# Chromatography

**Applications in Forensic Science**

http://sciencespot.net/

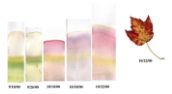
## What is chromatography?

**Chromatography** (from Greek word for ___chromos___ for color) is the collective term for a family of laboratory techniques for the separation of mixtures. It involves passing a mixture through a stationary phase, which separates it from other molecules in the mixture and allows it to be isolated.

**Which means ...**

Chromatography is the ___physical separation___ of a mixture into its ___individual components___.

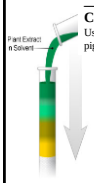
We can use chromatography to separate the components of **inks** and **dyes**, such as those found in pens, markers, clothing, and even candy shells. Chromatography can also be used to separate the colored **pigments in plants** or used to determine the **chemical composition** of many substances.

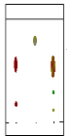



http://members.shaw.ca/vict/chemistry_test3.htm

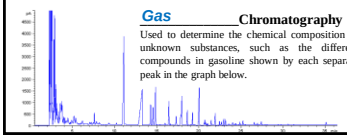
## Examples of Chromatography

___Liquid___ **Chromatography**
Used to identify unknown plant pigments & other compounds.

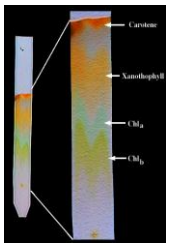


___Thin-layer___ **Chromatography**
Uses thin plastic or glass trays to identify the composition of pigments, chemicals, and other unknown substances.



___Gas___ **Chromatography**
Used to determine the chemical composition of unknown substances, such as the different compounds in gasoline shown by each separate peak in the graph below.




___Paper___ **Chromatography**
Can be used to separate the components of inks, dyes, plant compounds (chlorophyll), make-up, and many other substances

## Chromatography in Real Life

Chromatography is used in many different industries and labs. The police and other investigators use chromatography to identify clues at a crime scene like blood, ink, or drugs. More accurate chromatography in combination with expensive equipment is used to make sure a food company's processes are working correctly and they are creating the right product. This type of chromatography works the same way as regular chromatography, but a scanner system in conjunction with a computer can be used to identify the different chemicals and their amounts. Chemists use chromatography in labs to track the progress of a reaction. By looking at the sample spots on the chromatography plate, they can easily find out when the products start to form and when the reactants have been used up (i.e., when the reaction is complete). Chemists and biologists also use chromatography to identify the compounds present in a sample, such as plants.

## Paper Chromatography

**How does it work?**

The ___water___ (solvent) is the mobile phase of the chromatography system. The ___paper___ is stationary phase. Chromatography works by ___capillary action___. The attraction of the water to the paper (___adhesion___ force) is larger than the attraction of the water to itself (___cohesion___ force); hence, the water moves up the paper. The ink will also be attracted to the paper, to itself, and to the water differently, and thus a different component will move a different distance depending upon the strength of attraction to each of these objects.

## Paper Chromatography

To measure how far each component travels, we calculate the retention factor ($R_f$ value) of the sample. The $R_f$ value is the ___ratio___ between how far the component travels and the distance the solvent travels from a common starting point (the origin). If one of the sample components moves 2.5 cm up the paper and the solvent moves 5.0 cm, then the $R_f$ value is 0.5. You can use $R_f$ values to identify different components as long as the solvent, temperature, pH, and type of paper remain the same. In the image below, the light blue shading represents the solvent and the dark blue spot is the chemical sample.

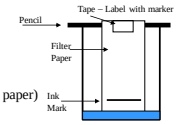
To calculate the $R_f$ value, we use the equation:

$R_f$ =
distance traveled by the sample component
distance traveled by the solvent

In our example, this would be:
$R_f$ =
2.5 cm
5.0 cm
= 0.5
Note that an $R_f$ value has no units because it is a ___ratio___ and the units of distance cancel.

# Paper Chromatography Lab

- Obtain the supplies you'll need.
  - 1 large beaker (or plastic cup)
  - 1 small beaker (or plastic cup) filled with water
  - 4 pieces of filter paper
  - 4 black markers for testing
  - 4 small pieces of masking tape
  - Glass stirring rod (to attach to the top of the filter paper)
  - Permanent marker
  - Timer




- Write the pen number on a piece of masking tape with a permanent marker and place it at the top of the strip.
- Choose one of the testing markers and draw a thick line near the bottom of the filter paper - about ¼ inch from the bottom.
- Pour a small amount of water into the large cup and then hang the paper strip in the cup. Make sure the ink line does not touch the water – only the bottom of the filter paper.
- Allow the water to move up the paper for 10 minutes and then remove the strip from the water. Hang it on the side of the table to dry.
- Follow these directions to test the other pens.

Complete the chart on and then answer the questions.

| Marker | #1 Marks A-Lot | #2 vis-à-vis | #3 School Smart | #4 Scented |
|---|---|---|---|---|
| Colors observed in ink sample | | | | |
| Distance traveled by the sample component | | | | |
| Rf value | | | | |

**Questions:**

What colors did your group observe in each of the black ink samples?

Do the colors occur in the same order on all the samples? Explain.

Did some ink samples not work? Why?

Compare and contrast the Rf value for the markers.

# Chromatography Challenge

**Earlier today, the girl's bathroom was vandalized with graffiti.**
**Fortunately, 4 girls were apprehended and questioned.**
**Each of the girls apprehended was caught leaving the bathroom with a black marker.**
**Suzy Q had a black Marks-A-Lot marker.**
**Margie B had a black Vis-à-vis marker.**
**Polly X had a black Scented marker.**
**Jeanie P had a black School Smart Marker.**

**VonFischer asked the chemistry class to help determine which marker was used for the act of vandalism. After using paper chromatography to test the marker it was found that the marker used had a Rf value of 0. Can you single out (or narrow down) a culprit for Mr. VonFischer?**