



# Using Paper Chromatography to Separate Ink

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## Topic

Paper chromatography



## Time

1 hour



## Safety

Please click on the safety icon to view the safety precautions. Be careful when handling the test tubes. Do not eat or drink any of the materials.

## Materials

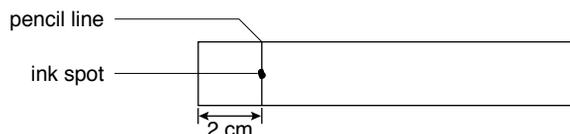
two to five large test tubes  
paper clips  
test-tube rack or modeling clay  
water  
an assortment of water-soluble  
stoppers to fit test tubes, or  
modeling clay

#2 lead pencil  
marker pens of different colors, with  
at least one black  
chromatography paper (sheets or  
12-cm  $\times$  2-cm strips)  
one ruler with millimeter markings

## Procedure

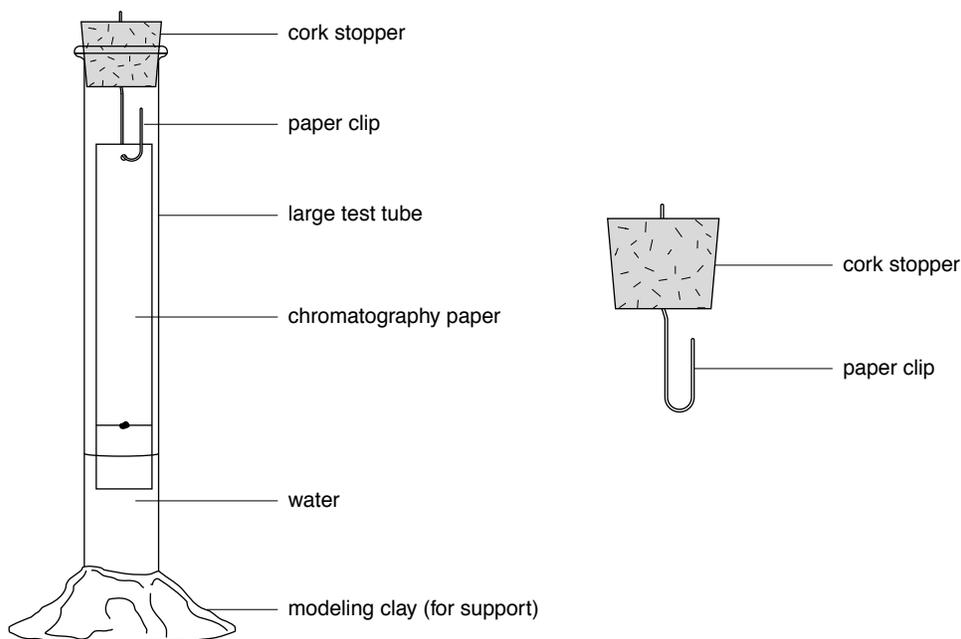
1. Collect an assortment of marker pens (different colors, makes, and styles). Make sure they are all water soluble.
2. If you have only large sheets of chromatography paper, cut strips 2 cm  $\times$  12 cm. Cut as many as you have pens to test and a few extra in case of mistakes.
3. *In pencil*, not ink, draw a line across a paper strip 2 cm from the bottom (see figure 1). Carefully touch the tip of one of your sample pens at the center of this line. Allow the spot to dry for a few seconds, and then repeat the touch 4 to 5 more times, so that the dot darkens. Do not allow the ink spot to become too large. In this case, the smaller and more concentrated the spot the better. Using this method make a sample ink dot on a paper strip for each pen you are testing.

Figure 1



4. Number each sample, in pencil, at the top, and enter this number and a description of the ink source on the data table, including color, brand, and any other information you think important.
5. Bend as many paper clips as you have test tubes into a “J” shape. Push the paper clip through a cork stopper or a ball of modeling clay large enough to act as a stopper (see figure 2).

Figure 2



6. Place the paper strips on the paper clips, as shown in figure 2.
7. Pour 3 mL water into a test tube, and place a paper strip into it. Make sure that the bottom of the paper touches the water but that the water does not reach the pencil line. Adjust the water level accordingly. Keep the paper from touching the sides of the test tube. If your paper should get wet at any point above the pencil line, start that test over with a new dry sample. Place the test tube in a rack or support on a tabletop with modeling clay (see figure 2).
8. As the dyes within a test sample begin to separate, you will see them moving up the paper at different rates. When the water nearly reaches the top of the paper, remove the strip and immediately mark this level in *pencil*. This level is called the *solvent front*; it provides the value for the distance moved by the water (the solvent) in later calculations. Measure this distance and record it on data table 1.
9. By giving it a letter, identify each different color band that appears on the test strip. Measure the distance that each color has traveled from the pencil line at the bottom of the strip. Enter this information on data table 1.
10. Repeat steps 7 to 9 for all of your samples.
11. After you have established the value of the solvent front and measured the distance of travel (or rate of flow) for each pigment (or color band), you are ready to calculate the *R<sub>f</sub>* value for each pigment. The value is the distance traveled by a substance (color band) relative to the distance traveled by the solvent front. The *R<sub>f</sub>* value of a substance is constant under standard conditions, so that the color bands can be at least temporarily identified by comparing their *R<sub>f</sub>* values.

DATA TABLE 1								
Sample	Description of pen: brand color, type	Solvent front	Color band height (cm)					
			Color height A	Color height B	Color height C	Color height D	Color height E	Color height F
1								
2								
3								
4								
5								

Calculate the  $R_f$  values for each color band by dividing the distance traveled by a given color by the distance traveled by the solvent front (measure both from the pencil line on the bottom of the strip):

$$R_f = \frac{\text{Distance moved by color band (cm)}}{\text{Distance moved by solvent front (cm)}}$$

Enter the  $R_f$  values on data table 2.

DATA TABLE 2						
Sample	$R_f$					
	A	B	C	D	E	F
1						
2						
3						
4						
5						

12. Which color pens tended to separate into the most different colors?
13. If you had an ink sample that did not separate into color bands during the procedure, what could be the reason for this?
14. What could it mean if pigments of the same color in ink samples from different pens have the same  $R_f$  values?

### What's Going On

Results will vary depending on the brands tested. Black markers frequently contain many different colors. Some colored inks will separate, while others may be made

from a single pure dye and will not separate. If an ink sample did not separate, either it contained only one pigment that is a pure color source or the ink is not soluble in water. Most inks that are not water soluble are alcohol soluble, so you could run another test using alcohol as the solvent. If the ink does not separate using the alcohol either, then the chances are that your test sample is made from a pure pigment. If pigments of the same color have the same  $R_f$  value, the chances are that the pigment is made from the same substance. More in-depth testing would have to be done to be certain of this and to provide a definite identification of the substance.

### Connections

To identify the components of a solution, scientists must often separate these components. Paper chromatography is a process by which different molecules can be separated according to their size or molecular mass. A small sample of a mixture is placed on one end of a piece of filter paper. Then a liquid is passed through the paper. The components of the mixture dissolve in the liquid and are carried up the paper. Molecules with less mass will move further up the paper than heavier molecules. In this investigation you practiced this technique on marking pens to separate the different colored dyes present in pens.

# Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say “be careful with hot liquids” or “don’t cut yourself with the knife” does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

## PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

## PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

## USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don’t use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

**USING CHEMICALS**

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

**HEATING INSTRUCTIONS**

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

**WORKING WITH MICROORGANISMS**

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

**GOING ON FIELD TRIPS**

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

**FINISHING UP**

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES