Western Engineering Outreach

Chromatography: The Proof Is in The Ink

Grades 3-5

Meet Today's ENG HERO!

Lauren Flynn –Professor

Dr. Flynn is a professor of Chemical and Biochemical Engineering at Western. Her research involves stem cells and tissue regeneration technologies. She is working on the development of cell-based regenerative therapies and bio scaffolds that could be applied to wound healing and angiogenesis. This research requires collaboration with other engineers, biologists, imaging scientists and clinicians. To learn more about Dr. Flynn and her research, visit:
https://www.eng.uwo.ca/chemical/faculty/flynn_l/index.html

Learning Goal:

- Students will learn about chromatography
- Students will learn about chemical and physical changes
- Investigate the applications of chromatography
- Curriculum Connections: Grade 5: Properties and Changes in Matter

Materials Needed:

Intro & Scenario #2

- filter paper
- Sharpie black marker
- Various permanent markers / gel pens (these show up the best)
- Isopropyl alcohol
- two clear small containers or beakers

<u>Scenario #1(In Addition to Above):</u>

- Kool-Aid (grape, cherry, blue raspberry)
- water
- Salt (NaCl)

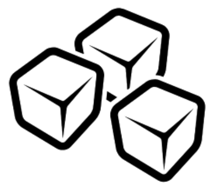
Engineering and Science Connections:

Today we will learn about chromatography and its applications to engineering and science. We will also explore the differences between chemical and physical changes.

Chemical vs. Physical Changes

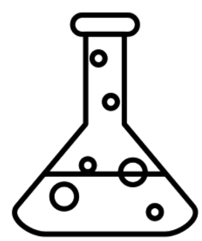
Physical Change

- Can be reversed easily
- E.g. freezing water to make ice cubes



Chemical Change

- 2 or more substances are combined to form a new substance
- Indicators can be:
  - Light given off
  - Temperature change
  - Gas production
  - Colour change
  - Forms a precipitate
- E.g. baking a cake



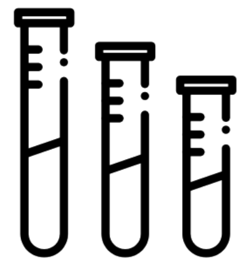
What is Chromatography?

Chromatography is a way of looking at complex mixtures by separating them into their separate compounds. Since the components of the mixture is **physically** (and not chemically) combined, they can be separated by physical means. We can do this by moving the mixture (the *mobile phase*) over some surface surface (the *stationary phase*). There are many types of chromatography such as column and gas chromatography, but this activity will be focused on paper chromatography.

Using ink as the mixture and paper as the stationary phase in the case of paper chromatography, the paper acts as a “race track”. When a dot of ink is placed at the bottom of the paper and the paper placed vertically in a solvent, the ink molecules run up the paper through capillary action. As the ink molecules move through the paper, some of its molecules are *temporarily* pulled toward the paper before being pulled back into the liquid ink that they are from (this is called **adsorption**). Since ink is made up of different liquid compounds, each compound has a different sized molecule. The bigger the molecule, the slower they travel up paper. Also, the molecules that are more soluble in the solvent travel faster up the page. As the molecules travel up the page, they separate into specific bands that can be used almost as a fingerprint of the pen or ink that you are using!

Chromatography Applications

Chromatography can help environmental engineers determine the chemicals in polluted water / air, or if there are any new (toxic) chemicals present due to chemical reactions that occurred. They can then use this information to come up with a solution as to how to reduce the polluted effects. Chromatography can also be used in forensics (blood / fluid samples), studying plant pigments (ex. chlorophyll) and complex mixtures such as food and perfume.



Video Recommendation: *Separation Techniques | Paper Chromatography*

https://www.youtube.com/watch?v=uOhefwQBAbI

In the above video, the process of chromatography is demonstrated with many types of ink. Many of the topics discussed above appear in this video.

Activity:

Before you start, think about the following questions:

- What is the difference between a chemical and physical change? Which one does chromatography use?
- What causes the ink to travel up the filter paper?

Intro

Before we can apply our new knowledge of chromatography, test your skills with this simple experiment!

Preparation

- Cut the filter paper into strips about an inch wide and 4 inches tall, about 5 of them

Experiment

- Draw a line using the pen/marker of your choice
    - Should be about a pinky's width from the bottom of the filter paper

- Put enough solvent in a small beaker/container so that the bottom of the container is just covered
    - The ink should NOT be touching the solvent when the paper is put into the container
    - You can attach the top of the filter to a pencil to keep it from falling into the solvent.

Results

- What colours did you see?
- Were they what you expected?
- Why do you think inks are made from different dyes?

Test other pens and markers to compare and contrast your results.

Scenario #1

You are hosting a small get-together, and find out that your friend Alex is terribly allergic to blue dye. the problem is that you've already made all three types of Kool-Aid, so the packs have been thrown out. The only way to find out if the Kool-Aid has blue dye in it is to run a chromatography experiment.

Preparation

- Prepare a concentrated solution of Kool Aid by mixing 2g of powder with 5 mL of water
- Make 100 mL of dilute NaCl solution (0.1 g salt in 100 mL water) → This will be the solvent
- Cut the filter paper strips as in the Intro activity so that the strips can fit into the beaker / container used with solvent

Experiment

- We will use a similar technique to the Intro, but with a few changes
- Draw a line in pencil about a pinky width from the bottom of the filter paper
- Place a small dot of the Kool Aid on the pencil line
- Follow the rest of the procedure from the Intro

Results

- Which Kool Aid drinks were safe for Alex to drink?
- Which ones did you not expect to have blue dye in?
- Why shouldn't we use pen when drawing lines on the paper?
- Were there some chromatographies that did not turn out well? Why or why not?
- Can you think of other scenarios that you can do where this technique would be useful?

Scenario #2

You know that each of your friends/family members prefers to use a specific pen to write things. Suddenly, a mysterious note shows up! After asking around, no one wants to admit that they wrote it. How do you find out who? Maybe their pen-fingerprint can tell you.

Preparation

- Select 3 different pens. Have a friend or family member write a note with one of the pens without telling you which one they used.
- All 3 pens are now evidence! Use chromatography to solve the case.

Experiment

- Cut the note into enough pieces to do a paper chromatography on it
- Run chromatographies on the pens in question as well as a chromatography on the note (using the same techniques as the Intro and Scenario #1)
    - compare the results and see which pen matches up to the note!

Results

- How were you able to determine which pen was used to write the note?
- Explain the patterns and how you think the patterns were made on your filter paper
- What real life applications do you think this technique can be used for?

What Did You Learn?

- What is chromatography
- How is chromatography used by engineers and scientists?
- Would chromatography work if the process to make the ink was chemical instead of physical?

Future Learning

- Try this on a piece of paper with printer ink on it (anything with printed letters on it should work). What do you notice?
- Research chromatography columns. Using what you have learned, how do you think the mixture gets separated into its components?

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

Instagram: @westernueng
Twitter: @westernueng
Facebook: @westernueng

Thanks for discovering with us!