BASF
We create chemistry

Leader Guide

# Chromatography Butterflies

## Objective

Chromatography is a process that separates the components of complex mixtures. Students will create multicolored butterflies through the process of Chromatography.

## Introduction to Kids' Lab

Welcome to the BASF Kids' Lab. BASF is the world's largest chemical company and run Kids' Lab programs like this all around the world. Use the suggested guide below to lead this experiment.

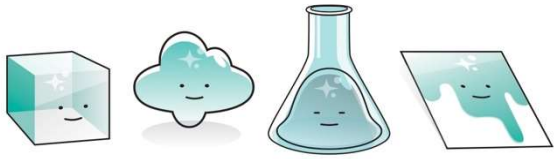
Kids' Lab
Creating Fun with Chemistry!

# Instructor guide

- Can anyone think why BASF has this program?
  - BASF wants children all over the world to understand and enjoy experimenting with chemistry!
- Has anyone heard that word before: Chemistry?
- What do you think it means?
- **Chemistry is the science of matter.**
- Have you heard the word “matter” before? What is matter?
  - Matter is anything that takes up space and has a weight here on earth. So basically, matter is a scientific word for stuff.
  - Chemistry is a science that explores the composition of substances and their properties and reactions. In other words, Chemistry is a science that explores how different stuff behaves.
  - Matter comes in a few different forms or states: Solids, Liquids and Gases are the most common.
- Chemistry is all around us.

  **For example:**
  - Who takes a vitamin?
  - How do vitamins help you? (Grow big and strong, boost immunity).
- BASF makes chemicals that go into vitamins.
  - Raise your hand if you play a sport or ride a bike.
  - What should you do to be safe? (Wear a helmet, pads, etc.)
  - What materials make up the helmets that you wear? (Plastics and foam)
- BASF makes chemicals that go into the plastics and foams in helmets and padding.
- Besides helping you grow strong and keeping you safe when you are playing your favorite sport, BASF chemistry keeps farmers crops safe, cleans water for those in need and keeps babies clean and dry.
- Let me introduce you to morpH, the face of Kids’ Lab.
- morpH can move through the three states of matter with ease.
- Is there a substance that you know of, like morph that can easily shift from solid to liquid to gas (and back again)?
  - Water! That’s right!
  - You know that water is usually liquid but what happens when you freeze water?
  - Water becomes a solid ice cube.
- What happens when you boil water?
  - Water becomes a gas.
- Water is one of the most important substances on earth.
- Not only does water make life possible, but it can be used to create beautiful works of art.

morpH and I would like you to **explore Chromatography**.



# Experiment Introduction

Chromatography is the process of separating mixtures of different chemicals into individual components. Chemicals in a mixture usually have different chemical properties, such as molecule size or the ability to dissolve in different kinds of solutions. Chromatography is a technique used to analyze the components of a mixture and has applications across many scientific disciplines.

There are several types of chromatography such as paper, thin layer, column, and gas chromatography. For all chromatography techniques, there are two phases, the mobile phase, and the stationary phase. In the mobile phase, there is some mixture in one state of matter, such as a gas or a liquid. The stationary phase is typically a solid state of matter and does not move as the mobile phase moves across it.

In this activity, paper (or a coffee filter) is the stationary phase and water is the mobile phase. This type of chromatography is called paper chromatography. Water is a solvent that is absorbed into the paper by capillary action. The ink from the markers is the mixture solution that we are trying to separate into different components or pigments of color.

**Make sure you are familiar with the following terms:**

**Chromatography:** the separation of a mixture by passing it in a solution or as a vapor through a medium.

**Solution:** a liquid mixture where the minor component, the solute, is universally and uniformly distributed within the major component, the solvent.

**Solvent:** a fluid that molecules dissolve in.

**Capillary action:** the phenomenon whereby a liquid can flow through narrow surfaces despite external forces like gravity. This is due to an interaction between the surface tension of a liquid and the attraction to a solid surface.

**Stationary Phase:** an unmovable or fixed substance that restricts the movement of substances that are not dissolved by the mobile phase. In our case, the stationary phase is paper.

**Mobile phase:** a solvent like water that moves through the stationary phase.

# Additional Background Information

Chromatography was first used in the early 1900s by Russian botanist, Mikhail Tsvet to research pigments from plants. He called the technique chromatography which is derived from the Greek words “chroma” which means color and “graphein” which means to write. With chromatography, Tsvet was able to separate green chlorophyll pigments and yellow xanthophyll pigments found in plant leaf extracts. Today, there are multiple chromatography techniques used for a variety of purposes.

All chromatography techniques involve a mobile phase and a stationary phase. The stationary phase is usually a solid like paper, a glass plate coated with a thin layer of absorbent material, or a column packed with silica gel. The mobile phase is usually a liquid or solvent containing the sample that you are analyzing. In gas chromatography (GC), a gas is the mobile phase, and the gas moves through a liquid or solid stationary phase.

As the mobile phase moves through the stationary phase, different components of the mixture will separate based on different chemical properties. These chemical properties include the solubility of the components in the solvent used, the size of the molecules in the mixture, and the attraction of the molecules towards the stationary phase. For example, a large molecule may move through the stationary phase much slower than a smaller molecule. This is one way chromatography is used to separate different components of a mixture.

Chromatography is frequently used by chemists to analyze known and unknown substances. By separating the components of a mixture, scientists can analyze and identify each component of a mixture individually. Chromatography can be used in forensic analysis to determine the identity of unknown substances. Similarly, chromatography can be used to detect illegal substances in human or food samples. Chromatography is frequently used in the pharmaceutical industry to purify the ingredients of medicines. Furthermore, manufacturers routinely use chromatography to detect contamination and ensure quality of final products.

For this chromatography activity, it is important to know that the molecules in the marker pen ink have different properties and characteristics, such as size and solubility. Remember that solubility is the ability for molecules to dissolve in different fluids, and a solvent is the fluid that the molecules dissolve in. Because the ink has different molecules with distinctive characteristics, the molecules will travel at different speeds through the paper. The large and heavy molecules in the ink won't move as far as the small and light molecules. Therefore, they move at different speeds and settle in separate places on the coffee filter as the water travels through the filter paper.

The water (mobile phase) moves through the paper coffee filter (stationary phase) because of capillary action, where the surface tension of the water interacts with the surface tension of the paper. As the water migrates, it dissolves and carries some of the ink molecules with it. Black ink works the best because black ink is made up of different pigments of color. When the water flows through the black ink, the molecules of the assorted colors will behave differently. This makes the "rainbow" effect that you see.

## Safety Guidelines

**Lab safety is a must**! In order to safely explore Chemistry, we need to follow proper lab safety. How do you think we are going to do this? Chemists follow very strict procedures to protect themselves and they include:

- Gloves
- Safety glasses
- Lab aprons or lab coats

Add IMAGE of gloves, glasses and lab coats

**Before we get started:**

- Be sure everyone including instructors and helpers are wearing safety glasses.
- Point out any safety features in the classroom (i.e. Eyewash or emergency shower; emergency exits).
- Mention housekeeping rules – NO EATING OR DRINKING.
- Mention location of bathrooms.

# Make a Butterfly with Chromatography

**Materials**

- Looped tag for name tag and pencil
- Pipe cleaners (about 6 inches in length)
- 2 large coffee filters per butterfly
- Paper plates
- Flip chart markers, multiple colors
- Water (spray bottles)
- Quart size or gallon size Ziploc bag -OR- Drying line and drying area

**Notes:** Flip chart markers give the best results. Other types of markers may not have the same effect. After the butterflies have been created, hang them on a string with clothespins or the pipe cleaner antennae to dry. If they are still not dry by the end of the time or there is nowhere to hang them, place them and seal them in a quart size or gallon size Ziploc bag to dry.

## Step 1: Make a Label with your name

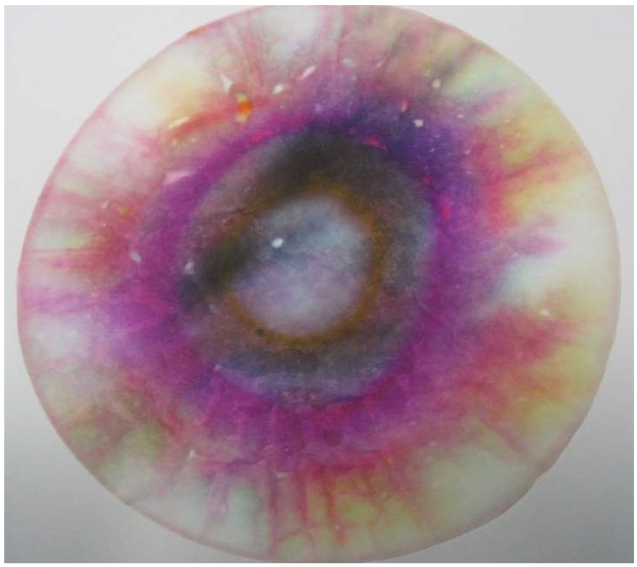
Use a looped tag and write your name on the tag with a pencil. Then, bend a pipe cleaner in half and loop the tag over the end. Set this aside. This will become the body of your butterfly in step 5.

## Step 2: Color your Butterfly wings

Place two coffee filters on a paper plate. Align the filters so they are stacked on top of each other. Draw on the filter paper with the flip chart markers. The ink will go through both layers of the coffee filters. Black and Brown have the best effect but do not color the entire surface.

## Step 3: Spray water on the filters

Have an instructor spray water on the coffee filters over the plate. Spray just enough to wet both layers. Allow a couple minutes for the water to soak into the filters. Observe how the water and the ink from the markers migrate through the filter. Do you see colors other than the colors you used to draw on the paper?



## Step 4: Separate the Filters

Carefully pull apart the coffee filters and hold vertically to let excess water drip onto the paper plate. Place each filter out on the table to start to dry. Continue to observe how the colors change.

## Step 5: Complete your Butterfly

The filters do not have to be completely dry for this step. Loosely fold the coffee filters in an accordion fashion and combine in the center. Use the pipe cleaner (with the name tag) to join the two filters in the center. Twist the pipe cleaner ends together to hold the filters and make two antennae from the loose ends. Expand the filters outwards to create wings.

Hang the butterfly from the antenna on a line to dry. If not dry by the end of the event, place the butterfly in a quart size or gallon size Ziploc bag.

# Summary

You have a colorful butterfly to remind you about how Chromatography works. In our Chromatography experiment, we used paper coffee filters as the stationary phase and water as a solvent and mobile phase. As the water moved through the paper filter by capillary action, it dissolved the ink pigments and carried these colors through the paper. The different pigments within each color separated and you could see the various pigments that the color contains. Black ink contains many pigments. Did you see blue, red, and orange pigments separate from the black ink?