# Lab 10: Document Analysis

## Introduction:

Crime-scene investigators use many kinds of evidence when trying to solve a crime. Often the evidence includes the analysis of written or printed documents. This may include analysis of the paper, the writing, the inks, or other properties of the documents. Analyzing documents is an important aspect of forensic science and scientific analysis of documents is often used as evidence in a court of law.

## Report:

You are to submit a report in which you identify the type of paper and pen used on evidence left at the scene of a crime. In your report, make sure that you:

1. Clearly state which paper (A – E) was used for writing the ransom note. Justify your answer using the techniques you used in Part One.
2. Clearly state which pen was used for writing the ransom note. Justify your answer and include all labeled thin layer chromatography (TLC) plates with your report.
3. Briefly discuss the theory that allows you to make your pen analysis. (How does thin layer chromatography work?)
4. Include any additional information (or clues) that would help with the investigation. (HINT: Think about what you did in Section B.)

## Background:

The analysis of documents from a crime scene can take many different paths and can employ many different analysis techniques. The document experts of a crime will make use of chemistry, physics, microscopy, chromatography, photography, handwriting analysis, and various other specialized techniques. Most of the work in the crime lab emphasizes comparison of materials and writing with known standards. This often allows the crime scene investigator to trace the materials back to a certain location or to a certain manufacturer. Documents at crime scenes can include wills, checks, handwritten notes, typed materials, printed materials, photographic materials, and a variety of other paper documents. In addition to the actual documents, printing machines as well as an individual's handwriting can also be analyzed. Analysis of tampered documents is often important in criminal investigations.

Paper, in its simplest terms, is a very thin layer of bonded fibers. Paper has been made from many different fibers throughout history, but today most paper fiber is cotton, linen, wood or some combination of these. Because the formula and mixture of fibers for all papers is slightly different, various papers have distinctive looks and structures. The structure of a paper can help to identify its source or authenticity. Some manufacturers place a translucent mark, called a watermark, on the paper. These are specific to a certain manufacturer and are changed periodically. Watermarks can reveal information about the date and origin of a document.

What is written on paper is often more revealing than the paper itself. Secret messages may be written in code or with "invisible" chemicals that can be revealed later. Inks, pens, and pencils all have distinctive "trails" that are left behind on the paper. All of these things are analyzed carefully by the document specialists on a crime scene investigation team.

One common laboratory technique used to analyze the makeup of materials, such as inks, lipsticks and other markings on paper is called paper chromatography. You will perform one type of chromatography in Part II of this lab.

# Document Analysis: Part I

## Procedure:

Part A: Paper Examination

1. Obtain paper samples labeled #A - #E.
2. Observe each paper type and record your observations in an organized manner. Describe the color. Is it white, yellow-white, gray-white, blue-white, etc…Is it dull/shiny? Thick/thin? Smooth/rough?
3. Hold the papers up to a light or window. Does it have a watermark? What does the watermark look like? Are any of the marks the same?
4. Observe the papers under an ultraviolet light. (Use longwave ultraviolet light for best results). Shine the light on each paper and observe if the paper fluoresces or glows. What color is each paper under UV light?

   Warning: Do NOT look directly at a UV light; it may cause eye damage.

5. Try to rank the papers by mass. Rank them from lightest (#1) to heaviest (#5). Mass each paper on the centigram balance and record your results.
6. Use a microscope (on lowest power) to observe the fiber structure of each paper. Rank the fiber structure of each paper. Rank them from the smoothest (#1) to the roughest (#5).
7. Examine the ransom note provided by your instructor. Which paper (A – E) was used for writing the ransom note? Make sure you can justify your answer using the techniques you used above.

Part B: Pencils/Erasers

1. Sharpen a #1, #2, and #3 pencil to the same degree.
2. Draw a 2 cm-long mark from each pencil on a sheet of notebook paper side by side so that they are relatively close together. Try to apply the same pressure on the pencil when making the lines. Label the lines 1, 2, and 3, respectively.
3. Examine each line using low power on a microscope. Focus on each line carefully and note its thickness, color intensity, sharpness, etc…Record your observations.
4. Have a partner secretly select one of the three pencils and write a short sentence on another small piece of paper. Compare the writing with the three original marks. Examine the sentence writing using a microscope. Can you determine which pencil your partner used to write the sentence?
5. Have a partner make an "X" on a small piece of paper noting which line of the X was drawn first (bottom) and which line was drawn second (top). Use the microscope to determine which line is on top and which is on the bottom. (This technique could be important in trying to determine if one line has been written over the top of another.)
6. Use a pencil to write your name on another small piece of paper. Press firmly as you write. Erase part of a letter. Examine the eraser mark under the microscope. Shine the UV light on the eraser mark. Are the erasures easily detected?
7. Use a pencil to write a sentence on a piece of paper. Have a partner do the same. Erase a word in the sentence. Try to write the erased word again with the same pencil, being as careful to write right over the old writing as possible. (See if you are a good forger!) Swap the written sentences with your partner and use the microscope and UV light to track down the erased word. Were you able to detect the forgeries?

8. Examine your ransom note to see if any pencil markings were erased from the paper or if any indentations were made (which you can shade with a pencil). Use the techniques you learned above to assist you with this. Record any observations.
9. Write a summary of your observations about erasing pencil from paper.

Part C: Handwriting/Forgery

1. Use a ballpoint pen to firmly write your signature onto a small piece of paper. Label this paper "O".
2. On a second sheet of paper, write your signature again. Label this signature "A".
3. Give your partner paper "O" and instruct them to place a piece of paper over the signature and attempt to trace it. Have them label this paper "B".
4. Give your partner paper "A" and instruct them to forge the original signature by just looking at it and trying to make it look identical to "A". Have them label this paper "C".
5. Switch papers "O", "A", "B", and "C" with another group. Using your naked eye and a microscope, can you determine which signatures – A, B, C are forgeries and which is an original like "O"? (Based on the letter labels you will know, but can you justify your answers based on actual evidence?)
6. Once you feel confident on how to detect a forgery, obtain papers "J", "X", "Y", and "Z" from your instructor. Paper "J" is the actual signature of your instructor. Can you determine which of the other papers are forgeries? Use evidence to support your answer.
7. Describe typical clues (especially microscopic evidence) in handwriting that might signal a forgery.
8. Is it easy to detect a forgery? Why or why not?

Part D: Secret Messages

1. Use a cotton-tipped applicator to "write" a message with the phenolphthalein "disappearing ink" solution on a piece of white paper.
2. Allow the secret message to dry and disappear completely. If necessary, blow on the secret message to make the ink dry and disappear faster.
3. Once the ink has disappeared, it can be "developed" (made to reappear) by spraying the message with a mist of ammonia solution from a spray bottle. A pink color will appear almost instantly and will usually last 3-5 minutes before it fades again.
4. Describe a crime situation where disappearing ink or hidden messages might be useful to a criminal or to a secret agent.

# Document Analysis: Part 2
# (Thin Layer Chromatography)

## Procedure:

Part E: Thin Layer Chromatography with Given Food Colors

1. Place about 1 cm (height wise) of 0.1% NaCl solution in a 250-mL beaker.
2. Use a capillary tube to apply each sample of the food coloring to the TLC plate. Place a capillary tube into a sample of food coloring. You will notice the sample goes into the tube. Touch the capillary tube to the TLC plate 2 cm from the bottom. Let this dry completely and apply another spot. Let this dry.
3. Place the TLC plate in the beaker (touch the sides of the plate only). Let the plate stand and observe until the solvent front has moved about 1 cm from the **top** of the plate.
4. Remove the TLC plate and mark the solvent front (where the solvent stops).

Part F: Thin Layer Chromatography with Mixtures of Food Colors

1. Make the following food color mixtures:
   a. 1 drop red with 1 drop blue
   b. 2 drops red with 1 drop blue
   c. 1 drop blue with 1 drop yellow
   d. 1 drop red with 1 drop yellow
2. Repeat all of the steps from Part One with these mixtures. Put all of the mixtures on one TLC plate.

Part G: Isolating the Ink

1. Obtain the ransom note you received last week and cut out a small portion containing the ink to be tested. Cut this portion into small pieces.
2. Put the pieces of paper in a test tube.
3. Add ~1 mL (height wise) of methanol to the test tube and let it stand. The ink should be extracted from the paper.
4. Make a heavy mark on a different piece of paper with each of the suspected pens.
5. Treat these marks as you did the ransom note. Make sure to keep track of which ink is in which test tube.

Part H: TLC with Ink

1. Place developing solvent in a 400-mL beaker to a depth of about 0.5 cm. Place a watch glass plate on the beaker.
2. Pipet the liquids into different test tubes (so that the paper pieces are not with the liquids anymore).
3. Place the test tubes in a hot water bath (using a different beaker) and evaporate the methanol completely. The samples should become dry.
4. Add 1 drop of methanol to each test tube and shake gently.
5. Use a capillary tube to apply the ink to the TLC plate. Place a capillary tube into the methanol ink. You will notice the solution goes into the tube. Touch the capillary tube to the TLC plate 1 cm from the bottom. Let this dry completely and apply another spot. Let this dry. Do this for all samples.
6. Place the TLC plate(s) in the 400-mL beaker (touch the sides of the plates only). Replace the watch glass on top of the beaker.

7. Let stand and observe until the solvent front has moved about 5 cm from the sample spot.
8. Remove the TLC plate(s) and mark the solvent front.
9. Let them dry and compare the colored bands. Which pen was used to write the ransom note?

## Lab Questions:

1. Discuss your results from Parts E and F and provide an explanation for your results.
2. Discuss how good of a qualitative and quantitative tool TLC is, given your results.