Section 1.3

Objectives

- **Explain** why precise communication is crucial in science.
- **Compare and contrast** scientific theories and scientific laws.
- **Identify** when it is appropriate to use a graph or a model.

Review Vocabulary

hypothesis: testable explanation of a situation

New Vocabulary

scientific model
scientific theory
scientific law

Communication in Science

MAIN Idea Precise communication is crucial for scientists to share their results effectively with each other and with society.

Real-World Reading Link If you read an advertisement for a product called "Glag" without any description, would you know whether to eat it or wear it? When a scientist does an investigation, he or she has to describe every part of it precisely so that everyone can understand his or her conclusions.

Communicating Results

There are many ways to communicate information, such as newspapers, magazines, TV, the Internet, and scientific journals. Think back to the Launch Lab from the beginning of the chapter. Although you and your lab partner both used the same form of communication, were your descriptions identical? Scientists have the responsibility to truthfully and accurately report their methods and results. To keep them ethical, a system of peer review is used in which scientists in the same field verify each other's results and examine procedures and conclusions for bias. Communicating scientific data and results, as the scientists are shown doing in **Figure 1.9,** also allows others to learn of new discoveries and conduct new investigations that build on previous investigations.

Lab reports Throughout this book, you will conduct many Earth science investigations and experiments. During and after each, you will be asked to record and analyze the information that you collected and to draw conclusions based on your data. Your written account of each lab is your lab report. This will be used by your teacher to assess your understanding. You might also be asked to compare your results with those of other students to help you find both similarities and differences among the results.

Figure 1.9 Scientists, like those shown in the photo, communicate data and discoveries with each other to maintain accuracy in methods and reporting.
Infer *what could happen if scientists did not compare results.*

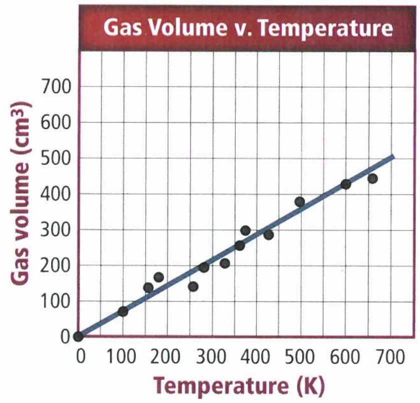

Figure 1.10 A line graph shows the relationship between two variables.
Determine *Based on this graph, what is the relationship between gas volume and temperature?*

Graphs By graphing data in a variety of ways, scientists can more easily show the relationships among data sets. Graphs also allow scientists to represent trends in their data. You will be asked to graph the results of many experiments and activities in this book. There are three types of graphs you will use in this book.

Line graphs A visual display that shows how two variables are related is called a line graph. As shown in **Figure 1.10,** on a line graph, the independent variable is plotted on the horizontal (x) axis, and the dependent variable is plotted on the vertical (y) axis.

Circle graphs To show a fixed quantity, scientists often use a circle graph, also called a pie graph. The circle represents the total and the slices represent the different parts of the whole. The slices are usually presented as percentages.

Bar graphs To represent quantitative data, bar graphs use rectangular blocks called bars. The length of the bar is determined by the amount of the variable you are measuring as well as the scale of the bar graph. See the *Skillbuilder Handbook,* page 951, for examples of all the types of graphs described above.

Models In some of the investigations, you will be making and using models. A **scientific model** is an idea picture, a system, or a mathematical expression that represents the concept being explained. While a model might not have all of the components of a given idea, it should be a fairly accurate representation.

DATA ANALYSIS LAB

Based on Real Data*

Make and Use Graphs

How can graphs help interpret data? The table shows the average surface temperature of Earth over the past 125 years. The data in the table are global, average surface temperatures, in kelvin, starting in the year 1880.

Think Critically

1. **Construct** a line graph from the average surface temperatures in the data table.
2. **Convert** each temperature from kelvin to degrees Celsius by subtracting 273 from each value. Place both on your graph.
3. **Determine** from your graph the average surface temperature for 1988 in degrees Celsius.
4. **Extrapolate,** in Celsius, what the average surface temperature will be in the year 2100 if this trend continues.

Data and Observations

Average Global Surface Temperatures

Years	Average surface temperature (K)
1880–1899	286.76
1900–1919	286.77
1920–1939	286.97
1940–1959	287.02
1960–1979	286.98
1980–1999	287.33
2000–2004	287.59

*Data obtained from Goddard Institute for Space Studies, NASA Goddard Space Flight Center

Models can change when more data are gathered. As shown in **Figure 1.11**, early astronomers thought that Earth was the center of the solar system. This model was changed as the result of observations of the motions of the Sun and the planets in the night sky. The observations showed that the planets in our solar system orbit the Sun.

Theories and Laws

A **scientific theory** is an explanation based on many observations during repeated investigations. A scientific theory is valid only if it is consistent with observations, makes predictions that can be tested, and is the simplest explanation of observations. Like a scientific model, a theory can be changed or modified with the discovery of new data.

A **scientific law** is a principle that describes the behavior of a natural phenomenon. A scientific law can be thought of as a rule of nature, even though the cause of the law might not be known. The events described by a law are observed to be the same every time. An example of a scientific law is Newton's first law of motion, which states that an object at rest or in motion stays at rest or in motion unless it is acted on by an outside force. This law explains why Earth and other planets in our solar system remain in orbit around the Sun. Theories are often used to explain scientific laws.

In this book, you will communicate your observations and draw conclusions based on scientific data. You will also read that many of the models, theories, and laws used by Earth scientists to explain various processes and phenomena grow from the work of other scientists and sometimes develop from unexpected discoveries.

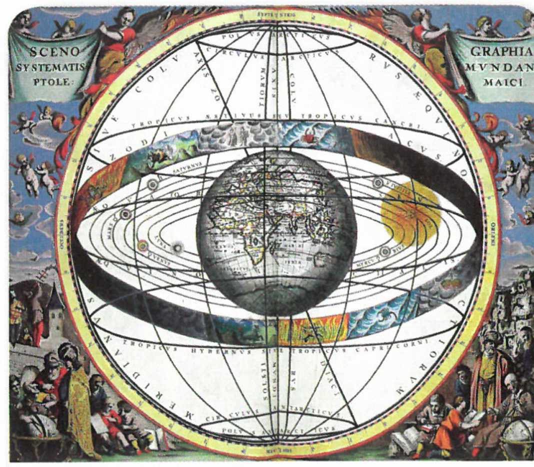

Figure 1.11 Scientific models, like this ancient one of the solar system, are used to represent a larger idea or system. As scientists gather new information, models can change or be revised.
Explain *what is wrong with this model.*

Section 1.3 Assessment

Section Summary

- Scientists communicate data so others can learn the results, verify the results, examine conclusions for bias, and conduct new experiments.
- There are three main types of graphs scientists use to represent data: line graphs, circle graphs, and bar graphs.
- A scientific model is an accurate representation of an idea or theory.
- Scientific theories and scientific laws are sometimes discovered accidentally.

Understand Main Ideas

1. MAIN Idea **Explain** what might happen if a scientist inaccurately reported data from his or her experiment.
2. **Describe** the difference between scientific theory and scientific law.
3. **Apply** Why is it important to compare your data from a lab with that of your classmates?

Think Critically

4. **Interpret** Why would a model be important when studying the solar system?
5. **Explain** when to use a line graph, a circle graph, and a bar graph.

WRITING in Earth Science

6. Research scientific laws and theories, and write a concise example of each.

ON SITE: IN THE FOOTSTEPS OF DISASTER


The tsunami destroyed many homes and buildings, leaving few of the structures standing.

On December 26, 2004, a massive earthquake rattled the seafloor of the Indian Ocean. A tsunami was generated by the earthquake, which devastated the landscape and killed almost 300,000 people in 12 countries. After humanitarian efforts were underway, many Earth scientists mobilized to collect data before the area was changed by cleanup efforts.

Planning the investigation Jose Borrero, an environmental engineer at University of Southern California, wanted to determine the height of the waves associated with the tsunami, how far inland they traveled, the number of waves, and the distance between them. This information would determine where to rebuild towns and assist in the development of a warning system and a hazard plan.

Taking measurements To measure heights of the waves and the following rush of water, Borrero looked for mud or watermarks on the buildings that were left standing. He then placed a 5-m pole next to the watermark to measure the height the water reached. The closer he got to the coast, however, the less he was able to measure accurately. The water had surged up over 5 m deep, so he relied on visual estimates and photos for documentation. With each measurement, he recorded the location on the Global Positioning Satellite system (GPS).

After a six-day study of the devastation, Borrero had more than 150 data points. Upon returning to the United States, scientists used these data to determine that the waves reached 15–30 m high in Banda Aceh, and almost 3.2 km inland.

Using models It is impossible and unethical to simulate natural disasters on an actual scale, so scientists use the data collected from real incidents to create models of those events to learn more about how nature behaves. Using scientific methods and data gathered, scientists are able to provide information for model building or computer simulation. Back at the lab, Borrero applies the data to study other possible tsunami scenarios. He uses data to predict wave height and the area of inundation along the coast, should a tsunami hit the United States.

He hopes that the data collected will enable better detection and prevent widespread devastation from a natural tsunami disaster.

WRITING in Earth Science

Journal Imagine you are a geologist who is accompanying a team of scientists to a natural disaster. Describe the way you will use the scientific method to gather data for your report. Visit glencoe.com to learn more about scientific methods in the field.