Which Ink Is Which?

Topic

Identification of inks using chromatography

Introduction

Because manufacturers use different ink formulations, black pens from different sources may well contain a mixture of colors. In the first part of this experiment, you will use a technique called "paper chromatography" to separate the colors used in different black pens. Because most fiber-tipped pens use water-soluble ink, you will use water as the medium for the chromatography.

Sometimes criminals add additional words to a check that has already been made out. Forensic investigators can examine such checks and determine what ink was used for each of the words (hoping the criminal has used a different pen from the original). In the second part of this experiment, you will pretend to alter a check fraudulently and perform paper chromatography on the ink to determine which part of the writing was altered.

Time required

Part A: 45 minutes
Part B: 45 minutes

Materials

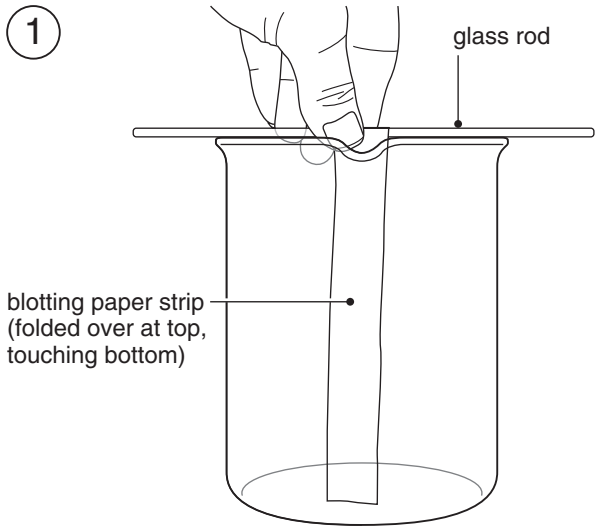
selection of 3 black pens from different manufacters (use roller-ball, gel, or fiber-tipped pens, not ballpoint pens)
five 2 cm wide strips of white blotting paper each 17 cm long
stapler
15 cm glass rod
3 multi-purpose labels
pencil
1 liter beaker
approximately 40 ml water
eyedropper
re-usable adhesive putty
sheet of aluminum foil (big enough to fit over the top of beaker)
30 cm ruler
scissors
clock or stopwatch
2 sheets of paper towel
2 paper clips

Safety note

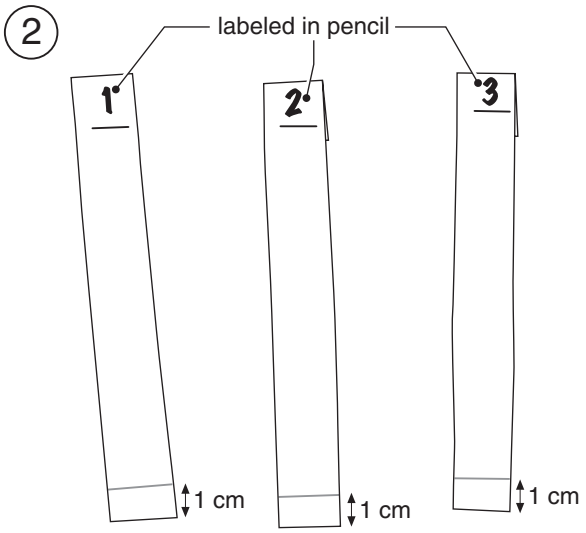
Please read the general safety precautions.

Procedure

Part A: Testing the pens



Strip supported by the glass rod inside the beaker

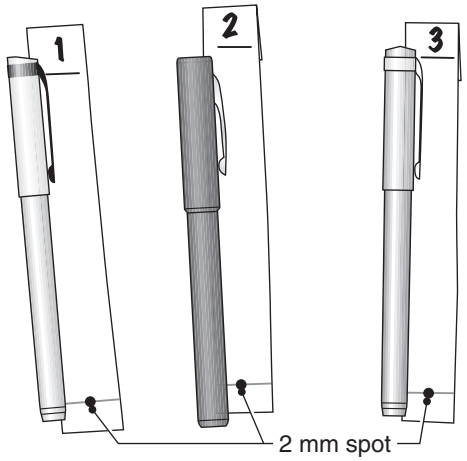


Prepared strips

1. Using the labels and the pencil, label each pen 1, 2, 3.
2. Measure the depth of the beaker and then cut 3 strips of blotting paper each 2 cm longer than the depth of the beaker.
3. Place the glass rod over the top of the beaker and fold a strip of blotting paper over it so the lower end of the strip touches the bottom of the beaker (as in diagram 1 above). Remove the paper from the glass rod while holding the position of the folded edge of the blotting paper. Staple the blotting paper fold in place about 1 cm from the fold.
4. Fold over and staple the two remaining strips, making sure they are the same length as the first. Use the pencil to label each strip 1, 2, 3 at the folded end. Use the pencil again to draw a line 1 cm from, and parallel to, the unfolded end of each strip (see diagram 2 above).
5. Using the correctly labeled pen for each strip, make a 2 mm diameter dot on the center of the pencil line at the unfolded end of each strip (see diagram 3 on the next page).
6. Thread the strips onto the glass rod and place it over the top of the beaker. Use a small amount of re-usable adhesive putty to hold the rod in place. Move the strips so that they do not touch each other.
7. Use the eyedropper to carefully add about 20 ml of water to the bottom of the beaker (see diagram 4 on the next page). Be careful not to splash the blotting paper strips.

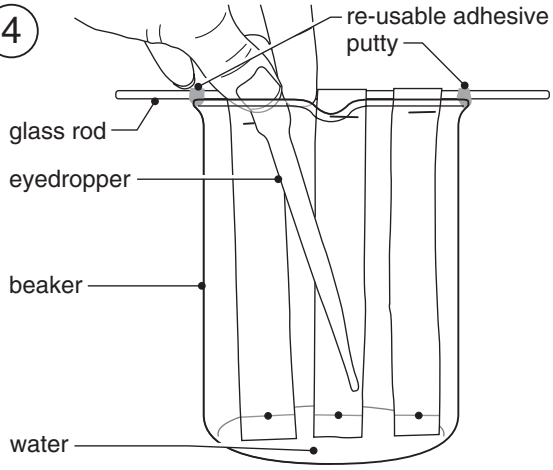
8. Cover the top of the beaker with aluminum foil (see diagram 5 below) and observe the strips every few minutes for half an hour.
9. Remove the strips from the water and slide them carefully from the glass rod. Place the strips on a sheet of paper towel and allow them to dry for about 15 minutes (see diagram 6 below).

3



Ink dots applied to each strip using different pens

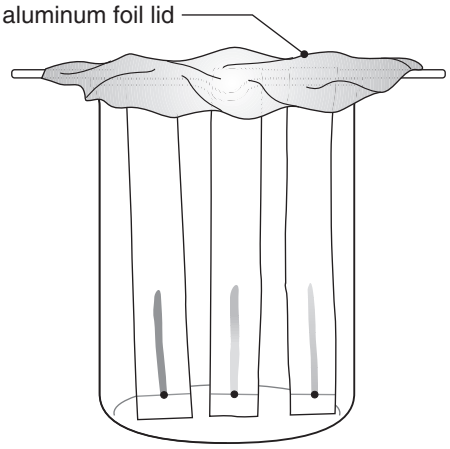
4



Adding water to the beaker containing the suspended strips

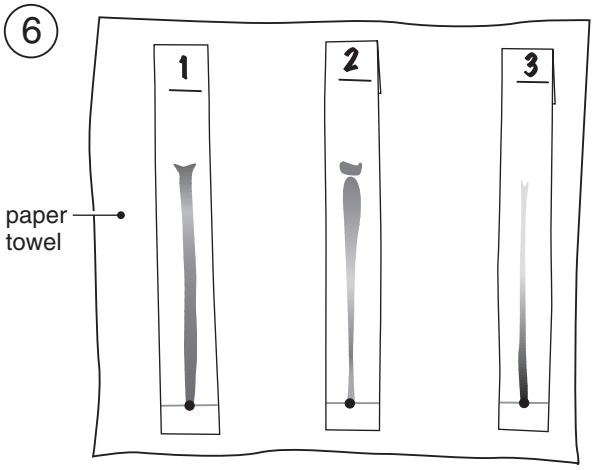
10. When the strips are dry, staple them to the correct column of the data table on the next page.

5



Beaker with aluminum foil lid

6



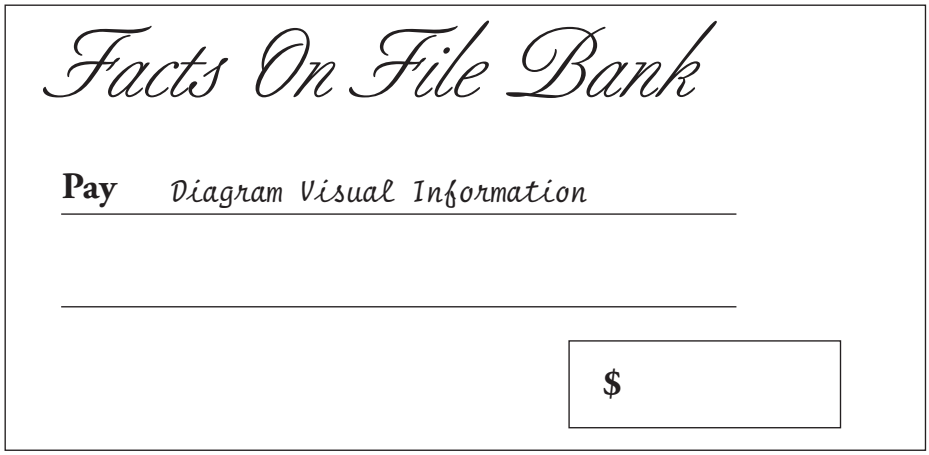
Strips laid out to dry on the paper towel

Part B: Detecting the fraud

1. Choose two pens (X and Y) from Part A that showed different ink patterns.
2. Use pen X to make out the check in diagram 7 on page 9.03–5 for the sum of "one hundred dollars," writing the words on the line, and filling in the box with the number 100.
3. Use pen Y to squeeze in the word "thousand" between the word "hundred" and the word "dollars," and add three zeros to the number in the box. The check now appears to be made out for the sum of $100,000.

DATA TABLE		
Strip 1	Strip 2	Strip 3

4. To show that a forgery has taken place, cut out the word “hundred” and the word “thousand,” making sure you do not cut out any of the line under the writing.
5. Prepare two strips of blotting paper following the procedure in steps 2 to 3 of Part A. Use the pencil to draw a line 1 cm from, and parallel to, the unfolded end of each strip.
6. Use a paper clip to attach the cutout word “hundred” to one strip and the word “thousand” to the other. The ink must be on the side that touches the blotting paper, and the lower edge of the cutout word must touch the pencil line.
7. Follow steps 6 to 9 of Part A.



Check

Analysis

Part A: Testing the pens

1. What did you observe on the blotting paper strips after you added the water?
2. Did all the ink dots move?
3. Did all the ink dots form the same pattern?

Part B: Detecting the fraud

1. Were you able to identify the inks used for the different words?
2. Why were you careful not to cut out any of the line when you cut out the writing?

Want to know more?

Part A: Testing the pens

1. The blotting paper strips became progressively wetter. The level of water moved up, parallel to the pencil line, and the ink from the dot also moved upward with the water. As it moved upward, the color of the ink separated into a range of colors that was different for each pen used. For example, one dot might produce a range of colors with yellow at the bottom, then blue, and red at the top. Another may produce a purple column with green at the top. Results will vary depending on the particular ink in the pens.
2. If one of your dots did not move upward with the water in this experiment, it is because the ink in the pen is not soluble in water. Some pens use a spirit-based ink, which makes markings that are waterproof. If you want to use chromatography to separate the ink colors in a spirit-based pen, you will need to find a liquid in which the ink dissolves.
3. Because different companies use different inks for their pens, the dots should have made different patterns. However, if the patterns were the same, try to find some more pens and repeat the experiment.

Part B: Deleting the fraud

1. Because you chose pens that showed differences in Part A, these differences should also have enabled you to identify the pens used in the attempted fraud.
2. The ink used for the line on the check may have been printed in water-soluble ink (it would not be on a real check), and this would have confused the results.

Special Safety Note To Experimenters

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely essential that you read, copy, and remain mindful of the General Safety Precautions that follow this note. Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Be prepared for unexpected dangers by following basic safety guidelines the entire time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will remember them. Except in rare instances, the general precautions listed below will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say **BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE** does not mean that you should be careless when boiling water or cutting a section of a stem for microscope work. 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, wait to perform it until you find out from a qualified adult that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the individual experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:

—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:

—Follow the directions step-by-step; only do one experiment at a time
—Locate exits, fire blanket and extinguisher, gas and electricity shut-offs, eyewash, and first-aid kit
—Make sure there is adequate ventilation
—Act sensibly at all times
—Wear an apron and safety glasses
—Do not wear open shoes, loose clothing, or loose hair
—Keep floor and workspace neat, clean, and dry
—Clean up spills immediately, being careful to follow the recommended procedure for dealing with the spilt substance
—Never eat, drink, or smoke in the laboratory or workspace
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:

—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs

—Don't use your mouth to pipette liquids; use a suction bulb
—Check glassware is clean and dry before use
—Check glassware for scratches, cracks, and sharp edges
—Report broken glassware immediately so that it can be cleaned up by a responsible person
—Do not use reflected sunlight to illuminate your microscope
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS AND BIOLOGICAL MATERIALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear safety glasses, lab apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly
—Use sterile procedures when handling even common and harmless microorganisms
—Avoid contact with human blood
—Treat all living organisms with appropriate respect

HEATING SUBSTANCES:
—Wear safety glasses, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Use test tubes, beakers, and other glassware made of Pyrex™ or borosilicate glass
—Use alcohol-filled thermometers (do not used mercury-filled thermometers)
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it
—Take care when lighting your Bunsen burner; use a Bunsen burner lighter in preference to wooden matches
—Turn off hot plates, Bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Keep sheets of paper and other flammable objects away from your Bunsen burner
—Have a fire extinguisher on hand

FIELDWORK:
—Be aware of environmental dangers (e.g., do not carry out fieldwork near dangerous roads, cliffs, or water)
—Remember that strong sunlight can be dangerous – pack sunscreen and a good supply of drinking water if you will be outside all day
—Never carry out fieldwork in areas where you cannot find your way to safety easily and quickly and never wander off on your own in search of new areas to study

FINISHING UP:
—Clean your work area and glassware (follow any instructions given by a supervising adult)
—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
—Clean up all residues and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws
—Dispose of all microbiological cultures by treatment with an appropriate disinfectant

BE SAFETY CONSCIOUS AT ALL TIMES