Chapter 6

A Sample Project

Pick a topic. Each of the 50 project ideas in Part II begins with a detailed exploratory experiment. Read some or all of these easy experiments to discover the topic you like best and want to know more about. Regardless of the topic you choose for the science fair, what you discover from any of these experiments will make you more knowledgeable about science.

How can you turn a project idea from this book into your own unique project?

This chapter uses a project idea similar in format to those found in Part II. The detailed exploratory experiment will be referred to as the sample experiment, and is used for several purposes. Like all exploratory experiments, its main purpose is to provide research data on which to base a hypothesis. But in this chapter, it is also used as a model for a project experiment. During the experimentation phase of your project, you can use the following data-collecting techniques and other ideas to design, develop, and fine-tune your project.

KEEPING YOUR PROJECT JOURNAL

Every step of the way, you will keep a journal in which to record the progress of the project. After experimentation has been completed, the journal will be very useful to you when you begin to write your project report. Chapter 7 explains how to write a project report.

TITLE AND PROBLEM QUESTION

The title and problem question for the sample experiment (see Figure 6.1) may or may not be acceptable for your project. Because you'll know so much more after doing the sample experiment and other research, let's wait before deciding on the title and problem question.

> **More Heat**
>
> **PROBLEM**
>
> *Which warms faster, water or soil?*

Figure 6.1 Sample Experiment Title and Problem

> **Materials**
>
> knife (to be used only by an adult)
> small box at least 10 inches (25 cm) square
> two 9-ounce (270-ml) paper cups
> light-colored soil
> tap water
> 2 thermometers
> ruler
> duct tape
> paper
> pencil
> timer
> desk lamp
> adult helper

Figure 6.2 Sample Experiment Materials List

MATERIALS

As Figure 6.2 shows, all the materials for the sample experiment, like those for all the experiments in this book, can be found around the house or purchased without much money at a local grocery or hardware store. Collect the supplies before you start the experiment. You will have less frustration and more fun if all the materials are ready before you start.

Substituting materials is not suggested, but if something is not available, ask an adult's advice before using different materials.

Note that each of the project ideas in Part II contains more than one exploratory experiment. The "Materials" section at the beginning of each project contains only the materials for the first experiment. Be sure to read through the entire project prior to starting to determine all the materials you'll need to complete each experiment.

Procedure

1. Ask an adult to cut off the top and one side of the box.
2. Fill one cup with soil and the other with water.
3. Place the cups together at the back of the box.
4. Put a thermometer in each cup. The bulb of each thermometer should be about ¼ inch (0.63 cm) below the surface of the water or soil in the cup.
5. Tape the top of each thermometer to the back of the box.
6. Prepare a chart to record the experimental results.
7. After the thermometers have been in the cups for at least 5 minutes, record the temperature of each material. These are the starting temperatures.
8. Place the box under the lamp so that the lightbulb is about 10 inches (25 cm) from the top of the cups and centered over them. Make sure that the lightbulb does not touch the box.
9. After 10 minutes, turn the lamp off and immediately record the temperature in each cup. These are the final temperatures.
10. Calculate and record the changes between the starting temperatures and the final temperatures.

Figure 6.3 Sample Experiment Procedure

PROCEDURE

The "Procedure" section for the sample experiment contains the steps needed to complete the experiment. As described in Chapter 2, a variable is anything that has an effect on the experiment. In the sample experiment, water and soil are tested to see which surface warms faster. The type of surface being tested is the independent, or manipulated, variable. Each surface absorbs a certain amount of heat from the lamp. The resulting change in temperature of each surface is the dependent, or responding, variable. All other variables, such as the amount of light that the surfaces receive, the amount of water and soil tested, the containers for the test materials, and, generally, the total environment around each container (room temperature, humidity, etc.), are the controlled, or constant, variables. Note: Approximate metric equivalents have been given after all English measurements.

Remember, this sample experiment is part of your project research. Have someone take a photograph of you performing the experiment, as in Figure 6.4, or take photos of the procedure setup to use as part of the project display. Use the format of the procedure shown in Figure 6.3 as a guideline to design your own project experiment.

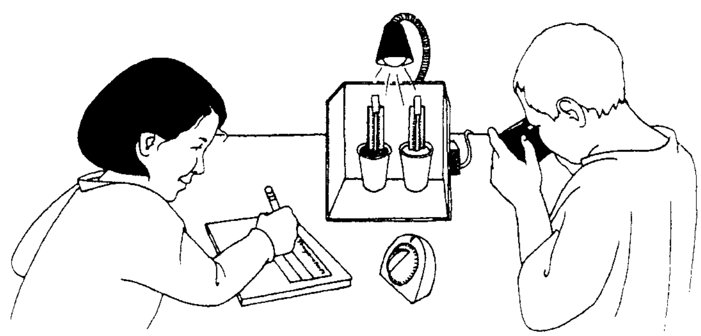

Figure 6.4 Procedure Setup

TEMPERATURE CHANGES FOR SOIL AND WATER

	Temperature (°F)		
Material	**Starting**	**Final**	**Change**
light-colored soil	75	82	7
tap water	73	77	4

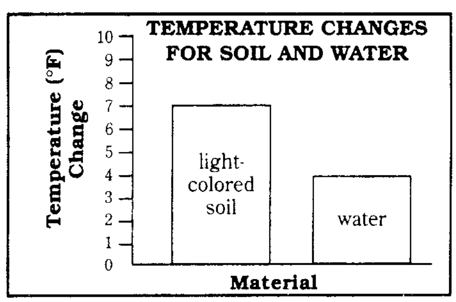

Figure 6.5 Table and Bar Graph for Sample Experiment

SOIL SURFACE TEMPERATURE
(Direct Light)

Time (min.)	Temperature (°F)
0	77
5	83
10	82
15	84
20	84
25	85
30	86

Figure 6.6 Example of a Table

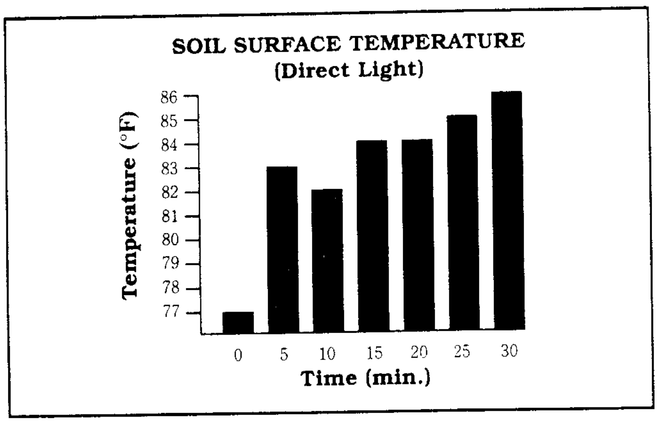

Figure 6.7 Example of a Bar Graph

RESULTS

Before you can state the results of an experiment, you must first organize all the data collected during experimentation. Numbers, called "raw data," have little meaning unless you organize and label them. Data from each experiment needs to be written down in an orderly way in your journal. Use a **table** (a diagram that uses words and numbers in columns and rows to represent data) to record data. Use a graph, such as a **bar graph** (a diagram that uses bars to represent data) similar to the one shown in Figure 6.5 to **analyze** (separate and examine) data.

Figures 6.6 through 6.8 give examples of three different ways to express the same data for surface temperature of soil. Figure 6.6 shows another example of a table, Figure 6.7 shows a bar graph, and Figure 6.8 shows a **line graph** (a diagram that uses lines to express patterns of change).

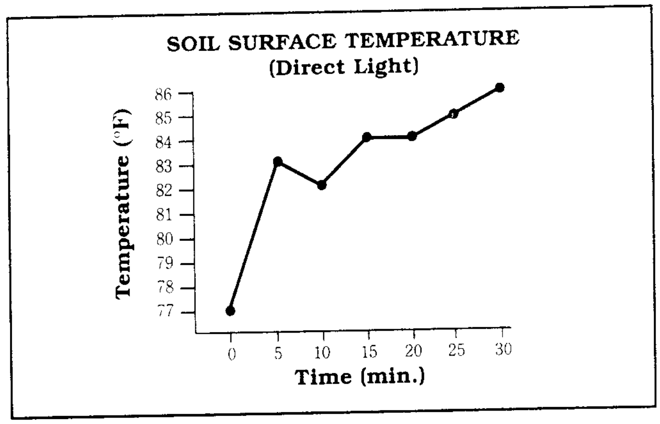

Figure 6.8 Example of a Line Graph

There are other useful ways to represent data. A circle graph, or **pie chart**, is a **chart** (data or other information in the form of a table, graph, or list) that shows information in percentages. The larger the section of the circle, the greater the percentage represented. The whole circle represents 100 percent, or the total amount. For example, a pie chart can be used to represent the results of an experiment measuring soil surface temperatures for June. To make a pie chart, first record the number and percentage of days that have each average daily temperature in a table, as shown in Figure 6.9. Then, express the same data as percentages in a pie chart, as shown in Figure 6.10. Note that illustrations of children are placed around the circle to add interest to the data display.

SOIL SURFACE TEMPERATURES FOR JUNE

Average Daily Temperature (°F)	Number of Days	Percentage of Days
90	12	40%
91	9	30%
92	6	20%
93	3	10%

Figure 6.9 Table of Soil Surface Temperatures

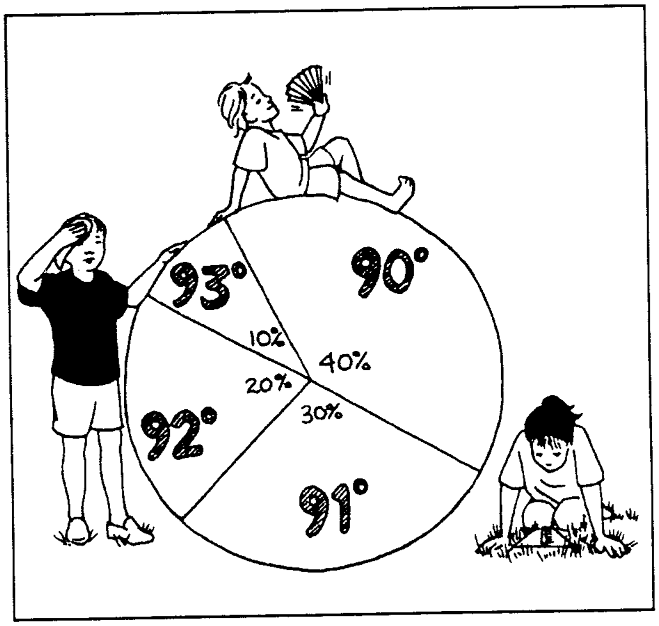

Figure 6.10 Pie Chart of Soil Surface Temperatures

WIND SPEED (6/1–6/3)

Date		Each ⚐ = 1 mph
6/1	Day	⚐ ⚐ ⚐ ⚐
	Night	⚐ ⚐ ⚐
6/2	Day	⚐ ⚐ ⚐ ⚐ ⚐
	Night	⚐ ⚐ ⚐ ⚐
6/3	Day	⚐ ⚐ ⚐ ⚐
	Night	⚐ ⚐ ⚐ ⚐

Figure 6.11 Example of a Pictograph

Results

After 10 minutes under the lamp, the temperature of the soil changed 7 degrees and the temperature of the water changed 4 degrees.

Figure 6.12 Sample Experiment Results

A pictograph could be used to represent the results of an experiment measuring wind speeds. A **pictograph** is a chart that contains symbols representing data, such as quantities of an object. In the pictograph shown in Figure 6.11, each flag represents wind speed of 1 mile per hour. Pictographs are easy to read and can add a little fun to your data display.

The data charted in Figure 6.5 was used to write a statement of the changes in temperature of the soil and water in the sample project, as shown in Figure 6.12.

WHY?

Figure 6.13 shows an explanation of the results of the sample experiment. This information, along with the other research, will be used to develop a project problem, hypothesis, and experiment(s).

Why?

Heat is the total energy of all particles in an object. When heat energy from the light is added to the object, its total energy increases. While the addition of heat usually causes the temperature of the object to increase, the same amount of heat does not cause the same change in temperature in all substances. The amount of heat needed to raise the temperature of 1 pound of a substance 1 degree Fahrenheit (1 g of a substance 1°C) is called **specific heat.**

Although the same amount of heat is added to both cups, the temperature change is not the same for the two materials. Water does not heat up as quickly as soil does; thus, water has a higher specific heat than the soil.

Figure 6.13 Sample Experiment "Why?"

LET'S EXPLORE

This is the point at which you begin to ask different exploring questions as the basis for more research ideas, such as "I wonder, does soil cool faster than water?" or "I wonder, does the color of soil affect the rate at which its temperature changes? Wow! That last question is great." You'll find that the more you think about the sample experiment, the more exploring questions you'll be able to think of and the better your questions will be. Figure 6.14 shows exploring questions and how to find their answers by changing the sample experiment. The experiments in this and the following sections could be performed and the data added to the research information. Another use would be as aids in designing your project experiment(s). Before any further experimentation, read through "Let's Explore," "Show Time!", and "Check It Out!"

LET'S EXPLORE

1. Do the materials cool at the same rate? Repeat the experiment, but record the temperatures as soon as the lamp has been turned off as the starting temperature. After the lamp has been off for 10 minutes, record the temperatures as the final temperatures. Calculate the temperature change for each cup.
2. Does the color of the soil affect the amount of heat needed to change its temperature? Repeat the original experiment, using soils of different colors. You may want to collect soil samples from different locations during a vacation or ask friends to send you soil. Use red, black, and other colors of soil.

Figure 6.14 Sample Experiment "Let's Explore"

SHOW TIME!

The "Show Time!" section in Figure 6.15 shows two ideas related to the sample experiment. It offers different experimental ideas for further investigation of the topic, as well as more ideas for designing your own experiments. (When you design your own experiments, make sure to get an adult's approval if you use supplies or procedures other than those given in this book.) Again, these experiments can provide project research or ideas for designing your project experiment(s).

SHOW TIME!

1. Is the temperature of the air above the materials affected when the materials are heated? Fill two 9-ounce (270-ml) paper cups half full, one with water and the other with dark-colored soil. Place the cups in the open box. Hold a thermometer in each cup so that the bulb is just above the surface of the material, and secure it to the box with tape. After 5 minutes, record the temperature of the air. Remove the thermometers and heat the cups under a lamp for 10 minutes as in the original experiment. Place a thermometer in each cup as before, then record the air temperature above the heated materials.
2. Do structures affect the earth's surface temperature? Read and record the temperatures on 2 thermometers. Place one thermometer on the ground (on either grass or soil) in the shade of a tree, building, or other large structure. Place the second thermometer on the same type of surface, but in direct sunlight. Record the temperatures on both thermometers every 5 minutes for 30 minutes. Use graphs to display the results.

Figure 6.15 Sample Experiment "Show Time!"

CHECK IT OUT!

At this point, you are ready for in-depth research on the topic. The questions asked at this point (see Figure 6.16) require some secondary research. A good place to start your research is the library. Earth science books have sections on weather, air temperature, and wind production. Science experiment books are also a good source of information and provide experiments to use as well.

You will discover from these sources that warm air rises and cold air sinks, and that wind moves from cool areas toward warmer areas. Wow! That's just like at the beach when the breezes blow in toward the land during the day and out to sea at night. This is a real-life experience that you are using to help you with your project. You will want to draw from your personal experiences, not only when looking for a topic as discussed in Chapter 3, but during your project research.

> **CHECK IT OUT!**
>
> The difference in the specific heat of the earth's land and water surfaces causes differences in their surface temperatures. Find out how different surface temperatures affect weather. How does surface temperature affect air temperature? What effect does air temperature have on wind production?

Figure 6.16 Sample Experiment "Check It Out!"

PROBLEM AND HYPOTHESIS

After collecting and analyzing your project research, it's time to zero in on the problem. Let's say you've decided to investigate the effect of surface temperature on wind direction. The question doesn't have to be complex and wordy to be good. Make it as simple and to the point as possible. Look at these two examples:

1. How does the change in temperature of sand and water affect wind direction at the beach?
2. Does the difference in the change in temperature of sand and water cause the air above these surfaces to move at different rates? If so, how does that difference affect the production of sea and land breezes?

Both of the examples have the same goal of discovering how sea and land breezes are produced, but the first example is short and quickly read. Keep in mind that your project will be judged at the science fair, and you want each judge to know immediately the single purpose for your project.

With your problem stated, it's time to developed the hypothesis. The hypothesis might be "I believe that there is a difference in the rate of change in the temperature of sand and water, resulting in a change of wind direction at the beach." This hypothesis is based on these facts:

- In my exploratory experiment, water heated more slowly than the soil during the same period of time.
- Water and land surfaces have different specific heats, thus it takes a greater gain or loss of heat to change the temperature of water than land surfaces.
- Winds move from cold areas to warm areas.

NOW YOU'RE ON YOUR OWN

Test your hypothesis by replacing the soil with sand in the exploratory experiments. Design new experiments that test rate changes in the temperatures of the surfaces and the air above them. But an experiment relating surface temperature to wind direction will also be needed. Think! What moves in the wind? Flags and smoke do. You might test air motion by using lightweight materials or, with adult assistance, smoke. Once one or more experiments have been designed, collect data, construct tables and graphs, draw diagrams, and/or take photos to represent results.

UNEXPECTED RESULTS?

What do you do if your results are not what you expected? First, if there is time, repeat the experiment and make sure everything is done properly. If there isn't time for this, or if you get the same unexpected results again, *don't* *panic*. A scientist's hypothesis often is not supported by his or her experiments. Report the truth in your conclusion. As before, state your hypothesis, but truthfully say that while your research backed up your hypothesis, your experimental results did not. Say what you expected and what actually happened. Report everything—if anything supported the hypothesis, identify it. Continue by giving reasons why you think the results did not support your original ideas. Make your explanation scientific. For example, if you think the experimental materials might have been moved during the experiment:

Do say: "There is a possibility that the lamp was not centered between the materials at all times. This would have resulted in the materials not receiving the same amount of light. This problem can be solved by securing the materials to the table so they are not accidentally moved during the experiment."

Don't say: "My little brother bumped into the box and moved it. I need to lock my door so my brother can't mess up my stuff."

Now it's time to sum up the entire project by writing a detailed report. Review the next chapter for advice on how to put together a science-fair project report.