Photo by Aaron Burden on Unsplash

BACKYARD SCIENCE ADVENTURES

Welcome!

Dear Parents and Caregivers,

This booklet contains four science activities your child can complete at home. These activities encourage your child to use experimentation in order to make scientific discoveries. By conducting experiments, your child will be able to explore the scientific method used in making a hypothesis, setting up a fair experiment, collecting data, and making conclusions about the observed results. Your child can complete these experiments independently, or you can work through these experiments together.

The goal of this booklet is to increase exposure of your child to STEM fields. Students learn better when engaged in hands-on problem-solving activities, like experimentation. By introducing kids to science earlier, they are better prepared to tackle science courses at the middle school, high school, or college level. Even in those who do not go on to a career in STEM, exposure at an early age can promote a life-long enthusiasm for the sciences. Additionally, this project increases exposure of students to science which supplements the time allotted for its instruction in schools.

These experiments align with the Next Generation Science Standards (NGSS). The NGSS are a set of academic standards developed by educators, policymakers, and content experts. The NGSS are widely used by teachers to identify age-appropriate concepts and practices that students should engage with at each grade level. Since the experiments within this booklet align with the NGSS, they reinforce crosscutting concepts and approaches that will likely be used in your child's classroom. To know which standards apply to each experiment, reference the footer of any page. For more detailed descriptions of these standards, visit https://www.nextgenscience.org/.

NGSS Practices For K-12 Science Classrooms

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

This booklet also contains a number of QR codes that refer you to related material to supplement each activity. To scan a QR Code, download a QR code reader app, or utilize the QR reader ability that is integrated into the camera software of some cell phones.

This booklet was produced as part of a year-long project through the Latham Science Engagement Initiative (LSEI) at the University of Iowa. Each year, Latham Fellows create, plan, and implement self-directed STEM outreach projects. These projects seek to engage the Iowa City community in thinking about science by making science more accessible to the general public. For more information about LSEI, or to access additional activities, please visit www.stem-o-sphere.org.

Sincerely,

Emily Ruba
Latham Fellow, 2017-2018

INK PEN CHROMATOGRAPHY

Forensic Science | Chemistry

Learning Goals:

#1 Use fair methods to test and compare samples.

#2 Demonstrate that different types of ink can be separated in characteristic ways.

#3 Understand that ink consists of molecules which can be pulled along as water moves through the paper.

Related Careers:

Forensic Scientist
Biochemist
Chemist
Materials Scientist

Follow Up Activities

Replicate this experiment using four different colors of the same pen to see how different colored inks behave.

"Traveling Waters Experiment"

Background:

A robbery has taken place at a nearby store. The suspect left a note at the scene, written in black pen. Only two words were on the note: "I'm sorry". The police have found four suspects who were near the scene and were carrying black pens with them at the time the crime was committed.

To determine which suspect's pen was used to write the note, you will carry out an ink pen **chromatography** experiment. This is a **forensic science** technique used to separate the components of a liquid. By comparing the way each type of ink separates, we can match the pen to the note.

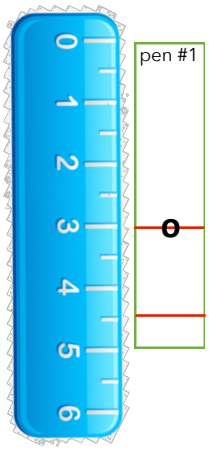
Before starting, create a mystery sample to test. Ask someone to secretly select one of the pens and write "I'm sorry" in the middle of a coffee filter. Make sure they do not show you which pen they used! This will be the "suspect's" pen, and it your job to determine which pen was used to write the note.

Materials Needed:

- Coffee filters
- Four identical glasses
- Four pencils
- Four binder clips
- Three black pens. These should be a mix of different types and brands of pens.
- Scissors
- Water
- Ruler
- Masking tape

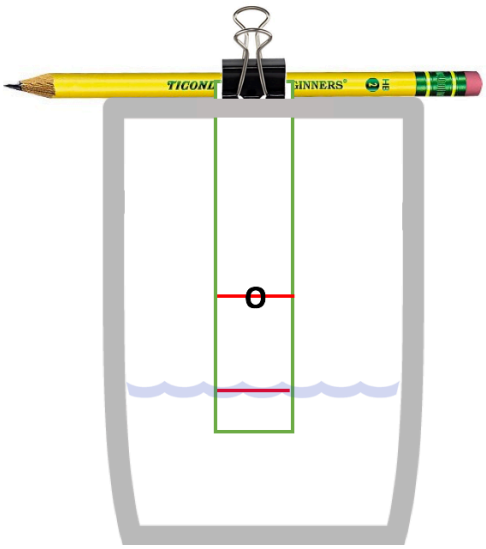
Set Up

1. Cut a thin rectangle out of the sample coffee filter. Your rectangle should include only the letter "o" of the word "sorry". The "o" should be two inches from the bottom of the paper, with three inches of space above the "o".



2. Cut out three more rectangles that have the same dimensions as the rectangle you made in Step #1. Using the ruler and a pencil, draw a line ½ inch from the bottom on the paper. Draw another line 2 inches from the bottom of the paper. These are shown in red on the picture to the right.

3. Using these three strips of paper, create a sample of each of the three black ink pens. These will be used to compare the pens, and each sample should resemble the mystery sample. Draw pencil lines on the strips of paper, just like you did in Step #2. Label each paper strip at the top with a pencil so you know which pen was used for each strip.



3. Clip one binder clip to the end of each sample paper you labeled. The prongs of the clip should point upwards rather than resting on the paper. See the diagram to the left to see how to set this up.

4. Put a pencil through the middle of the binder clip, and rest the pencil on a glass so that the paper hangs down into the glass. Standing at eye level with the glass, place a piece of masking tape on the glass. Use your pencil to mark the location of the bottom line on the tape. This is the fill line for how far you will fill the glass with water. Do this for all four samples.

STOP! Make a prediction. What will happen to the ink when you place the bottom of the paper in the water?

Experiment

1. Remove the samples from the glasses before filling them with water. Carefully add water to the fill line that you marked on the tape.
2. Return the samples to the glass, with the pencil resting on the glass and the paper hanging into the water. The ink on the paper should be above the water line, not underwater. Allow the paper to hang into the water until the water line rises up the paper two-thirds of the way to the top.
3. Write down your observations on the data chart below as the water migrates up the paper.
4. Remove the samples from the glass. In the data chart below, color in the rectangles to record what the paper strips look like. Compare the separation patterns of the samples with the separation pattern of the suspect's note. See if you can identify which pen belongs to the suspect!

Data Collection

Sample	Mystery Sample	Pen #1	Pen #2	Pen #3
Observations				
Appearance				

Capillary Action and Ink Pens

Capillary action is the process in which liquids move through a solid, like water trickling through a rocky stream. In your chromatography experiment, the liquid water moved upward through the solid paper, despite gravity pulling it downward. This occurs because the paper has small pores in it, giving the water many channels to move through as it spreads upward.

The water is propelled upward by cohesion, adhesion, and surface tension. **Cohesion** is what causes the water molecules to stick to each other like droplets. **Adhesion** occurs when these water droplets stick to the paper. **Surface tension** is important for the water molecules closest to the top of the paper, causing this top layer of water to behave like a sheet. This holds the water together as it moves upward.

The ink in the pens you used is made up of materials that may not all interact with the water in the same way. Some inks, like those made with water-based materials, will dissolve better in the water, so it will be easier for the water to carry these inks with it as it moves through the paper. Other inks may not dissolve in the water, like those made with oil-based materials, and will be left behind as the water moves upward. Inks will often vary in how long they take to dry, how much they form clumps, and how thick they are. Many inks are made up of a combination of these different materials. This will have an impact on the process of capillary action by affecting the cohesion, adhesion, and surface tension of the water and ink.

Discussion Questions

1. Is black ink really black? Explain.
2. Ink is often made of a mixture different pigments, liquids, waxes, and drying agents. What characteristics of the ink causes it to separate? What makes some components of the ink travel farther than others?

2-PS1-1, 3-5-ETS1-3, 5-PS1-1, 5-PSI-3