANSOM NOTE CHROMATOGRAPHY

1. Collect one strip of the RANSOM NOTE (from your instructor, who coincidentally looks a lot like Mr. Beals but MUST be an imposter – because Mr. Beals has been abducted, remember?). This piece of ransom note will be your "unknown".

2. Draw a pencil line through the dot on the ransom note horizontally. Place the chromatography strip (Ransom Note) into a beaker so the pencil line is near the bottom of the beaker. Lay a pencil across the top of your beaker so the paper can lean against it and it will hold the paper upright in the beaker so it doesn't touch the side of the glass. Tape it to the pencil if necessary.

3. Remove the Ransom Note from the beaker then add 10 ml of water to your 250ml beaker. Carefully place the ransom note into your beaker with the dot toward the bottom and **do not allow the dot to touch the water**. The ransom note strip should be touching the bottom of the beaker but not the sides of the beaker. Start a timer immediately.

4. Record observations of the ransom note chromatography paper as the color rises toward the top. Remove the paper after 12 minutes and allow it to dry on your lab table (do not put it on a paper towel).

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PART 2: SUSPECT CHROMATOGRAPHY

5. (See the drawing at the end of this document for help with this step) Using pencil, draw a circle in the center of the coffee filter by tracing the bottom of the 250ml beaker. Place one dark dot of ink (make it about the size of a BB) on the pencil line. Label the dot using pencil. **DO NOT REMOVE THE PENS FROM THEIR STATION - OTHER PEOPLE NEED TO USE THEM!**

6. Repeat with another pen making sure that the two dots are far enough away from each other that they will not bleed into each other (approx 1.5 cm). Using a pencil, label the dot with the name of the suspect.

7. Repeat with all of the pens. Be sure to label each pen-dot very clearly with pencil. These are your “standards” that you will use to compare with the “unknown”.
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8. Add 25ml of water to the 250ml beaker. Place the coffee filter over the top of the beaker and, using your pointer finger, push the center down into the water. The center of the filter should be immersed in the water. **Do not let the pen dots touch the water in the bottom of the beaker.** Start the timer.

9. After 12 minutes, remove the coffee filter. Allow to dry by gently waving around or blowing on it then place it on your lab table - do not set on a paper towel.

10. Make qualitative observations of the dots on the coffee filter and compare with the ransom note. Include the observations in your Data/Observations section.

DATA AND OBSERVATIONS:
Redraw the chromatography standards and the unknown in your lab notebook. Use appropriate colors. Refer back to this data for the post lab and conclusion.

CLEANUP:
Leave your coffee filter and ransom note in your lab locker in case you need it later.
Clean all glassware and your lab station.

~~HONORS ONLY: Calculate the Rf for each color that came from each ink dot. When you are done each ink dot should have its own data table showing the Rf for each color (including the unknown)~~
~~*Note: You only need to calculate the Rf values for the Ransom Note chromatogram and the suspect’s chromatogram (you must choose your suspect based on your visual observations of the chromatograms.~~

~~**Rf = Distance moved by the pigment color / Distance moved by the solvent**~~

~~Measure the distance in cm from the starting point (pencil line) to the center of each pigment band (each different color). Then measure the entire distance traveled by the solvent (this is the furthest point the alcohol traveled on your chromatography paper). Do the required divisions and record your Rf values in the data table.~~

POST LAB:

1. Read the excerpt below “How Does Chromatography Work” and briefly explain, using scientific principles and scientific terms, why the ink dyes separate into their different colors.
2. Solve the CheMystery! Who is the culprit? Prove it with science and data! (Just a very quick summary - you will elaborate on this in your conclusion)

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How Does Chromatography Work

excerpt from http://www.explainthatstuff.com/chromatography.html

Think of chromatography as a race and you'll find it's much simpler than it sounds. Waiting on the starting line, you've got a mixture of chemicals in some unidentified liquid or gas, just like a load of runners all mixed up and bunched together. When a race starts, runners soon spread out because they have different abilities. In exactly the same way, chemicals in something like a moving liquid mixture spread out because they travel at different speeds over a stationary solid. The key thing to remember is that chromatography is a surface effect.

As the liquid starts to move past the solid, some of its molecules (energetic things that are constantly moving about) are sucked toward the surface of the solid and stick there temporarily before being pulled back again into the liquid they came from. This exchange of molecules between the surface of the solid and the liquid is a kind of adhesive or gluing effect called adsorption (with a d—don't confuse it with absorption, with a b, where molecules of one substance are permanently trapped inside the body of another). Now remember that our liquid is actually a mixture of quite a few different liquids. Each one undergoes adsorption in a slightly different way and spends more or less time in either the solid or the liquid phase. One of the liquids might spend much longer in the solid phase than in the liquid, so it would travel more slowly over the solid; another one might spend less time in the solid and more in the liquid, so it would go a bit faster. Another way of looking at it is to think of the liquid as a mixture of glue-like liquids, some of which stick more to the solid (and travel more slowly) than others. This is what causes the different liquids within our original liquid mixture to spread out on the solid.

For chromatography to work effectively, we obviously need the components of the mobile phase to separate out as much as possible as they move past the stationary phase. That's why the stationary phase is often something with a large surface area, such as a sheet of filter paper, a solid made of finely divided particles, a liquid deposited on the surface of a solid, or some other highly adsorbent material.

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CONCLUSION

Justify your accusations about the abductor to the police man using SCIENCE, data and Rf values (if you calculated them) in RSVCP format.

Write a paragraph in RSVCP format that describes the results of the lab.

- Restate the purpose of the lab.

- Verify conclusions by providing 3 or more results. This should include any numerical findings (data) of significance and how they helped you determine the ‘culprit’ or rule out the other suspects.

- Provide a counterclaim by addressing specific experimental errors and suggest possible experimental improvements.

- Provide importance to the experimental process by providing a specific real-world application.