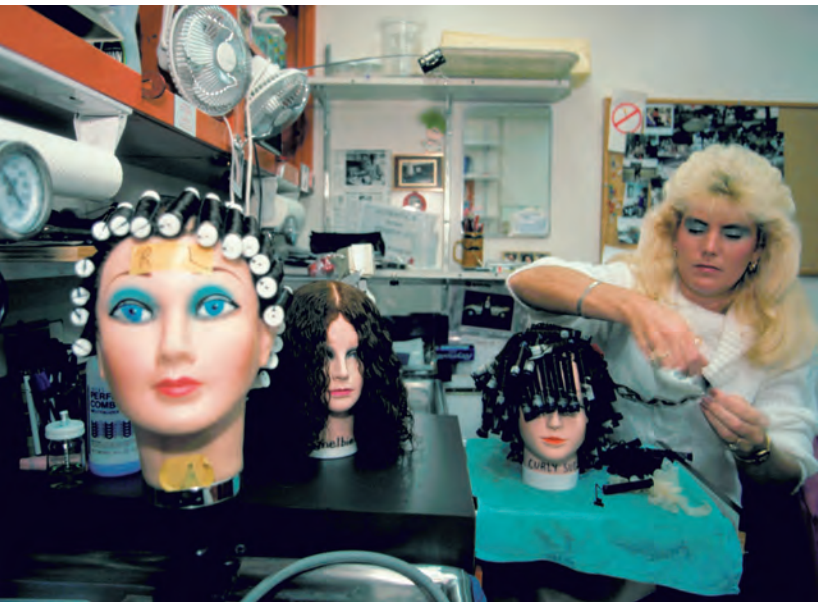
LESSON 16

Researching Solvents



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This scientist is testing hair products in a consumer test lab. She is using mannequins with real human hair. How do scientists design tests such as this one to make sure they are fair?

INTRODUCTION

How long does a pair of shoes last? How many years does it take for a carpet to wear out? Which toothbrush should I buy? These are typical questions that consumers ask. But where would you look to find the answers? Well, you could try looking in a consumer magazine. These magazines list a range of products—such as cameras, computers, toothbrushes, and household cleaners—and then score them according to how well they work.

Where do the magazines get their information? One approach is to collect details on consumers' experiences with a product. The magazine staff compiles the information to produce a rating. (For example, "Seven out of ten consumers scored the Zippoteeth electric toothbrush the best, while the Scrubboplaque scored the lowest.")

Another, more scientific, approach is to test the products (see Figure 16.1). Each product is put through a series of tests carefully designed to determine how well it does its job. Each product is then given a score using a predetermined scoring system. Results for the electric toothbrushes might look like this: "Zippoteeth scored

OBJECTIVES FOR THIS LESSON

Discuss solvents and their uses.

Design and conduct an inquiry on stain removal.

Present your results to the rest of the class.

5 on plaque removal but 10 on battery life. Scrubboplaque scored 6 on plaque removal but only 2 on battery life."

Do you think designing the tests that go into making this sort of report is easy? Scientists must take into account many factors and must standardize the tests so they are fair to all the products being tested. Could you design tests like this? In today's lesson, you will have the chance to solve a similar type of problem. This one involves stain removal as well as some topics you investigated in previous lessons—solutions and dissolving.

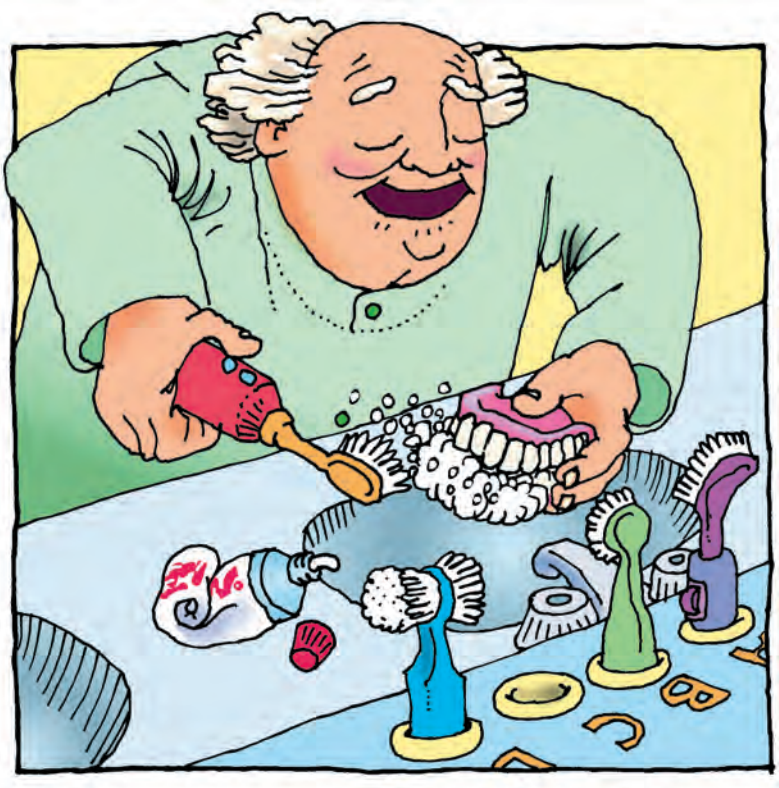


Figure 16.1 *This scientist knows that product testing requires many factors to be taken into account and standardized tests to be used.*

MATERIALS FOR LESSON 16

For you

1 pair of safety goggles

For your group

3 dropper bottles containing these solvents:
- Water
- Rubbing (isopropyl) alcohol
- Kerosene

3 plastic cups containing these staining substances:
- Ketchup
- Chocolate syrup
- Vegetable oil

1 black permanent marker
1 ballpoint pen
5 white cotton cloth squares
10 cotton swabs
2 sheets of newspaper
1 sheet of newsprint
Masking tape

Getting Started

1. Your teacher will ask you to think of examples of liquids that do not contain water. Write your examples in your science notebook. You will be asked to contribute your ideas during a short brainstorming session.

2. After the brainstorming session and discussion, copy the diagram the class has produced into your notebook.

SAFETY TIPS

Wear your safety goggles throughout the inquiry.

Take care not to get solvents or stains on your clothes.

Do not taste any of the substances.

If you spill rubbing alcohol or kerosene, immediately tell your teacher.

Inquiry 16.1
Removing Stains

PROCEDURE

1. One member of your group should collect a plastic box of materials. Check the contents of the box against the materials list.

2. Using the materials in the plastic box, your group should design a test that can be used to compare the effectiveness of the three solvents (in the bottles) at removing five different types of stain. The stains are ketchup, chocolate syrup, vegetable oil, marker pen ink, and ballpoint pen ink. Your teacher may give you some other stains as well. Think about the following questions and test design considerations and discuss them with the rest of your group:

A. How will you standardize your testing procedures so that the results obtained for each solvent and stain can be fairly compared? What elements will you need to standardize?

B. The stains will need to be dry before you test them. How will you accomplish this?

C. How will you score the effectiveness of the stain removers on each stain?

D. How will you present your results so they are easy for others to understand?

E. How will you divide the work among the members of your group?

F. How long will you take to conduct each step of the procedure? (Your teacher will tell you how much total time you have.)

3. In your notebook, write what you are trying to find out. Agree on the materials you are going to use, a procedure, and the design of a scoring rubric (system) and a results table. Record this information in your notebook under the following headings: Materials, Procedure, Scoring Rubric, and Results Table.

4. Draw a large version of your group's results table on the sheet of newsprint.

5. Apply the stains. Write the names of the members of your group on the cloth squares. Allow the stains to dry in the place suggested by your teacher.

6. Continue with your procedure during the next period.

7. Transfer all of your results to the table on the newsprint. Tack or tape the newsprint on the wall nearest your table. Make sure you also make a copy of all the results in your science notebook.

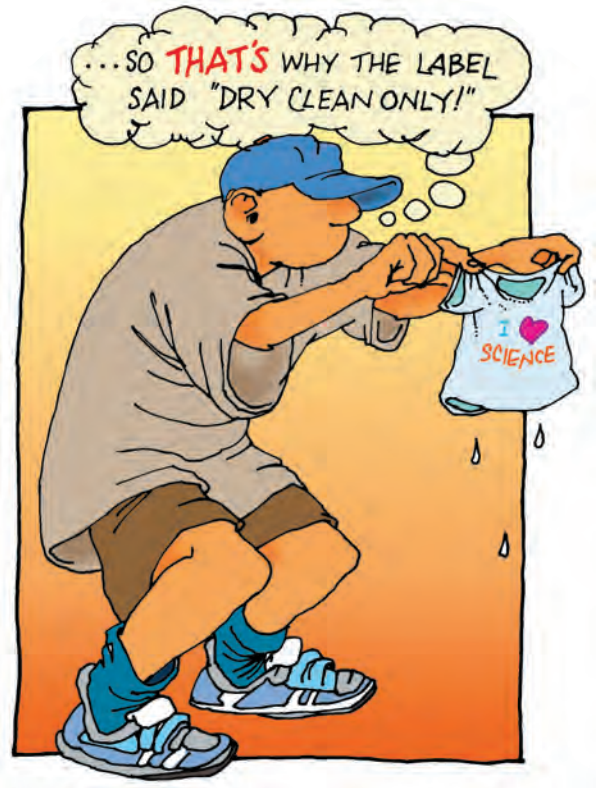
8. Clean up the materials. Dispose of the cotton swabs, cloths, and small containers of staining substances. Return the remaining items to the plastic box.

REFLECTING ON WHAT YOU'VE DONE

1. Discuss the results with members of your group. In your notebook, write any conclusions you can make from your test. Include any comments or suggestions about the effectiveness of your procedure.

2. Your teacher will lead a class discussion. One member of your group will be asked to report on your procedure, scoring rubric, results, and conclusions.

Getting Taken to the Cleaners



Have you ever bought a new piece of clothing, worn it once, put it through the wash, and when you've tried to wear it again, discovered it had shrunk or was completely misshapen? It's only then that you bother to read the label—"Dry clean only."

Dry cleaning is used to clean clothes that would be harmed by water. It is also used to remove stains that are insoluble in water (for example, grease). As the name suggests, dry cleaning involves cleaning without water. (Actually, a very small amount of water is used—you'll find out why later—but not enough to change the name to wet cleaning!) However, even though only a little water is

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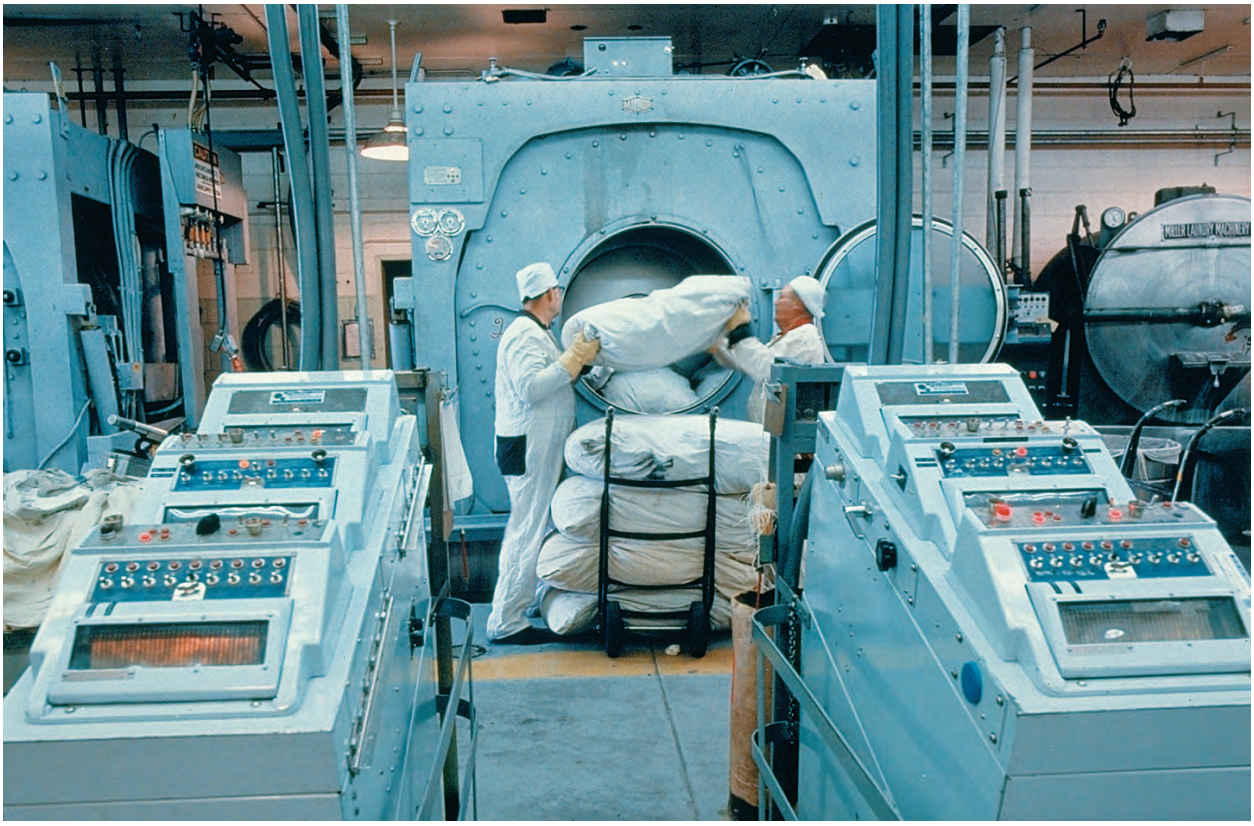

Dry-cleaning machines work somewhat like washing machines, but they use a solvent other than water.

If your dry cleaning smells strongly of solvent, open the windows of your car.

used, the term "dry cleaning" is still a bit deceptive. That's because liquids other than water *are* used.

Early forms of dry cleaning used petroleum solvents such as kerosene. But kerosene is flammable—it burns. After a series of explosions at dry cleaners, the solvent tetrachloroethylene was widely adopted, and it is still used today (along with other solvents). Tetrachloroethylene is not flammable, but its fumes can be toxic in enclosed spaces. That is one reason why, if dry-cleaned clothes smell strongly of solvent, you should drive home from the dry cleaners with your car windows open.

How does dry cleaning work? A dry-cleaning machine is like a giant washing machine. Clothes are placed in the machine. Tetrachloroethylene, mixed with a very small amount of water and a special detergent, is added. (Water is added to remove any stains caused by water-soluble substances.) The tetrachloroethylene flows continuously through the machine until the clothes are clean. Any solvent that remains in the clothes after the cleaning cycle eventually evaporates. All the remaining solvent is recycled. It is heated until it evaporates and then cooled until it condenses to produce a clean solvent that can be used again.

A new approach to dry cleaning has been developed. This method does not use any toxic dry-cleaning solvents. Special detergents and carbon dioxide, which is the solvent, clean the clothes. The carbon dioxide, a gas normally found in air and very much less toxic to the environment than solvents such as tetrachloroethylene, is put under pressure during the cleaning process. This pressure keeps the carbon dioxide in a liquid state. Both the special detergents and the carbon dioxide can be recycled. Will this more environmentally friendly approach be the future of dry cleaning? □

QUESTIONS

1. Why do people who own washing machines still go to the dry cleaners?
2. Can you suggest two advantages of recycling the solvents used in the dry-cleaning process?

MIXING COLORFUL COVERINGS

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Why do we use paint and what does it consist of?

Wouldn't the world be a dull place if there were no such thing as paint? Since prehistoric times, paints have been used in art. The earliest cave paintings were made using paints derived from colored soils and rocks or from animals and plants. These were mixed with other substances, such as egg white, which allowed the pigments to spread over and stick to the surface being painted. Today, paints are used to protect and decorate surfaces. They are carefully formulated mixtures, designed to do specific jobs, and are available in a seemingly infinite variety of colors. Let's examine these mixtures more closely and see how the different properties of the substances from which they are made work together.

Most paints consist of pigments, a vehicle, and a solvent, plus other additives

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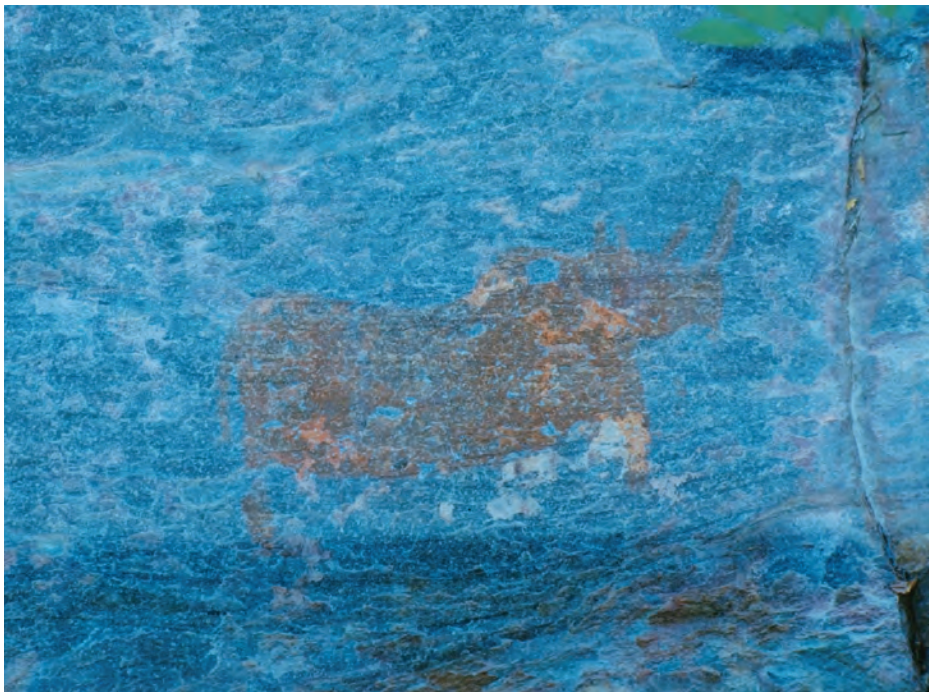

Throughout history, artists have used a wide variety of pigments in their paintings. Many paints contain oxides of metals, which provide color. Bushman rock artists used soils containing reddish brown iron oxide to paint these images. Many modern oil paints contain other metal oxides that produce the vivid colors associated with oil paintings.

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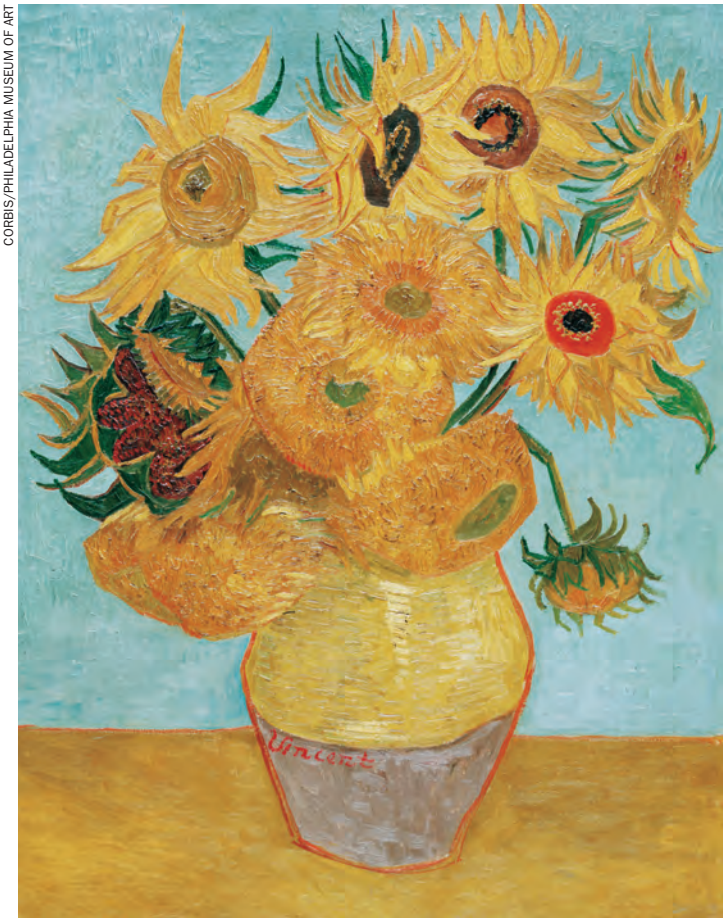

Van Gogh used bright yellows in many of his paintings (including Still Life: Vase with Twelve Sunflowers*, shown here). A lead chromate pigment provides the yellow color.*

that perform a variety of functions. Pigments give the paint color and also make it opaque (not transparent). The type of pigment used depends on the color of the paint wanted. For example, white paint often contains the pigment titanium dioxide. However, several pigments can be used together in varying quantities to produce a wide range of paint colors. For instance, even though titanium dioxide is used to make white paint, other pigments are often mixed with it to produce paints of

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This artist is painting a mural. Artists' paints contain many different solvents. Water and turpentine are the most common.

other colors. For example, titanium dioxide is mixed with barium chromate or cadmium sulfide to make yellow paints, with chromium oxide to make green paints, and with ultramarine or dyes such as indanthrone blue to make blue paints. In addition to adding color to paint, titanium dioxide has the ability to hide the surface that is being painted. For this reason it is called a hiding pigment.

Paint must also contain a substance that will make the pigment stick to the surface being painted (like the egg white used by prehistoric cave painters). These bonding substances are called the vehicle. They are usually made from plastic-like substances which, when dry, form a hard, flexible protective coating.

Solvent thins the paint and helps it spread during painting. Mineral spirits are used as solvents in some glossy paints. These dissolve the vehicle. When the paint dries, a hard film is left behind.

Many emulsion paints and modern latex paints use water as a thinner, although in these cases, the water does not dissolve the vehicle but keeps it finely divided. When the paint dries, the finely divided emulsion comes together to form a hard, flexible surface.

Paints often contain a variety of additives that perform various functions. They may improve the weather resistance of the paint, affect the way the pigment is dispersed to produce special finishes, or speed up the drying process. □

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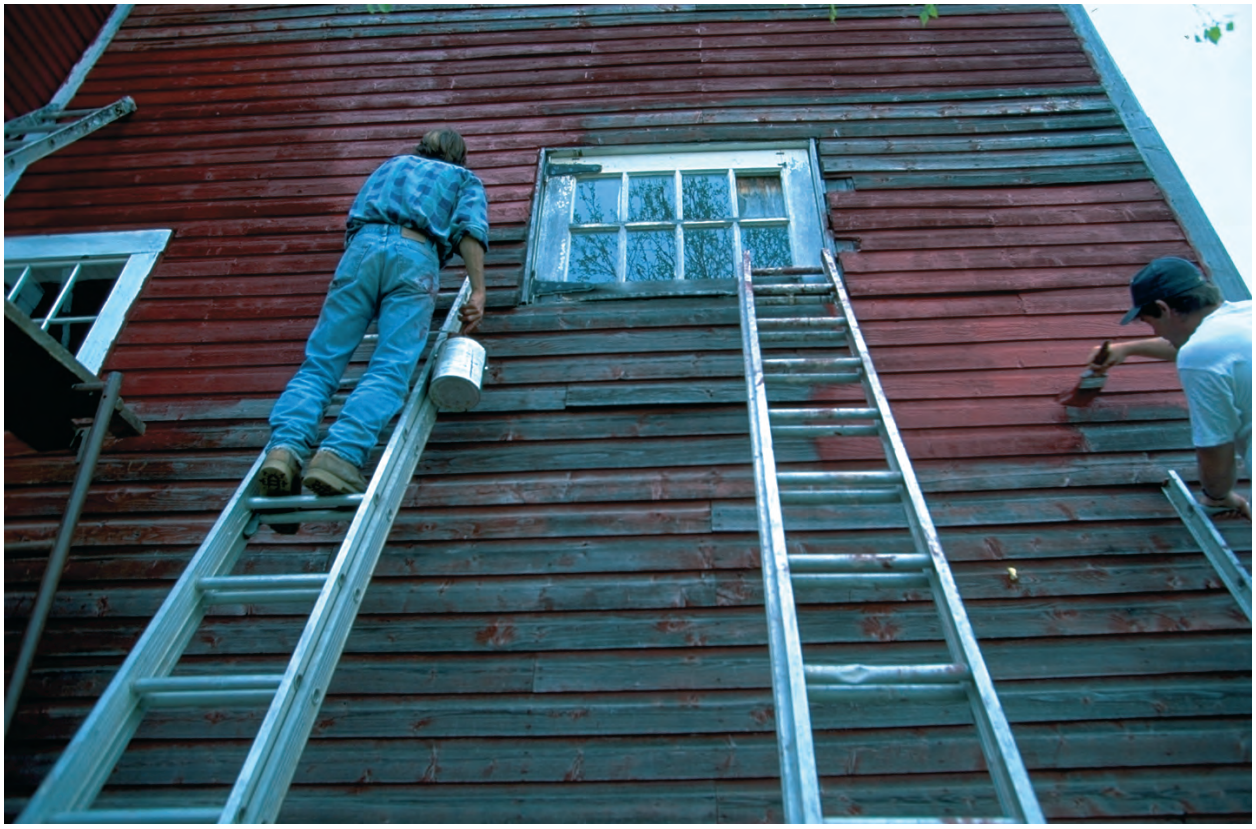

Paint is a complex mixture designed to be applied as a liquid and to dry into a decorative and hard, but flexible, protective finish.