

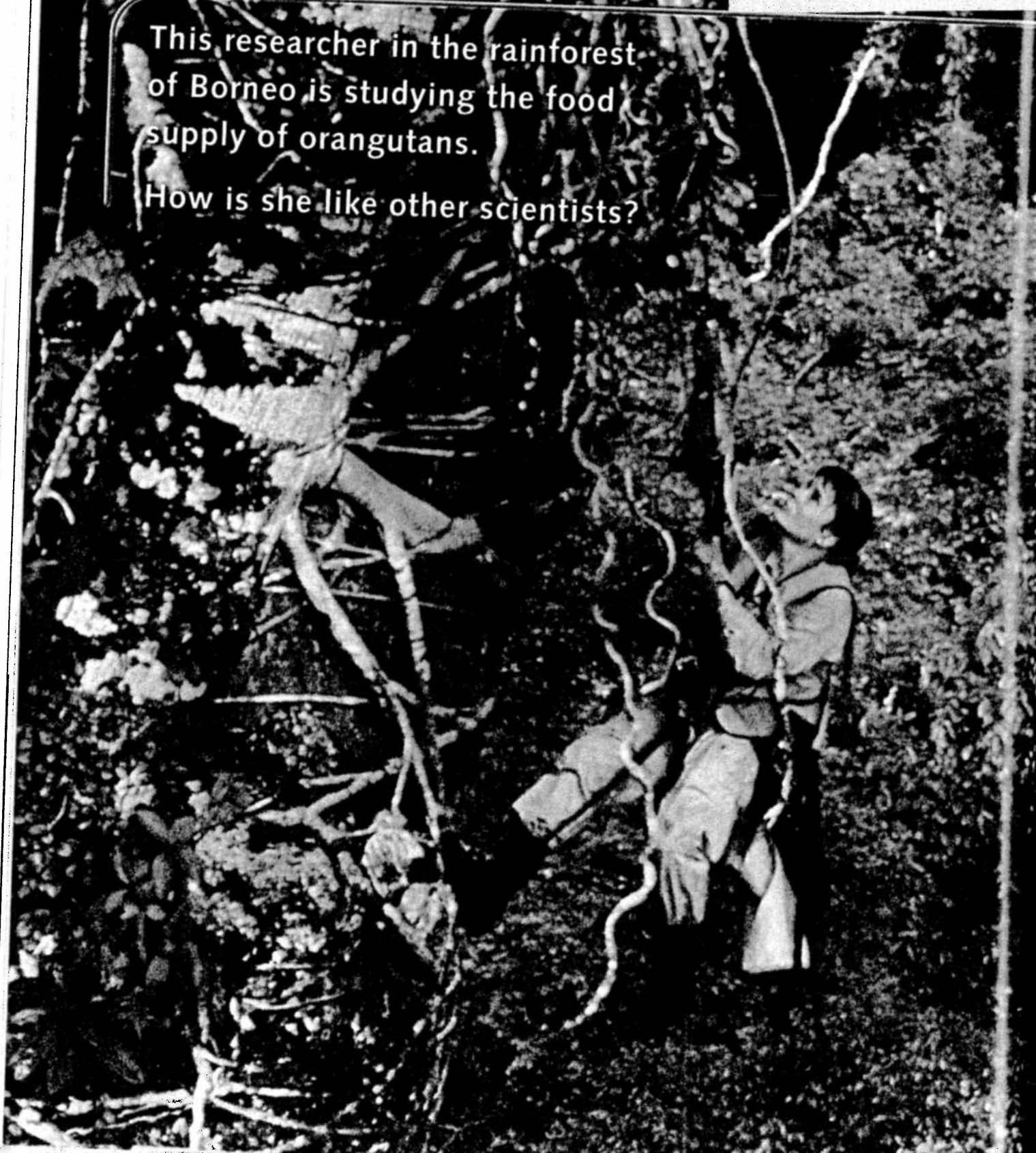
The Nature of Science

CHAPTER

2

This researcher in the rainforest of Borneo is studying the food supply of orangutans.

How is she like other scientists?



2.1

KEY IDEA

Although they come from varied backgrounds, scientists share a way of observing the world and solving problems.

KEY VOCABULARY

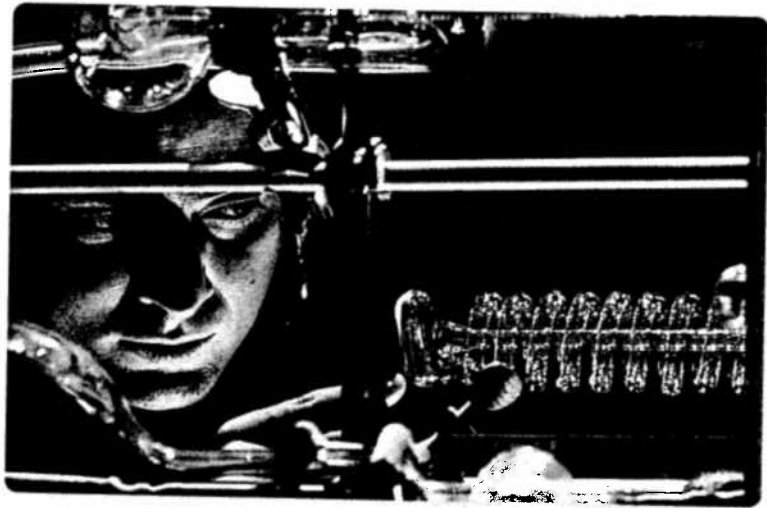
- evidence
- hypothesis
- technology

The Scientist's Mind

Every technological device humans use and every scientific discovery from which they benefit begins in the mind of a person: a scientist. But where do these scientists come from? How do they think? How do they work?

Three Scientists, Three Individuals

A boy from Brooklyn, New York, named Carl Sagan began to wonder what the stars were. He asked other people, but he didn't get an answer that satisfied him. So he went to the library and asked for a book about stars. The librarian gave him one—but it was about movie stars. Sagan was embarrassed that she had misunderstood, but he was not too embarrassed to ask again. That time, she gave him a book about the right kind of stars. It answered some of his questions but started him thinking about many more. Carl Sagan became a noted astronomer, Pulitzer Prize-winning author, and popularizer of science through books and television shows.



CARL SAGAN did much to dispel the notion that science was for only a select few.

While growing up in a small mountain town outside Caracas, the capital of Venezuela, Enriqueta Barrera used to explore the tropical forest and a small river near her home. On her walks, she collected specimens of plants, rocks, and small animals that she studied at home, first with a magnifying glass and later with a microscope her father bought her when she was seven years old.

A high school course sparked Barrera's interest in geology, and she received her doctoral degree from Case Western Reserve University in Cleveland, Ohio. Currently, she is the director of the Geology and Paleontology Program at the National Science Foundation, which funds study of the history of life and the evolution of Earth's environments. Her recent work investigates what conditions were like just prior to the extinction of the dinosaurs 65 million years ago.

In seventh grade, Evan B. Forde's science teacher set up a candle in the front of the classroom. As their midterm exam, he asked his students to write as many observations about the burning candle as they could. Forde finished the exam with more than 100 observations on his paper.



ENRIQUETA BARRERA became interested in geology during high school.

While Forde was growing up in Miami, his parents, both teachers, encouraged him to ask questions and to find the answers himself. He received his graduate degree from Columbia University after working for the National Oceanic and Atmospheric Administration (NOAA) as a researcher. He became the first African American to conduct research dives in the submersibles *Nekton Gamma*, *Alvin*, and *Johnson Sea Link*.

Today, Forde is working with NOAA to make the data from a satellite remote-sensing system more useful to meteorologists who forecast tropical storms. He feels observation is one of his great strengths as a scientist. “If you have enough detail,” he says, “sometimes you can make correlations that might otherwise be missed.” And he wonders if his powers of observation are a cause or an effect: “Am I a good scientist because I’m a keen observer? Or is it the other way around? Maybe I was born to be a scientist.”

Three different people, three different stories, and yet all became earth scientists. Although they came from varying backgrounds, Carl Sagan, Enriqueeta Barrera, and Evan B. Forde were each drawn to science when they were young. Although each faced obstacles, they all became respected scientists.

Different Lives, Common Goals

Some scientists wear lab coats, but many wear blue jeans. Some work in laboratories, but many (especially in the earth sciences) work in the field, diving deep into the ocean in bathyscaphes and searching for rocks in the desert or mountains.

Some scientists teach, while others focus on research. They work for universities and private corporations. Some study the universe; some study objects that can be seen only with a microscope—or, in the case of particle physicists, that really can’t be seen at all.

Given all these differences, do scientists have anything in common? Yes—just like Sagan, Barrera, and Forde, they share what might best be called the “scientist’s mind.” It’s a way of looking at the world with both logic and a sense of wonder.



EVAN B. FORDE conducts research in the *Alvin*, a free-diving deep-sea vessel known as a bathyscaph.

Qualities of Scientific Thinking

Scientists always seem to be asking questions. “Could there be life on other planets?” “What strange creatures live in the deep sea?” “How does human activity affect the atmosphere?” These and thousands more questions are being researched right now by scientists all over the world.

In the course of their careers, some scientists investigate many questions. Some seek the answer to only one. However many questions they ask, though, scientists are methodical in the way they go about finding the answers. Sometimes scientists must overcome great obstacles in their search for answers. A scientist who wants to study distant galaxies or Earth’s core cannot physically go there. Scientists must be inventive as they figure out ways to get the information they need.

Scientists are observant. They ask questions about what they observe. They predict what might cause the phenomena they observe by using **evidence**, material or data that can be measured and tested to verify their prediction.

Scientists are creative. Drawing upon what they know, they form a **hypothesis**, which is a tentative explanation for an observation or phenomenon. Then they think of ways to test their explanations.

Scientists are skeptical. They question long-held assumptions and try to prove or disprove ideas. As they do, they form hypotheses, analyze what is known, experiment to test their hypotheses, and interpret the results. They use mathematics and they use scientific tools and instruments.

Technology, which is the practical application of science to meet human needs, provides scientists with the means to gather accurate and reliable data. The object of scientific study is to understand the natural world, for example, to learn what factors affect plant growth. Often that understanding leads to technology that has wide-ranging benefits, for example, providing farmers with the means to grow more plants per acre.

Because no one can know everything, no matter how long he or she has studied or how smart he or she is, scientists must work together. Scientists cooperate with one another by publishing their results in scientific journals, speaking at conferences, and joining professional societies with other scientists. What they learn adds to what we know and can also be built on by other scientists in the future.

VOCABULARY STRATEGY

The word *skeptical* has its roots in the Greek word *skeptesthai*, which means “to examine.” In ancient Greece, the Sceptics were a group of philosophers who believed nothing can be known for certain.

2.1 Section Review

- 1 Describe the unique characteristics of Carl Sagan, Enriqueta Barrera, and Evan Forde that assisted them in their scientific careers.
- 2 Name two characteristics of scientific thinking that all scientists share.
- 3 Explain why it is important for scientists to be skeptical.
- 4 **COOPERATIVE LEARNING** Develop a presentation on two ways technology has built on scientific knowledge.

Scientific Methods of Inquiry

Creativity plays a large role in science. So does logic. While it's important to see things in a new way, it's equally important to test those new ideas rigorously. Testing ideas with experiments is the key to much of science.

How Scientists Approach Questions

What is scientific inquiry? Although it is often presented as a universal series of fixed steps, that doesn't capture how complex scientific study can be. Not every investigation leads to new knowledge. Not every question can best be answered by doing an experiment; in some cases, observation is the best way to gather data. Sometimes the evidence that is uncovered leads the scientist to explore entirely different issues. However, **scientific inquiry** generally involves observing, asking questions, forming a hypothesis, gathering data, testing the hypothesis, and sharing what has been learned.

Applying This Approach

A look at the approach taken by one scientist can illustrate how scientists approach questions.

Geologist Stephan Custer of Montana State University studies the hydrosphere. One day local residents came to him with a problem. Their wells were running dry, and they thought a new housing subdivision that had been built nearby was responsible.

Custer decided to design an experiment to check the water table, the level below which the ground is saturated with water. You will read more about water tables and groundwater in Chapter 14.

He decided the best way to figure out what was going on was to collect data about the water table's level over time. So he devised an experiment that involved measuring the water table at various wells at different times of the year. Data from one well appear in the graph below.

2.2

KEY IDEA

Scientists approach problems methodically, and their ideas are tested by themselves and by their peers.

KEY VOCABULARY

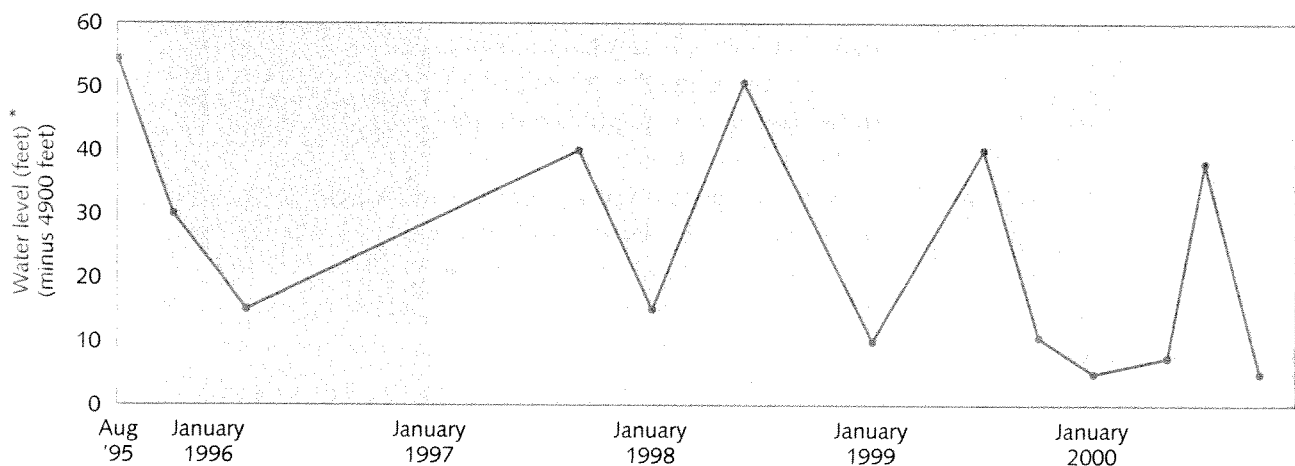
- scientific inquiry
- peer review
- theory
- law



How Might a Scientist Investigate Annual Patterns of Fires?

Examine satellite images to look for conditions that influence fires.
Keycode: ES0201

Water Well History (Well 91931)



* Measurements are relative to 4900 feet above sea level.



IN THE FIELD Stephan Custer prepares to measure a well's water level.

When Custer analyzed the data he and his graduate students had gathered, he noticed something startling: the level of the water table varied as much as 12 meters over the course of the year. Custer knew that too little rain fell in the area to account for such a large variation. So he formed a hypothesis to account for what he had seen. His hypothesis was that the water table was recharged (filled up) by spring runoff from melting snow in the nearby mountains.

To see if his hypothesis was correct, Custer investigated how much water from one mountain stream actually made it to the local river. Measurements showed that except for one day of the year, none of the stream's water made it to the river. Instead, it all soaked into the ground and raised the water table's level.

By repeating these measurements and collecting additional data, Custer has been able to observe the changes in the water table over a period of four years. He has found that the level, on average, has declined. That leads him to the next question: what is the cause of the decline?

Because Custer approached the question about the water table logically and methodically, he was able to gather evidence about changes in the water table before conflicts arose between area residents.

Peer Review and Scientific Journals

The end of an experiment is not the end of the scientific process. The scientist's new knowledge needs to be shared with and tested by other scientists. After completing experiments, scientists write scientific papers about their findings. A scientific paper explains what the scientist observed; how he or she gathered, analyzed and interpreted data; and what he or she thinks the results mean.

To share their knowledge, scientists publish their papers in a scientific journal. Worldwide, thousands of scientific journals are published every year. Some are widely read, such as the journals *Science* and *Nature*. Others are meant for smaller, more specialized audiences.

Scientific journals differ from magazines because of **peer review**. As part of peer review, the editors at a scientific journal ask experts in the field to read the papers scientists have submitted. If the experts agree that a paper has merit, it may be published. Or the experts may feel the scientist has not done enough work or has not proved his or her point. In that case, the editors decline to publish the paper or send it back to the scientist with suggestions for revision.

Once a scientist's paper is published, other scientists will read it. Some may accept the explanation. Others may not. Some will be interested enough to want to test the hypothesis themselves. They may repeat the original experiment and see if they can duplicate its results. They may design another experiment to test the hypothesis, or they may search for additional evidence. Then they may publish their own papers, supporting or disproving the original hypothesis.

This gathering of new evidence and suggesting of new hypotheses constantly changes science. As hypotheses are disproved, others are proposed to take their place. Scientists test the new hypotheses in turn.

VOCABULARY STRATEGY

Your *peers* are your equals. To be reviewed by your peers means that your equals are looking over your work. A scientist's peers would be other scientists.

A good example of how science changes is scientists' hypotheses about how the moon formed. Several ideas have been advanced and disproved; you can read about them on pages 32 and 33.

The Importance of Testing Ideas

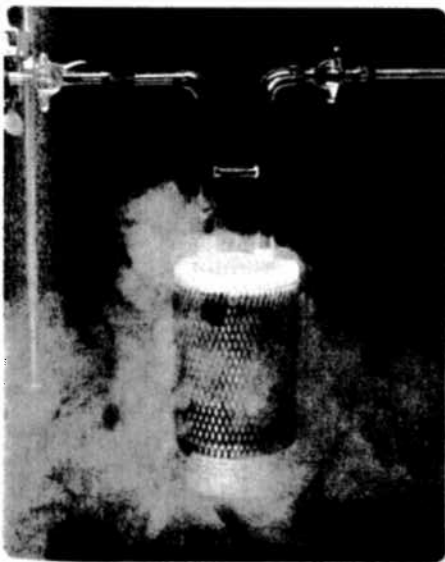
Scientists need to be willing to ask questions and experiment. They also need to be willing to change their minds about their hypothesis if the evidence they gather does not support it.

Do you think you could change your mind like that? It takes a lot of courage to let go of an idea, especially if you have worked hard to find evidence that supports it. But new evidence is being found all the time, and scientists need to be flexible. Scientific ideas are tested and retested every day. Some advances that look especially promising fall short when tested. This happened in 1989 to a team of researchers from the University of Utah. They announced that they had succeeded in producing atomic fusion at room temperature (a phenomenon called cold fusion).

Fusion is the process in which atomic nuclei combine to create new elements. For example, the nuclei of hydrogen atoms fuse to become helium. Along with producing a new element, fusion releases tremendous amounts of energy; it is fusion that fuels the stars. And unlike fission (which breaks up atoms to release energy), fusion leaves much less radioactive residue.

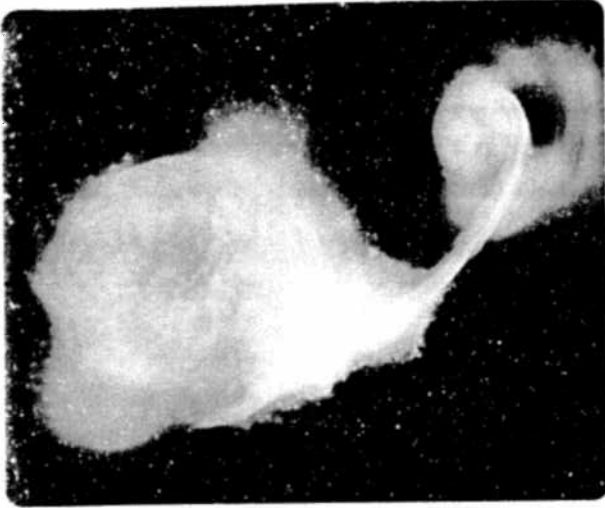
Why isn't fusion in common use? The problem is that it happens only at very high temperatures and pressures. Hydrogen bombs use fusion, but the resulting release of energy is uncontrolled. Many scientists have dreamed of creating controlled fusion at lower temperatures as a clean source of immense amounts of energy.

The Utah researchers were excited when they thought they had successfully produced a fusion reaction at room temperature. However, rather than waiting for their results to be published in a journal and tested by their peers, they announced their results to the media. The media were also excited by the possibility of cold fusion, which could solve humanity's energy problems.



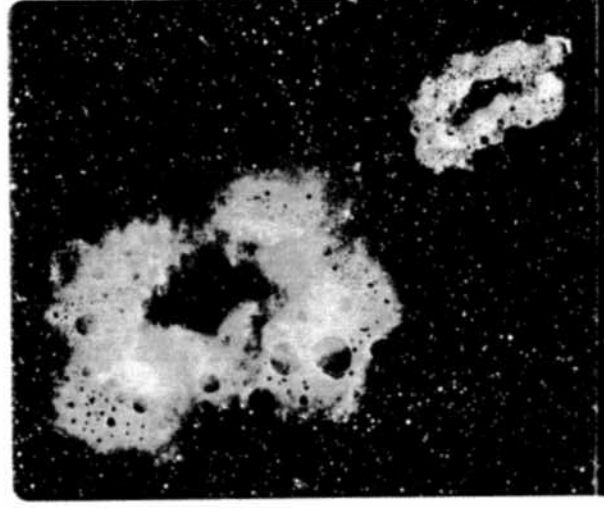
A FAILED ATTEMPT Researchers around the world tried to re-create the University of Utah team's cold fusion experiment with a setup such as this one. None of the attempts succeeded.

DEVELOPMENT OF A THEORY



FISSION This hypothesis proposed that the moon had once been part of Earth. Early in its formation, Earth was spinning so fast that a large piece tore away and flew off into space.

FISSION WAS DISPROVED when analysis of the energy and momentum required showed that the moon and Earth could not have formed this way.



CO-FORMATION This hypothesis proposed that the moon and Earth formed at about the same time out of the rocky debris ring that circled the sun.

CO-FORMATION WAS DISPROVED because it could not explain why the moon lacks iron, a common element on Earth.



CAPTURE This hypothesis proposed that the moon was a celestial body on a nearby orbit that was captured by Earth's gravity.

CAPTURE WAS DISPROVED because it could not explain why the moon and Earth do not have the same isotopic composition.

The story appeared on TV screens and in newspapers all over the world. But then the news came from their peers. Other scientists had tried to duplicate the experiment—and had failed. The failure of cold fusion was a disappointment. If it had worked, it would have been a tremendous benefit to humankind. But fortunately, other scientists tested the idea before hopes got too high. The story of cold fusion shows the value of testing and retesting experimental results.

Science depends on inquiry—asking questions—and experimentation—testing to find evidence. Testability separates scientific knowledge from nonscientific knowledge. Many beliefs people hold cannot be tested. Scientific explanations must be supportable by evidence and be able to be tested in the natural world.

Scientific Theories and Laws

When a hypothesis has been thoroughly tested and retested successfully, it may be considered a theory. A **theory** is an explanation for observable events or facts for which no exception has been found. A theory has passed the scrutiny of many people and seems to be the best explanation for an observed phenomenon, based on the available information.

One of earth science's best-known theories is the big bang theory. This theory states that the entire universe was once packed into a very hot, very dense sphere. The sphere exploded, forming a huge expanding cloud. As parts of the cloud cooled, they condensed into galaxies. Right now, this theory is the best scientific explanation we have for the origin of the

universe. Scientists study the cosmic background radiation. However, it is the big bang theory that comes to light. Scientific theories are about how the universe works, with exceptions to the rule. An object that has gravity. Human beings are from laws, but

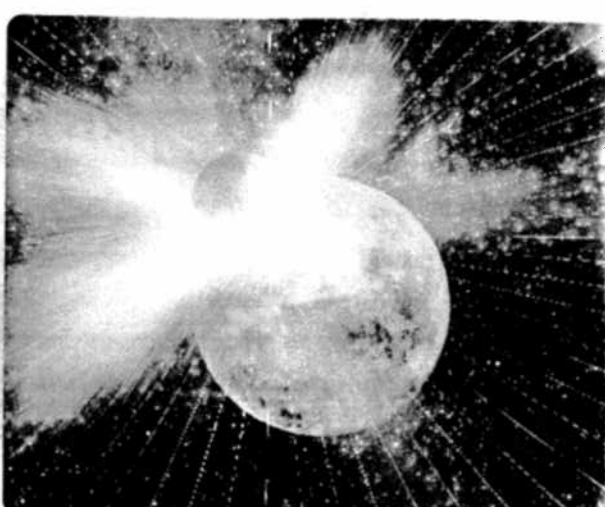
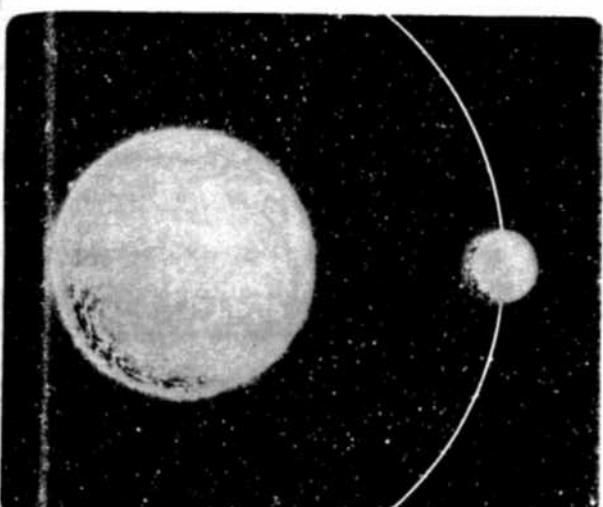
Scientific Thinking

PREDICT

What do you think might have happened if people had taken the researchers' word that cold fusion worked?

2.2 Section

- 1 What is can be f
- 2 What is
- 3 Explain
- 4 CRITIC, scientific forming
- 5 PAIRED between



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it of the rocky
it could not
element

CAPTURE This hypothesis proposed that the moon was a celestial body on a path that took it near Earth, and Earth's gravitation captured the moon, drawing it into orbit.

CAPTURE WAS DISPROVED when lunar rocks were found to have the same isotope composition as Earth rocks do.

IMPACT This hypothesis proposes that during Earth's formation, a planet-sized object struck it. The impact destroyed the other planet and released debris, which eventually coalesced into the moon we know today. This theory is currently accepted among scientists.

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universe. Scientists have found evidence to support the theory, including cosmic background microwave radiation that is an echo of the big bang. However, it is still possible that someone will find evidence that disproves the big bang theory. Theories rise and fall from favor as new information comes to light.

Scientific **laws** are different from theories. They are generalizations about how the natural world behaves under certain conditions. No exceptions to these generalizations have ever been found; for example, no object that has been dropped has ever fallen up. This upholds the law of gravity. Humans don't create the laws; they discover them. Theories grow from laws, but they do not become laws after further testing.

2.2 Section Review

- 1 What is a hypothesis? What steps are necessary before a hypothesis can be formulated?
- 2 What is peer review? What is its role in scientific inquiry?
- 3 Explain the value of testing and retesting ideas scientifically.
- 4 **CRITICAL THINKING** How have you applied the method of scientific inquiry—formulating a question, gathering data, and forming a hypothesis—in your own life?
- 5 **PAIRED ACTIVITY** Prepare a presentation to explain the difference between a theory and a law.

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Scientific Literacy: What's the Big Deal?

You may think that science doesn't have much impact on your daily life, but every time you turn on a computer or listen to a CD, you are enjoying the fruits of scientific research, the advancement of technology.

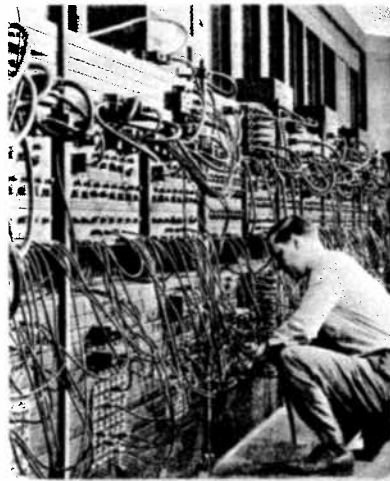
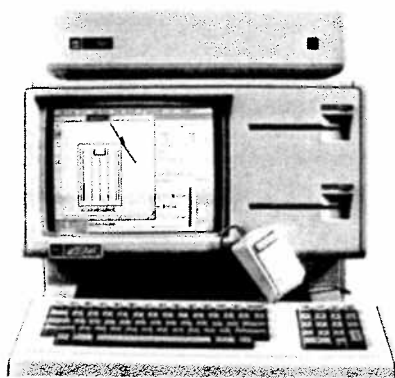
What changes lie ahead? How can you make sure you aren't left behind?

Do the adults in your life ask you for help when they are trying to set the VCR to record or when the computer won't work? Maybe you wonder why adults seem so hopeless when it comes to technology.

Although many adults are perfectly capable of debugging their computers and recording a TV show successfully, other adults aren't so lucky. Technology has changed so fast that they just can't keep up.

To put the changes in perspective, remember that Steven Jobs introduced the Apple II, the first personal computer marketed for home use, in 1977. Since then, computers have become part of many aspects of life, and the Internet has

THE LISA was a desktop computer introduced by Apple in 1983 for home or office use. Its high price (\$10,000) prevented it from becoming a market success.



THE ENIAC was the first general purpose computer. First activated in 1946, it weighed 30 tons and contained 18,000 vacuum tubes.

experienced explosive growth.

Now consider when your parents were born. How old were they when the Apple II was introduced?

Learning can be easier when you're younger, and that's part of the reason your parents turn to you for help with the technological devices around your house. For you, they're second nature because you've grown up with them, but for many adults, they're still new and a little strange.

The rate of technological development isn't likely to slow down. How are you going to keep up with each technological breakthrough reported in the media or hyped by the marketplace? How will you know



PERSONAL COMPUTERS today are less expensive, faster, easier to use and are becoming more and more a part of our everyday lives.

whether you should be concerned about advances in biotechnology? How will you be able to evaluate national issues such as financing a new space mission?

The best way is to make sure you understand the science behind these technological advances. You don't need to get a Ph.D. You should, however, learn as much about science and technology as you can. Even after you graduate, read. Keep learning.

After all, when you're an adult, you don't want your kids to roll their eyes at you, do you? ■

Extension

SCIENCE NOTEBOOK

What scientific and technological advances have occurred since you were born? Make a list of ways things have changed during your lifetime.



Learn more about how science affects your everyday life.

Keycode: ES0202

Scientist

Scientists use a variety of satellites, are costly and may cost just

Tools to St

In geology, which a hammer is an implement (chisel) to split rocks, soil augers and equipment. The geologists use bags and take the

In the laboratory for chemical analysis, a spectroscope to measure a caliper, an L-shaped determining the sieve shaker, a ge

Geologists also use inclinometers for measuring Earth's gravity field. Using composition of vibrations travel sledgehammer to study of the ocean research. about these tool



RESEARCH VESSEL laboratories for ma

Scientists' Tools

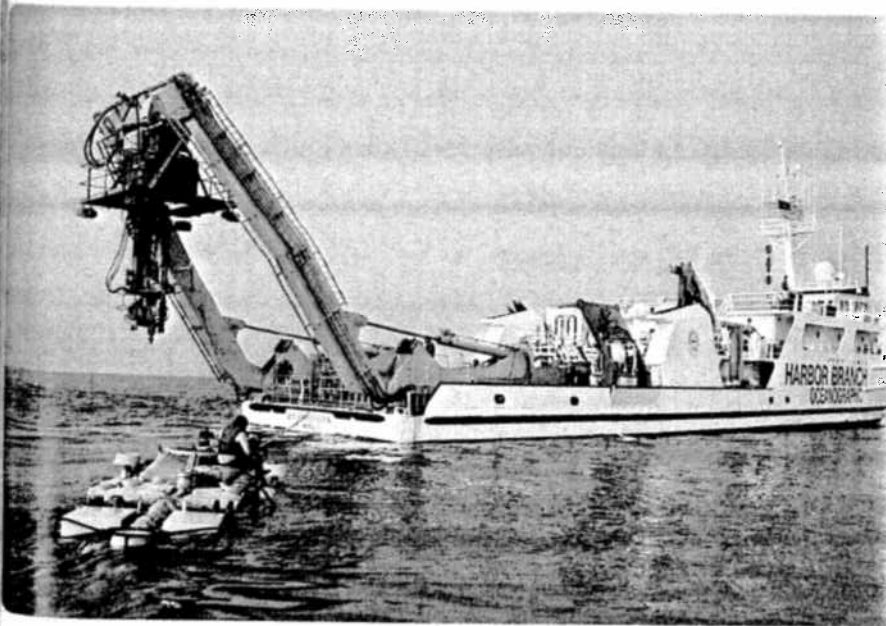
Scientists use a variety of tools in their inquiries. Some, like computers and satellites, are complex and may cost billions of dollars. Others are simple and may cost just a few pennies each, such as bags to hold specimens.

Tools to Study the Earth and Ocean

In geology, which is the scientific study of Earth's structure, a simple rock hammer is an important tool. Geologists use it (sometimes with a rock chisel) to split rocks or to loosen specimens from rock faces. They also use soil augers and earth drills to sample material beneath the ground's surface. The geologists collect their specimens in cloth or plastic sample bags and take them to the laboratory for further study.

In the laboratory, geologists may use a crusher to pulverize a specimen for chemical analysis. They may use a hand lens to examine it closely or a spectroscope to analyze its composition. They may measure it with a caliper, an L-shaped instrument that measures irregular objects by determining the distance between its two short arms. Using sieves and a sieve shaker, a geologist can quickly sort a bag of mixed sediments by size.

Geologists also use laser range finders for measuring distance, clinometers for measuring the slope of inclines, magnetometers for measuring Earth's magnetic field, and gravimeters to measure Earth's gravity field. Using a seismograph, geologists can determine the composition of the ground beneath their feet by measuring how fast vibrations travel through it from a source such as a dynamite blast, a sledgehammer blow, or an earthquake. In oceanography, the scientific study of the oceans, oceanographers employ tools specially suited for ocean research. These include dredges and gravity corers. You'll read more about these tools in Chapters 23 and 24.



RESEARCH VESSELS, such as the *Edwin Link* pictured here, serve as oceangoing laboratories for marine scientists.

2.3

KEY IDEA

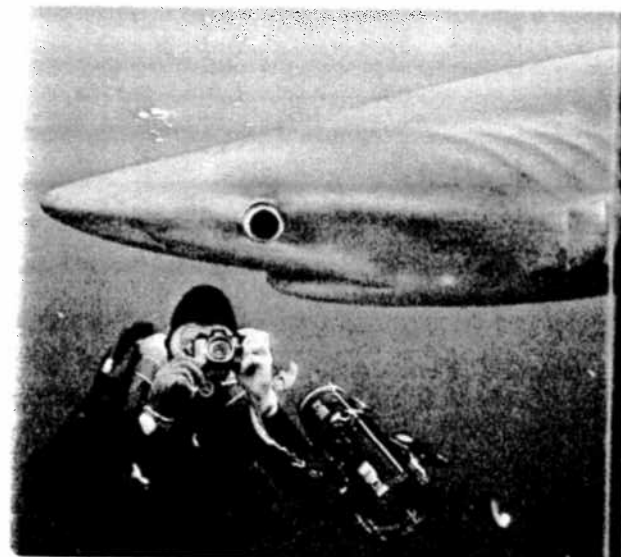
Scientists use both simple and complex tools in their inquiries.



Examine a case of how technology facilitated discovery.
Keycode: ES0203



GEOLOGY A creepmeter monitors creep, the downslope movement of soil.



OCEANOGRAPHY Oceanographers need their equipment to meet the special demands of exploring ocean environments.



METEOROLOGY and pencil and p

25-Minute Mini LAB

Making a Sextant

Materials

- string
- protractor
- straw
- metal washer
- tape

Procedure

- 1 Tie the washer to one end of the string. Fasten the other end to the protractor's center.
- 2 Tape the straw at the center mark so that one end hangs a little beyond the 90° mark.
- 3 Look through the straw at a tree. Let the string hang freely. When the string stops swinging, press the string in place and record the angle.

Analysis

Could you determine the height of a tree using the sextant? Why would a sextant have been important for early seafarers?

Tools to Study the Sky and Stars

In the scientific study of weather and climate, meteorology, scientists use a variety of instruments. These include the thermometer, which measures temperature; the anemometer, which measures wind speed and direction; and the barometer, which measures air pressure. Weather radar and satellite pictures give meteorologists a view of Earth's weather patterns that was unavailable to them just a few decades ago.

Astronomy is the scientific study of the universe. Astronomers use telescopes to study the stars and planets. Reflecting telescopes use mirrors to focus light waves into images, while refracting telescopes use lenses. Radio telescopes pick up radio waves rather than light waves. The Hubble Space Telescope, an orbiting reflecting telescope, is providing astronomers with images of objects never before seen. Some telescopes are portable and affordable enough for amateur stargazers. Others, such as the Arecibo radio telescope in Puerto Rico, take up about 20 acres of land.

Tools with Many Uses

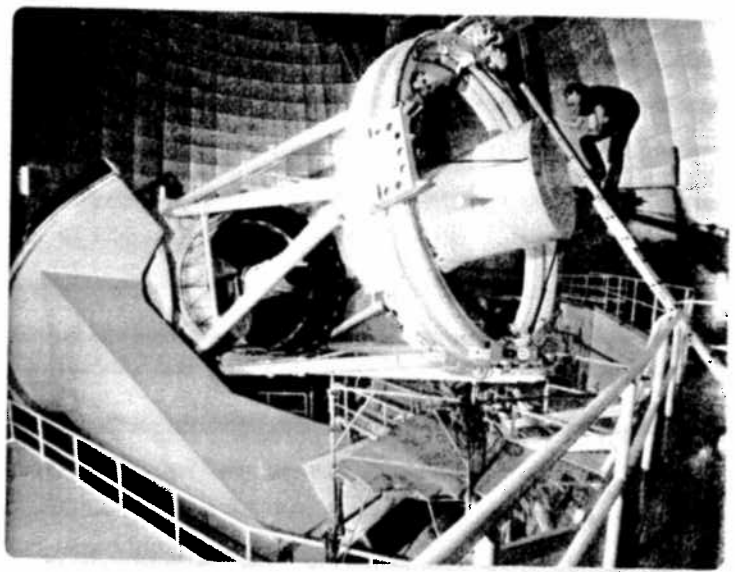
Not all of the earth scientist's tools were developed for purely scientific reasons. The telescope, for example, was originally designed for seafarers. Also originally used by seafarers was the sextant. The sextant is an instrument that measures the angle between two points, such as the horizon and a star. By determining the altitude of a star viewed through a sextant and comparing it with altitudes the star was known to have at various latitudes, a ship's navigator could find the latitude of the ship.

Two tools in particular have revolutionized earth science: the computer and the satellite. With computers, earth scientists can now analyze larger amounts of data than ever before, in a fraction of the time it took in the past. Computers can generate graphs, charts, and images that make data easier to interpret and understand. Among the most exciting uses of computer

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2.3 Sec

- Describe
- WRITING note-taking activity
- CRITICAL THINKING the natural world
- PAIRED WORK in your notebook



air equipment to environments.

METEOROLOGY Meteorologists use both computers and pencil and paper to do their work.

ASTRONOMY Telescopes, such as the Anglo-Australian Telescope in Sliding Spring, Australia (shown here), are among the largest tools of earth science.

scientists use a h measures direction; and and satellite s that was

technology are geographic information systems, which you will read more about in the next chapter. During the last few decades, computer technology has advanced rapidly, and the computer power that once filled a room now fits in a pocket. More portable computers can go with scientists into the field, instead of staying behind in the laboratory. In the field, computers allow scientists to analyze data and to connect to other computers.

ners use s use mirrors to lenses. Radio bble Space omers with able and Arcibo radio

Like computers, satellites are useful to earth scientists in all fields. Oceanographers can use satellite data to map the sea floor. Meteorologists use satellite images to study weather patterns. False-color satellite images can tell geologists where to find different rock types. They have dramatically changed mapmaking, as you will learn in the next chapter.

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From rock hammers to satellites, earth scientists have an amazing array of tools to choose from as they do their research. The most important tool, however, is the mind—the ability to wonder why, to ask questions, and to seek answers. Such inquiry has led us to invent and construct the most advanced tools to tell us more about our planet Earth and the worlds and stars that surround us.

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Observe some products of a Geographic Information System (GIS).
Keycode: ES0204

2.3 Section Review

- 1 Describe how tools help scientists in their work.
- 2 **WRITING** Earth scientists must take notes in the field. Practice your note-taking skills by observing an animal for five minutes and noting its activities, or by writing a description of a rock sample.
- 3 **CRITICAL THINKING** How are computers and satellites changing the nature of science?
- 4 **PAIRED ACTIVITY** Make a poster about one of the scientific tools in your science laboratory, describing its appearance and function.

CHAPTER 2

REVIEW

Summary of Key Ideas

2.1 Scientists come from many different backgrounds, but in their work they use many common tools, techniques, and habits of mind. The qualities of scientific thinking include asking questions, seeking evidence, forming hypotheses, testing hypotheses, being skeptical, and working cooperatively. Technology plays an important role in applying scientific discoveries to everyday life.

2.2 Doing science is a complex process that does not proceed neatly from one revelation to the next. When scientists investigate questions, they state the question, gather evidence, form a hypothesis, and test the hypothesis. Scientists publish their results in scientific journals, which provides the opportunity for their peers to review their work. Testing ideas is vital to science. When a hypothesis has been thoroughly tested, it may be considered a theory, an explanation for observable events for which no exceptions have been noted. Scientific laws are generalizations about the natural world and how it behaves.

2.3 Scientists use a variety of tools, both simple and complex, as they study the earth, ocean, sky, and stars.

KEY VOCABULARY

evidence (p. 28)

hypothesis (p. 28)

law (p. 33)

peer review (p. 30)

scientific inquiry (p. 29)

technology (p. 28)

theory (p. 32)

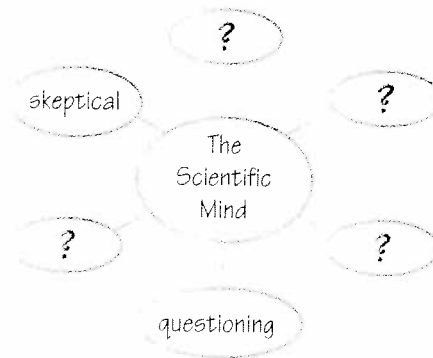
Vocabulary Review

Explain the difference between the terms in each pair.

1. theory, law
2. hypothesis, theory
3. science, technology
4. cooperation, peer review
5. evidence, inquiry
6. hypothesis, question

Concept Review

7. What are some qualities that scientists share?
8. How do scientists support their hypotheses?
9. Describe the way in which a scientist might approach a question.
10. Why is it important for scientists to be skeptical?
11. Describe how peer review works.
12. Explain why it is important to test scientific ideas.
13. Can a scientific theory become a scientific law? Why or why not?
14. Describe some of the tools Earth scientists use as they work.
15. **Graphic Organizer** Copy and complete the concept map below by adding characteristics that are important for looking at the world scientifically.



Critical Thinking

16. **Observe** 7 grade exper asked him candle. Ta yourself: H object can the key.
17. **Communic** observed ir based on y detail so so Forde says, from anoth
18. **Predict** W discoveries peer review

Interpreti

- As you saw in S be able to inter information from the one Dr. Steg water levels. Ea result of a water
19. How many tested in St
 20. During Stud water level i measureme measureme
 21. During Stud water level c measureme measureme
 22. Given both : weeks were

Critical Thinking

Internet Extension



How Might You Investigate Scientific Phenomena?

Examine sets of satellite images. Develop a plan for conducting an investigation.

Keycode: ES0205

Writing About the Earth System

SCIENCE NOTEBOOK If you could meet any of the scientists described in this chapter, or another scientist (past or present) you have heard of, what would you like to ask him or her? Make a list of questions you would ask your chosen scientist.

Interpreting Graphs

As you saw in Section 2.2, it is vital for scientists to be able to interpret graphs and draw useful information from them. The graph shown is similar to the one Dr. Stephan Custer used in his study of well-water levels. Each bullet on the graph represents the result of a water-level test.

19. How many times was the water level tested in Study 1? in Study 2?
20. During Study 1, by how much did the water level decline between the first measurement and the final measurement?
21. During Study 2, by how much did the water level decline between the first measurement and the final measurement?
22. Given both studies, for how many weeks were water levels monitored?

23. What must have taken place between the measurement taken near March 1, 1995, and the one taken September 1, 1995?
24. If a third study were done, what do you think a graph made from its data would look like? Explain your thinking.

