Lesson 2

Trace Evidence

Reading Preview

Key Concepts

- How does a CSI collect trace evidence?
- What are five major types of trace evidence?
- How do crime labs use technology to test trace evidence?

Key Terms

- trace evidence
- classifying
- concentration
- chromatography
- microscope

Target Reading Skill

Using Prior Knowledge Before you read, write one thing you know about hair, paint, glass, and soil in a graphic organizer. As you read, fill in four things you learned that you didn't know before.

What You Know
1. Hair varies in color and length.
2.

What You Learned
1.
2.

Discover Activity

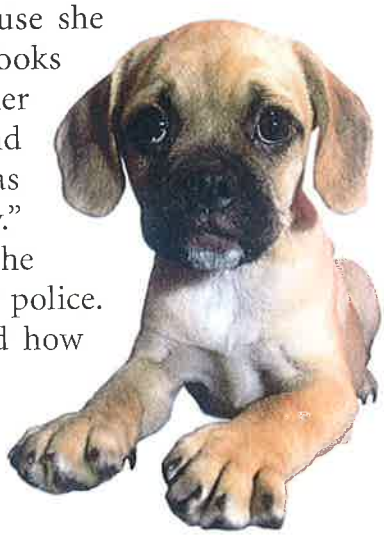
What Clues Does Sand Contain?

Use a hand lens to examine the sand provided by your teacher. Record your answers in your notebook.

1. What color are most of the particles of sand? What other colors can you see?
2. What size are most of the particles? Are they closer in size to grains of table salt, to seeds in a banana, or to poppy seeds?
3. List one property other than color and size you could use to describe the sand.

Think It Over

Developing Hypotheses A CSI finds sand at a crime scene. How could she begin to determine where the sand came from?



Jada wakes up from a nap because she hears a dog barking. When she looks out her window, Jada can see her neighbor Eva get into her van and drive away. She thinks, "As long as I'm up, I'll check on my new puppy." But her puppy is missing! When she can't find the puppy, she calls the police. She tells them what she saw and how much her puppy is worth.

When Eva returns home, the police ask her about the dog. She says, "I didn't take the dog." Then she offers, "Feel free to search my van." The van appears spotless inside and out. It looks as if it was just cleaned. Yet a CSI still finds a few hairs in the van. The hairs might be from the missing puppy. The hairs are an example of trace evidence.

The word *trace* can mean "a tiny amount." It can also mean "a sign of a person that remains after the person has left." So it makes sense that tiny amounts of physical evidence that are transferred at a crime scene are called **trace evidence.**

Collecting Trace Evidence

Investigators must find trace evidence before they can collect it. Given the size of the evidence, this isn't always an easy task. But trained investigators know what to do. **To collect trace evidence, investigators need to know where to look. They also must have the right tools.**

Knowing Where to Look Consider the stolen puppy. What did investigators observe at the crime scene? A glass pane in Jada's back door was broken. A CSI looked for fibers from Eva's clothing on the door. There was soil on the floor where a flowerpot had been knocked over near the puppy's bed.

After getting a search warrant for Eva's house, a CSI looked for the clothing Jada said Eva was wearing. He expected to find bits of glass and soil in the soles of Eva's shoes and dog hairs on Eva's sweater. Even if Eva had brushed the sweater, some hairs could still remain.

Using the Right Tools Evidence kits usually have a hand lens and tweezers. With these tools, a CSI can find and pick up larger pieces of trace evidence, such as the hair in Figure 10. He might also use tape to collect a hair. Objects that are likely to contain trace evidence, such as a sweater, are folded, packed separately, and sent to the lab.

A CSI might use a vacuum cleaner to collect dust. Like the vacuum cleaners people use at home, it draws bits of material onto a filter. But the filters in a forensic vacuum cleaner are designed to be changed frequently. That way the CSI can keep track of where each bit of evidence was found.

Reading Checkpoint What does the CSI need before he can search Eva's house?

FIGURE 10
Collecting Trace Evidence
Tweezers can be used to collect trace evidence such as hairs.
Applying Concepts *What might a CSI use instead of a tweezers to collect hairs?*

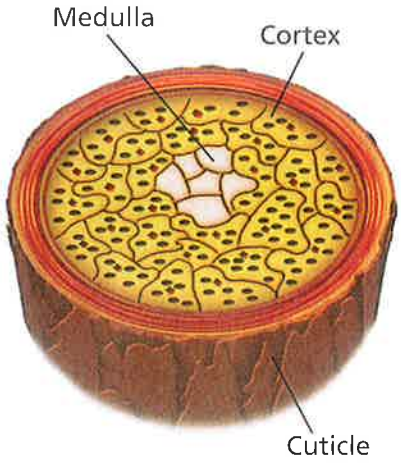


FIGURE 11
The Structure of Hair
Overlapping scales in the cuticle form an outer protective layer. The pigments that give hair its color are found in the cortex. A thick hair often has a visible inner layer called a medulla.
Comparing and Contrasting *What shape are the cells in the medulla of dog hair and cat hair?*

Types of Trace Evidence

Grouping objects together that are alike in some way is called **classifying.** Forensic scientists use this skill to organize the trace evidence they collect. All the samples in a group share certain properties. **Five major groups, or types, of trace evidence are hair, fibers, paint, glass, and soil.**

Hair Sometimes a victim will struggle with his attacker. During the struggle, hairs from the attacker may end up on the victim. If detectives can collect hairs from a suspect, those hairs can be compared to the hairs found on the victim.

The examiner will look at a hair found on the victim under a microscope. She will note its color, length, and diameter. She can tell if the hair was dyed. With the right microscope, she will see the layers that are described in Figure 11. The central layer, the medulla, may be wide or thin. It may be full of cells separated by pockets of air. Or it may not be visible at all!

Then the examiner looks at a hair from the suspect under a microscope. She may see clear differences between this hair and the one found on the victim. For example, one hair may be thicker than the other. Hairs can be used to narrow the list of suspects. But they can't be used to positively identify a suspect because many people have hair with a similar structure.

Many crime labs use visual exams of hair to decide if it is worth doing other tests on the hair. These tests might result in a positive identification, but they are very expensive. You will learn about these tests when you study DNA in Chapter 3.

Fibers Your clothes, the sheets you sleep on, and the towels you dry yourself with all contain fibers. These are long, slender strands that can be woven or knitted together. Figure 12 shows examples of natural fibers and synthetic fibers.

- **Natural Fibers** These fibers come from animals and plants. Wool, for example, comes from sheep, and cotton comes from a plant grown in warm climates. Wool and cotton are common fibers. Fibers that are less common, such as silk and cashmere, can be more useful in solving a crime.
- **Synthetic Fibers** Today, many fabrics contain synthetic fibers. These fibers do not come from animals or plants. Chemists develop these fibers in a lab. Examples are nylon and polyester.

Fibers that a suspect *carries from* a crime scene may not be useful unless the suspect is found right away. After all, clothes can be washed, dry-cleaned, or even thrown away. Fibers that a suspect *brings to* a crime scene can be more useful. If these fibers come from an object in a suspect's home, such as a rug, they may help solve the case.

Suppose an examiner is able to match a fiber found at a crime scene to a fiber found at a suspect's house. Can this match be used to positively identify a suspect? No, but the match can help to make a case against the suspect. Even then, the team will need evidence other than fibers to use in court.

Reading Checkpoint **What is the main difference between natural fibers and synthetic fibers?**

FIGURE 12
The Structure of Fibers
Wool has scales that are typical of animal hair. Cotton fibers are like flat ribbons. Every now and then the "ribbon" twists. Synthetic fibers, such as polyester, have a uniform shape because of the way they are manufactured.

FIGURE 13

Paint, Glass, and Soil Evidence

A car involved in a hit-and-run is likely to contain different types of trace evidence. **Applying Concepts** *How could paint, glass, and soil evidence be used to connect this car to a crime scene?*

This soil contains daisy, cherry, and hornbeam pollen.

Paint A driver speeding along a road hits a man on a bicycle. Instead of stopping to help, the driver speeds off. Police call this type of case a hit-and-run. If investigators find paint at the crime scene, they may be able to identify the make and model of car.

Paint is a mixture, meaning that its composition can vary. For example, the red paint used on one make and model is not likely to match the red paint used on another make and model. Even the red paint used at two factories making the same model can vary. These differences may not be visible to the human eye. But they will show up in the lab.

There is a database for paint samples called the Paint Data Query, or PDQ. The FBI and the Royal Canadian Mounted Police worked together to develop the database. It contains test results for hundreds of thousands of automotive paint samples. Any crime lab can use the database for free. But the lab must send 60 new samples to the PDQ each year. The samples can come from junkyards, body shops, or automakers.

Paint is applied to a car in very thin layers. Even a new car can have four or five layers of paint. If a car has been repaired or repainted, there will be additional layers. These extra layers of paint can make it easier to match a sample from a crime scene to a sample from a suspect's car.

Reading Checkpoint **What does the Paint Data Query contain?**

Skills Activity

Making Models

Changing the composition of a mixture can affect the mixture's properties.

1. Pick two colors. Decide how many "dabs" of each color you want to use.
2. Transfer the chosen number of dabs from each master container to your container. Do not contaminate the swabs.
3. Use a clean swab to mix the dabs together.
4. After the paint dries, add a label describing its composition. Add your sample to the class display.

A car has many layers of paint.

Glass from the crime scene may fit the broken headlight.

Glass To most people, tiny bits of broken glass look even more alike than paint samples do. But bits of glass are not all the same. Glass is made from a mixture of sand and other materials. Forensic scientists can use differences in the composition of glass to compare samples of glass.

A scientist can measure the concentration of elements in a sample of glass. **Concentration** is the amount of a substance in a given mass or volume of a mixture. The scientist tests for elements that are present in very small amounts.

If the type of glass is common, scientists won't be able to use its composition to solve a crime. But they still may be able to use the shape of the glass. For example, bits of broken glass may fit cracks in a broken headlight.

Soil Like paint and glass, soil is a mixture. So the composition of soil can vary, and so can its properties. These properties can be used to match a sample to a specific location. A forensic scientist might, for example, be able to show that soil on the wheels of a car came from a crime scene.

The scientist often begins by looking at the color of the samples. Next, he might look at the size and types of particles in the soil. Seeds or pollen from flowering plants can be very useful. If, for example, the scientist finds seeds from a plant that doesn't grow in the local area, investigators know to search in areas where the plant does grow.

Go Online
SCILINKS NSTA
For: Links on soil types
Visit: www.SciLinks.org
Web Code: dan-1022

Using Chromatography

There are tests a forensic scientist can use to positively identify a substance. But there is a catch. The tests provide the best results when the substance being tested is pure. In other words, the substance should not be mixed with other substances. **Trace evidence is often a mixture. So a forensic scientist needs a way to separate mixtures.**

Suppose you mix table salt with water. If you heat the mixture, the water changes to a gas, but the salt does not. You are able to separate table salt from water because these substances have different properties. Every method a scientist uses to separate mixtures takes advantage of such differences.

Chromatography (kroh muh TAHG ruh fee) is one way to separate mixtures based on their properties. You may have seen this simple example. A spot of food coloring is placed on paper. The food coloring spreads out as water moves along the paper. This happens because some particles in the dye move faster than others. The size of the particles affects their speed. So does their ability to dissolve in water.

The chromatography methods used in a crime lab are not simple. But the concept is the same. Particles in a mixture move through the equipment at different speeds. In a crime lab, a gas that does not react easily is often used to carry the sample being tested. The sample may be a gas, a liquid, or even a solid. Figure 14 explains how gas chromatography can be used to test a paint chip.

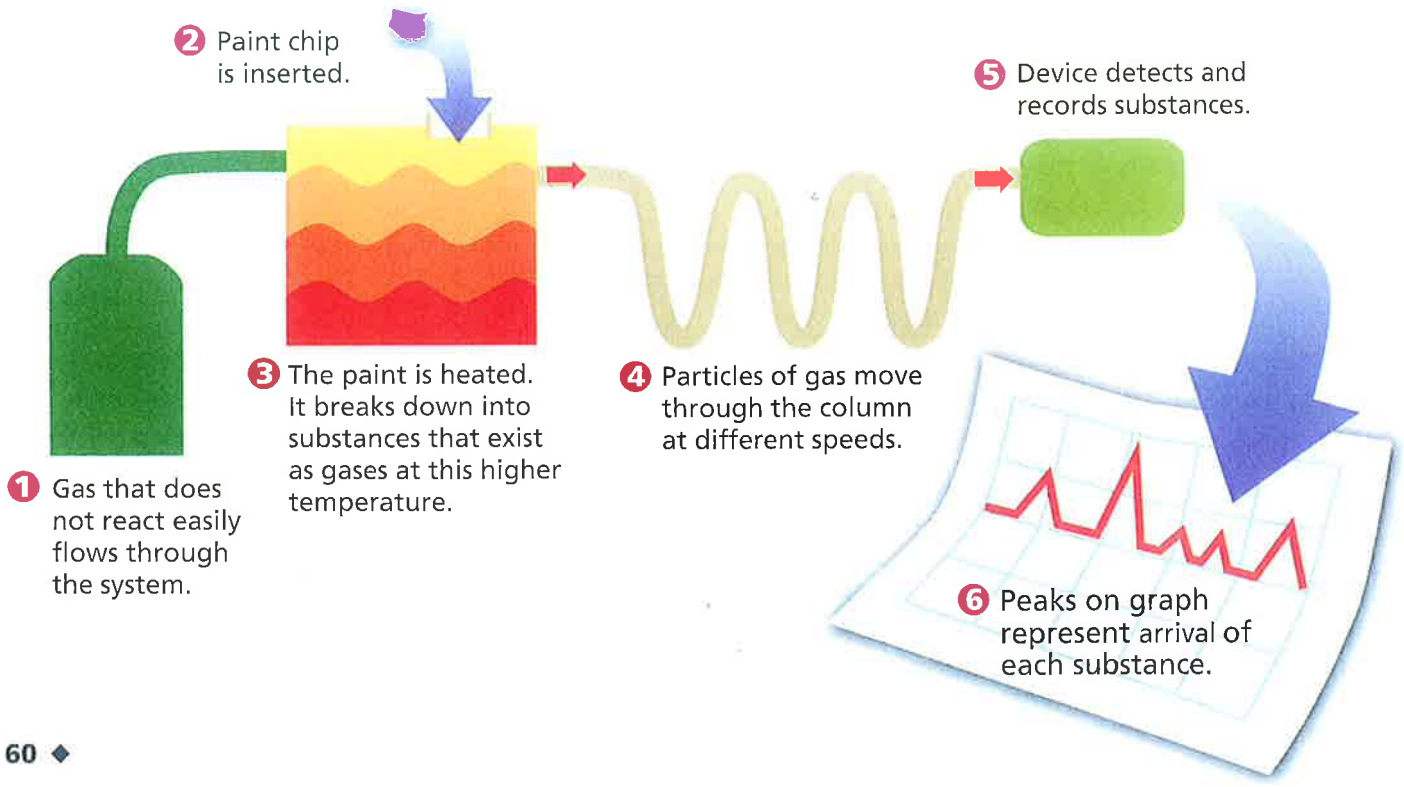


FIGURE 14
Gas Chromatography
Chromatography is used to separate substances in a mixture. Particles of different substances will move through the equipment at different speeds.
Interpreting Diagrams *Why is the paint chip heated?*

Using Microscopes

A hundred years ago, when Edmond Locard worked in his lab in France, he had very few tools. But he did have a microscope. A **microscope** is an instrument that makes very small objects look larger. The microscope is still an important tool for forensic science. **With a microscope, scientists can see details of evidence that are not visible to the unaided eye.** Those details help scientists identify and compare trace evidence.

Crime labs often have a comparison microscope like the one in Figure 15. It has two microscopes joined together. Looking through the eyepiece, a scientist can see two images side by side. The scientist can adjust the images to see if marks on one sample line up with marks on the other.

To magnify tiny traces many hundreds of times, scientists use a scanning electron microscope (SEM). An SEM does not use light to produce an image. It uses a stream of electrons—the tiny negatively charged particles found in atoms. An SEM was used to make the image of pollen in Figure 13.

FIGURE 15
Comparison Microscope
This microscope is ideal for comparing a sample from a crime scene to a sample from a suspect.

Reading Checkpoint What does the SEM use to produce images?

Lesson 2 Assessment

Target Reading Skill Using Prior Knowledge
Use your graphic organizer about trace evidence to help you answer the questions below.

Reviewing Key Concepts

1. a. Defining What is trace evidence?
   b. Describing Give two examples of how a CSI might collect trace evidence.
   c. Applying Concepts A burglar breaks a window and forces open a door to steal a computer. What kinds of trace evidence would a CSI look for at the crime scene?
2. a. Identifying Give two examples of natural fibers and two of synthetic fibers.
   b. Making Judgments A hair from a suspect matches a hair found at a crime scene. Does this match prove that the suspect did the crime? Explain your answer.
   c. Making Generalizations In general, which evidence is more useful—evidence that is brought to a crime scene or evidence that is carried from a crime scene? Why?
3. a. Making Generalizations Why is chromatography used in a crime lab?
   b. Explaining What can forensic scientists see with a microscope that they can't see without the microscope?

At-Home Activity

Collecting Trace Evidence Work with family members to collect trace evidence from a car. First remove large items from the floor and seats. Put an unused filter bag into a vacuum cleaner. Then vacuum the floor and seats. Use an attachment that can reach into narrow spots. Empty the filter bag onto a clean sheet of white paper. Put on gloves to sort through the contents. Use a hand lens to identify the materials. Record the results in your notebook. How might a CSI use the trace evidence you found?