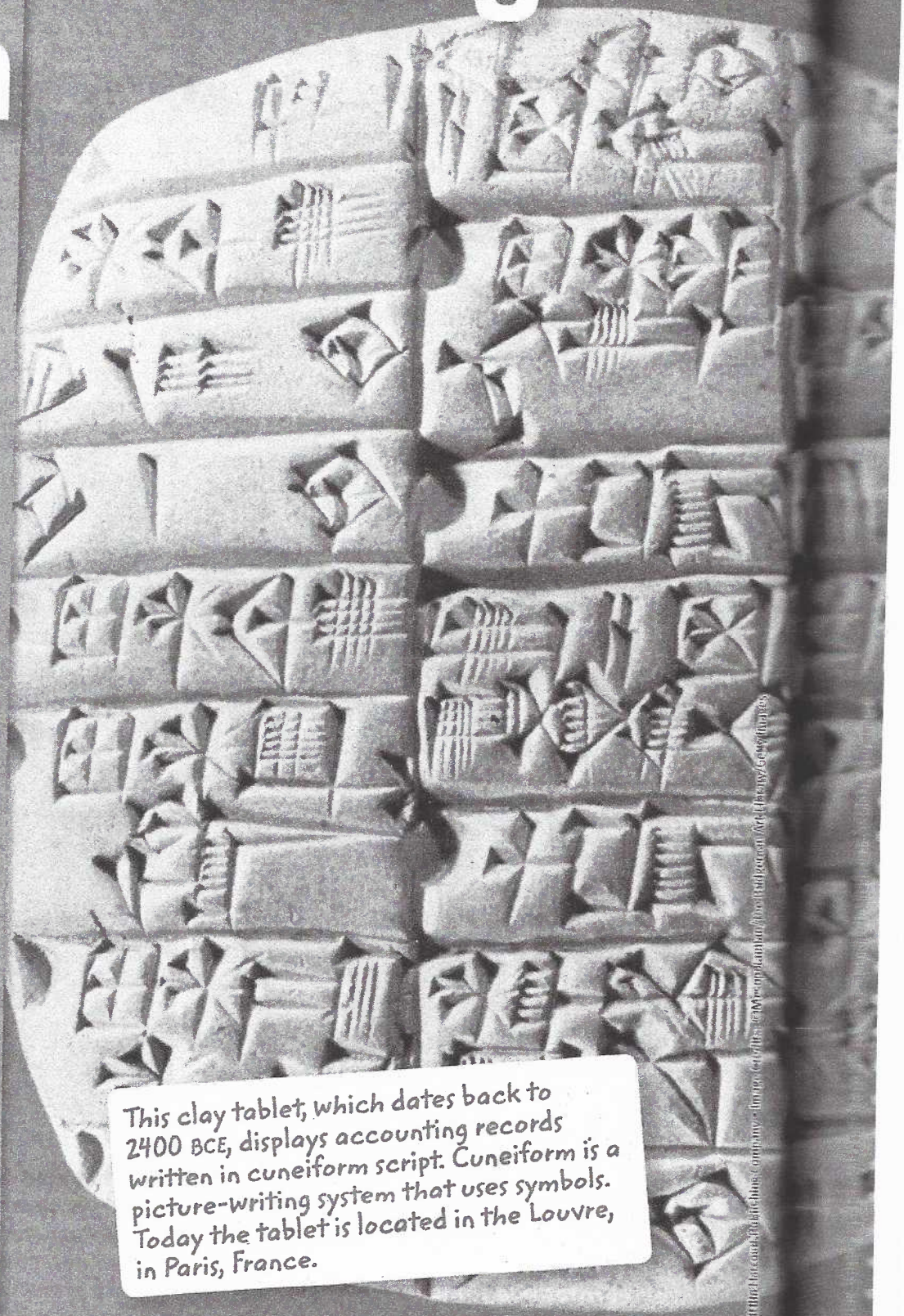
Lesson 1

Representing Data

ESSENTIAL QUESTION

How do scientists show the results of investigations?

By the end of this lesson, you should be able to use tables, graphs, and models to display and analyze scientific data.



This clay tablet, which dates back to 2400 BCE, displays accounting records written in cuneiform script. Cuneiform is a picture-writing system that uses symbols. Today the tablet is located in the Louvre, in Paris, France.

Modeling Data with Graphs

How do scientists make sense of data?

There are many different kinds of scientific investigations conducted in science, all of which involve the collection of data. *Data* are the facts, figures, and other evidence scientists gather when they conduct an investigation.

Scientists Organize the Data

Scientists use data tables to organize and record the data that they collect. By creating a data table, they can record their observations and measurements in an orderly way.

Data tables often have two columns. One column lists the **independent variable**. This is the variable that is deliberately manipulated in an investigation. The other column lists the **dependent variable**. This is the variable that changes as a result of the manipulation of the independent variable. When creating a data table, any units of measurement, such as seconds or degrees, should be included in the table's column headings and not in the individual cells.

The data table below shows the high temperatures for certain days and the number of cold drinks sold at a concession stand on those days.

Drink Sales

High temperature (°F)	Number of cold drinks sold
25	43
40	55
58	60
70	72
81	70

Visualize It!

5 Apply Name the independent variable and the dependent variable in the data table. Explain your answer.

Scientists Graph and Analyze the Data

Scientists often analyze data for patterns or trends by constructing graphs of the data. The type of graph they construct depends upon the data they collected and what they want to show.

A *scatter plot* is a graph with points plotted to show a possible relationship between two sets of data. A scatter plot has a horizontal x-axis and a vertical y-axis. The x-axis usually represents the independent variable in the data table. The y-axis usually represents the dependent variable.

To show the general relationship between the two variables in the graph, a "line of best fit" is often used. A line of best fit is a line that is drawn to "fit," or come close to, most of the data points.

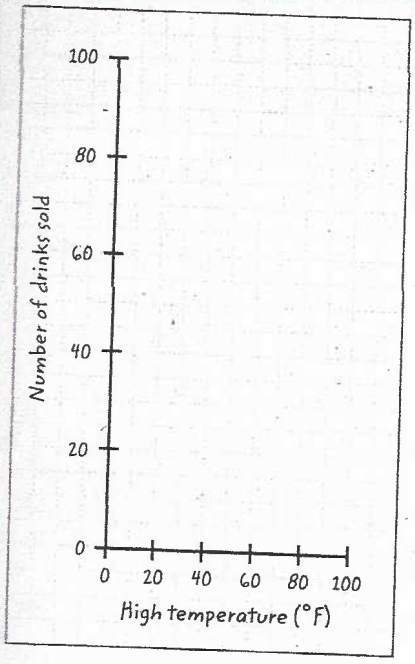
The graphs below show steps used to construct a scatter plot of the drink sales data at the left.

Active Reading

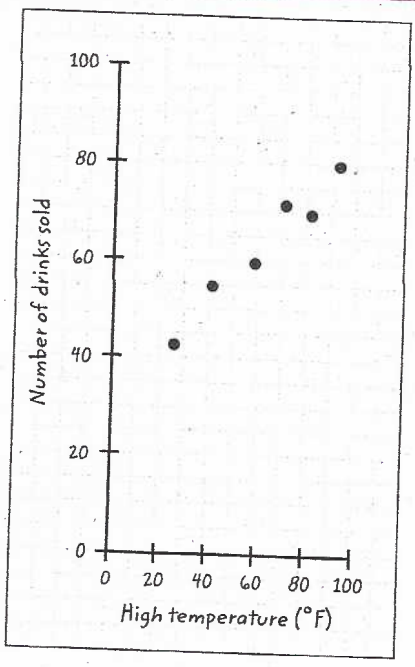
6 Identify Which axis of a graph usually represents the independent variable?

_____

Visualize It!



Step 1 Label the Axes Label each axis on a graph with the name of the variable that is represented. Each axis can have its own range and scale so that the data can be seen easily. The range is the difference between the greatest value and the least value of a variable. The scale is the size that is used for each box or grid mark on the graph.



Step 2 Plot the Data Points Plot the data from the table as data points on the graph.

7 Analyze Do you see a trend in these data? Explain.

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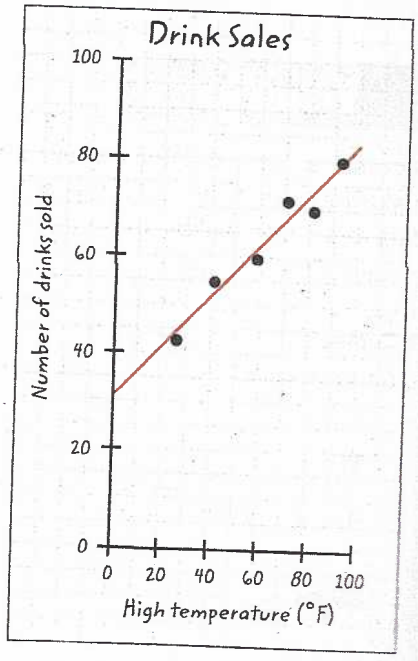


Step 3 Draw a Line of Best Fit Draw a line that comes close to most of the data points. The line shows the pattern described by the data. It also shows how the data differ from the pattern.

More Graphing!

What do graphs show?

Different types of graphs are used to show different types of information about data. On the previous pages, you read about scatter plots. Other graphs include bar graphs and circle graphs. A *bar graph* is used to display and compare data in a number of separate, or distinct, categories. Data about the number of inches it rained each month can be displayed in a bar graph. A *circle graph* is used when you are showing how each group of data relates to all of the data. Data about the number of boys and girls in your class can be displayed in a circle graph.

Active Reading **8 List** Name three different types of graphs.

_____

_____

Visualize It!

Dwayne has been training for several weeks for cross-country tryouts. To make the team, he must be able to run 1 mile in less than 8 minutes. The data at the right shows the amount of time in minutes that it took Dwayne to run a mile each week.

Week 1	11.95 min
Week 2	11.25 min
Week 3	11.40 min
Week 4	10.10 min
Week 5	9.25 min
Week 6	8.60 min

9 Complete Use the empty table below to organize Dwayne's running data. Include a title for the table, the column heads, and all of the data.

Title

Headings	
Data	

Visualize It!

Use the steps below to construct a graph of Dwayne's running data. The horizontal and vertical axes have been drawn for you.

Step 1
Label each axis with the name of the variable that is represented.

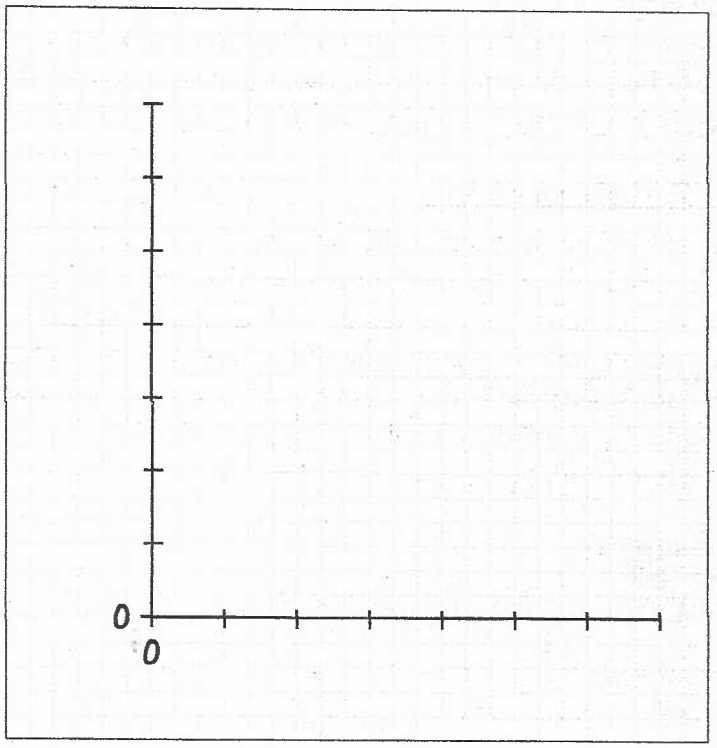
Step 2
Find the range for each axis. For the running data, the range of the independent variable is 6 weeks. Thus, the *x*-axis must cover at least 6 weeks.

Step 3
Decide the scale for each axis. For the running data, use a scale of 1 week for each grid mark on the *x*-axis.

Step 4
Graph the points by putting a dot on the graph for each pair of data in the data table.

Step 5
Title the graph. A good title tells a reader what the graph is all about.

10 Graph Use the steps at the left to construct a scatter plot of the running data given.



11 Assess Explain how you could use the graph to predict whether Dwayne will run 1 mile in less than 8 minutes.

Throw Me a Curve!

What kinds of patterns can be shown using graphs?

When you graph data, you can identify what the pattern, or *trend*, of the data is. A trend shows the relationship between the two variables studied in the experiment. Graphs make it easy to tell if something is increasing, decreasing, or staying the same.

Linear Relationships

A line can sometimes be used to show the trend of data on a graph. A graph in which the relationship between the independent variable and dependent variable can be shown with a straight line is called a *linear graph.* A straight line shows that the rate of change of the dependent variable with respect to the independent variable is constant. In other words, y always increases or decreases by the same value in relation to x.

Visualize It!

12 Interpret Use the graph to determine the mass of 7 cm^3 of water.

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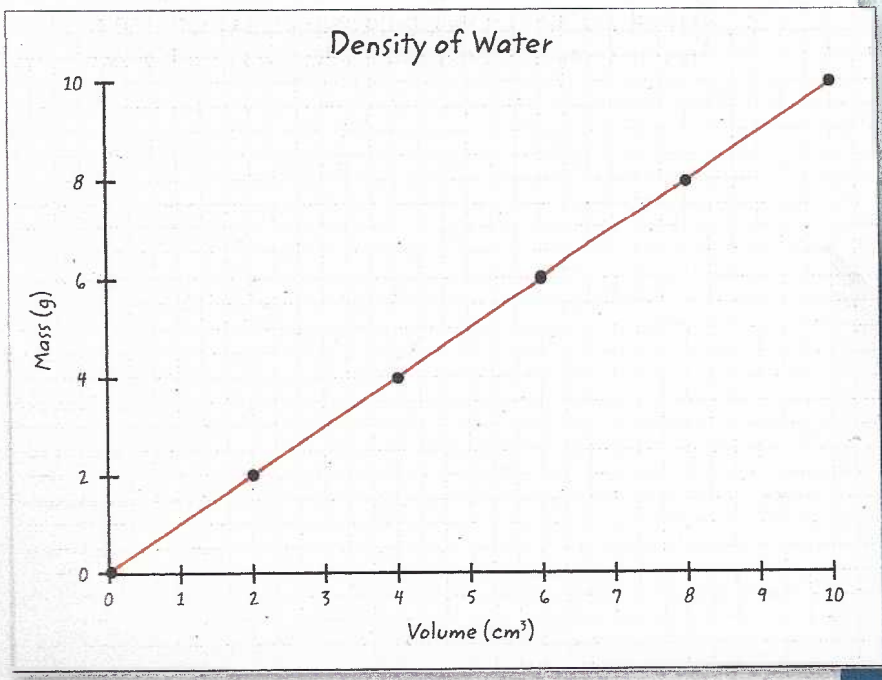


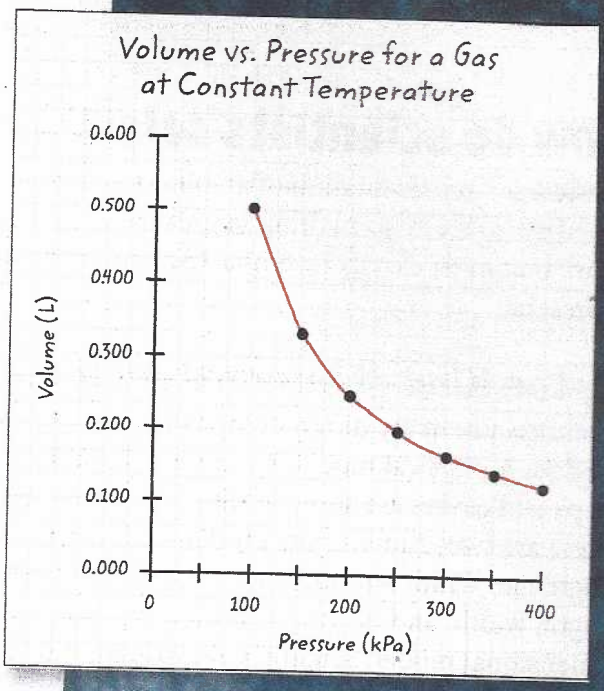
The density of water is an example of a linear relationship.

Nonlinear Relationships

Sometimes, the graph of the relationship between the independent variable and dependent variable studied is not a straight line but a smooth curve. Any graph in which the relationship between the variables cannot be shown with a straight line is called a *nonlinear graph*.

Graphs allow scientists to determine the relationship between variables. In a direct relationship, the value of one variable increases as the value of the other variable increases. In contrast, an inverse relationship is one in which the value of one variable decreases as the other increases. The graph of a direct relationship is an upward sloping line. The graph of an inverse relationship is a downward sloping line.

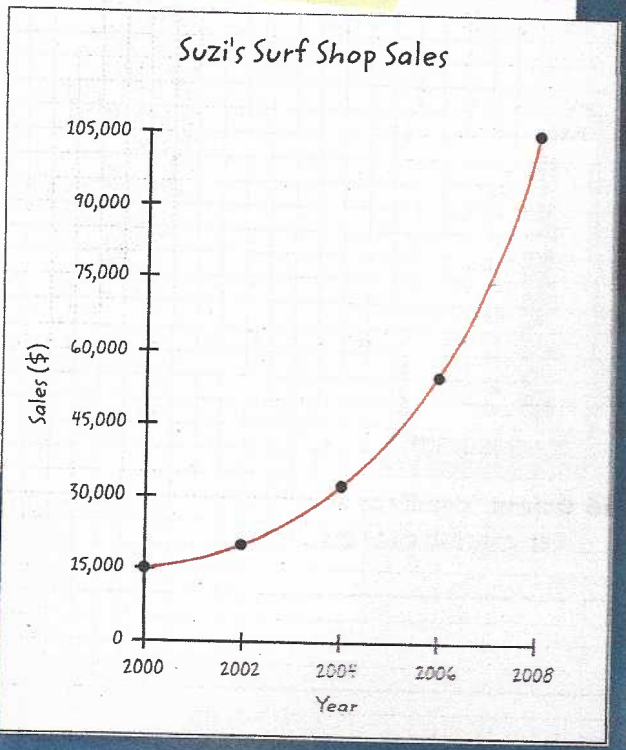
Active Reading **13 Apply** Describe the difference between linear and nonlinear relationships on a graph.



Both of these graphs show nonlinear relationships.

Visualize It!

14 Infer Describe the relationship shown in the graph of Suzi's Surf Shop Sales. Then use the graph to find the approximate sales of the surf shop in 2007.



The Perfect Model

How do scientists select a model?

A **model** is a representation of an object or a process that allows scientists to study something in greater detail. The best models are those that most closely resemble the system, process, or object they represent.

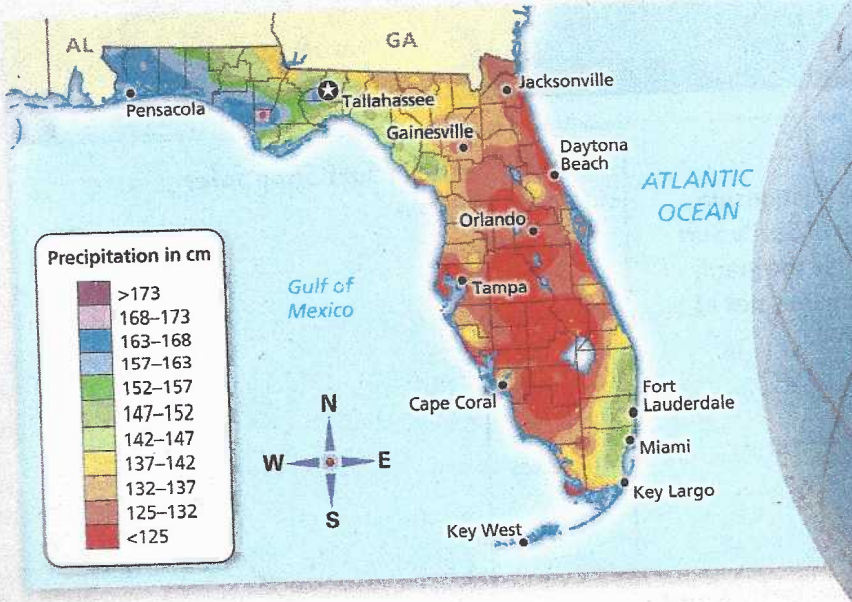
Active Reading

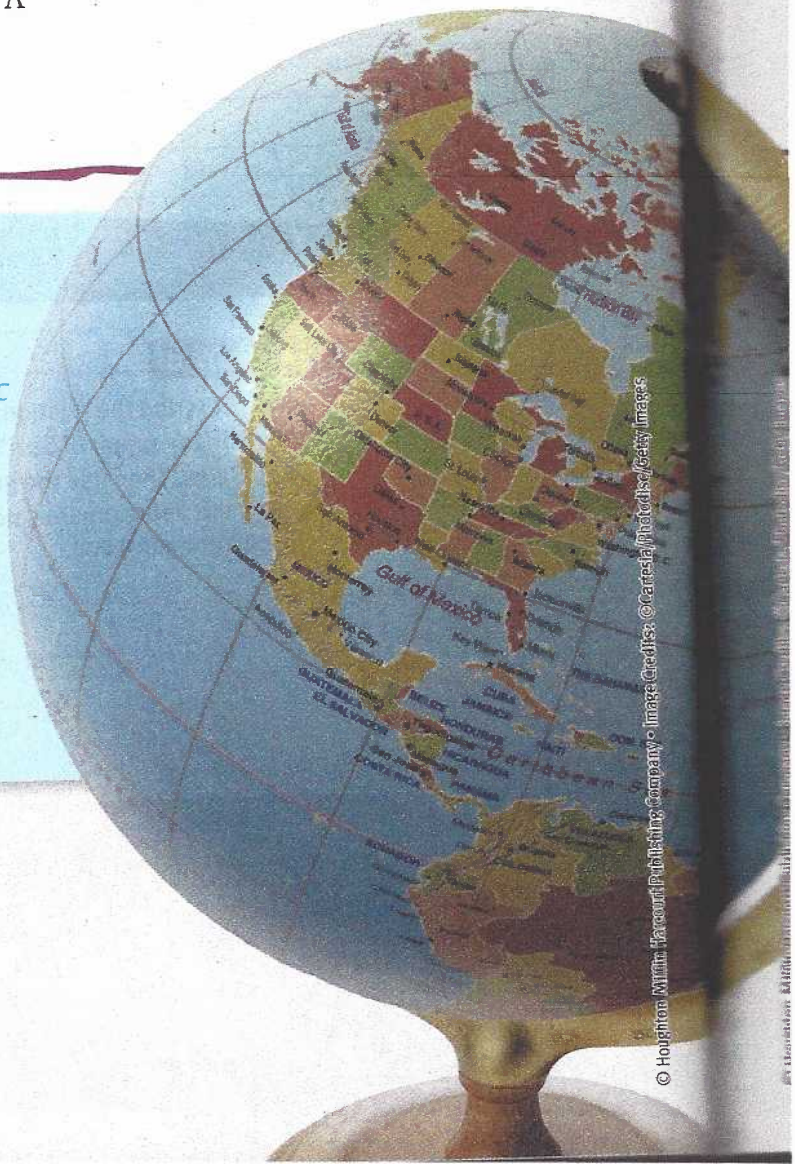
15 Apply As you read, underline some examples of models.

By the Kind of Information It Shows

Scientists use many different kinds of physical and mathematical models. A physical model is something that is drawn or built. Maps and globes are some of the oldest types of physical models. These are two-dimensional models. Two-dimensional models have length and width but not height. A three-dimensional model has length, width, and height. A diorama of a classroom is a three-dimensional model. Scientists also use mathematical models to represent how the natural world functions. With mathematical models, you can predict the results of changes in a system. A computer simulation is one type of mathematical model.

Visualize It!





16 Defend Identify an advantage of this precipitation map over tables of the same data.

By How It Can Be Used

A two-dimensional floor plan of a building would give you a good idea of the building's layout. You could add furniture to the floor plan to see how you would use the space, but you would not be able to determine anything about the height of the furniture in the room. A three-dimensional model would allow you to see the walls and windows, and get a better feeling for how objects fit in the room. A computerized simulation of the building could enable you to see what it would be like to move through the building.

Similar models could be made of a molecule such as DNA. A two-dimensional drawing of the molecule would show the atoms that make up the molecule and how those atoms are arranged. A three-dimensional model would enable you to study the molecule from different angles. A simulation would enable you to see how the molecule functions. Today, many processes in science can be modeled in great detail. The information needed from the model determines the type of model that is used.

Think Outside the Book Inquiry

19 Criticize Many advertisements feature models. Find an example of a nonhuman model in a magazine. Write a critique of the model. Consider the following questions: "How useful is the model? What has been left out or exaggerated? How could the model be improved?"

18 Predict Scale is the relationship between the dimensions of a model and the dimensions of the real object. How could the scale on this map be helpful when taking a trip?

Inquiry

17 Infer What are two advantages of the globe over the precipitation map of Florida for understanding characteristics of Florida? What are two advantages of the map over the globe?

Lesson Review

Lesson 1

Vocabulary

Fill in the blank with the term that best completes the following sentences.

1 The _____ variable in an investigation is the variable that is deliberately manipulated.

2 The _____ variable in an investigation is the variable that changes in response to changes in the investigation.

3 A(n) _____ can be a physical or mathematical representation of an object or a process.

Key Concepts

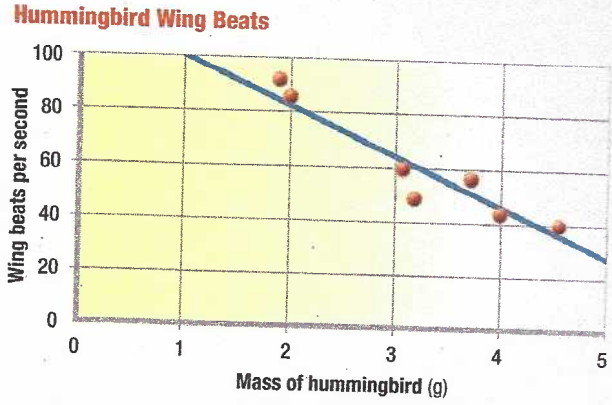
4 **Identify** Alfonso is conducting an experiment to determine whether temperature affects how fast earthworms move. What are the independent and dependent variables in his experiment?

5 **Apply** When creating a graph, why is an appropriate title for a graph important?

6 **Provide** Give an example of a model used in science that is larger than the real object and an example of a model that is smaller than the real object.

Critical Thinking

Use this graph to answer the following questions.



7 **Interpret** In this graph, what are the independent and dependent variables?

8 **Describe** Explain a trend or pattern you observe in the graph.

9 **Analyze** Both a globe and a flat world map can model features of Earth. Give an example of when you would use each of these models.

Think Science

Making Conclusions from Evidence

In scientific investigations, you will be asked to collect data and summarize your findings. Sometimes, a set of data can be interpreted in more than one way and lead to more than one conclusion. A reliable investigation will allow you to make conclusions that are supported by the data you have collected, and that reflect the findings of other scientists.

Tutorial

Take these steps as you analyze findings and evaluate a conclusion made from the findings.

Flu Prevention Breakthrough

A medical study has shown that a new drug, Compound Z, protected children from the flu. The results of the study that was conducted last year showed that only 5% of students who were taking Compound Z were affected by the flu. During the same period of time, 20% of the general population was affected by the flu.

Researchers do not know exactly how Compound Z protects children from the flu.

1 What conclusion is made by the study? Identify the conclusion or interpretation of the data that is being made in the study.

2 What evidence or data is given and does the data support the conclusion? Identify all the observations and findings that are presented to support the conclusion. Decide whether the findings support the conclusion. Look for information and data in other studies that replicate the experiments and verify the conclusion.

3 Should other data be considered before accepting the conclusion as true? There may be more than one way to interpret findings of scientific work, and important questions left unanswered. When this happens, plan to make observations, look for more information, or do further experiments that could eliminate one explanation as a possibility.

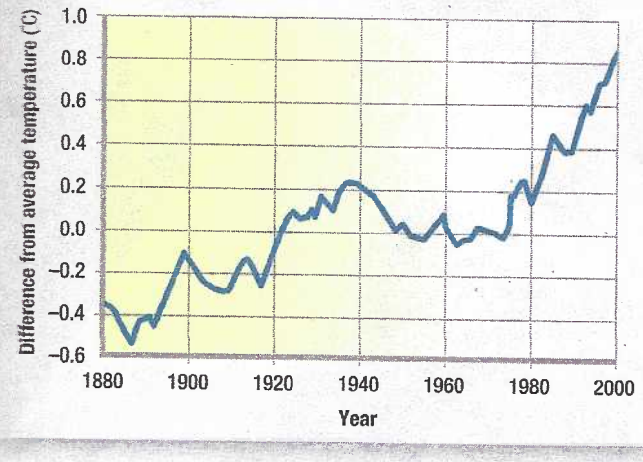
Other data should be considered before the conclusion above can be supported. For example, data should be gathered to determine the percentage of children who were not taking Compound Z and got the flu. And, within the 20% of the general population who got the flu, what percentage were children?

You Try It!

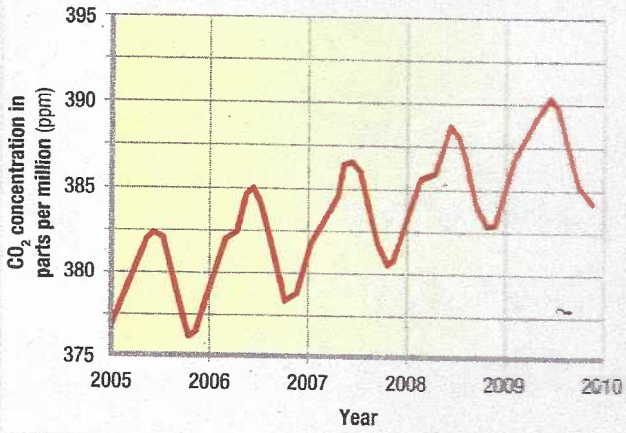
Climate change is one of the most debated issues in modern science.

In the past 100 years, Earth's average global temperature has risen more than 0.74 °C. In 2008, the cold La Niña current in the Pacific caused the average global temperature to drop, but the global average was still warmer than any year from 1880 to 1996. The concentration of the greenhouse gas carbon dioxide (CO_2), rose from by about 76 parts per million from 1958 to 2008. Many people interpret this to mean that human activity is causing global climate change. However, evidence from the geologic record shows that Earth's climate has experienced even larger climate changes in the past.

Variation in Average Global Land Temperatures



Mean CO_2 at Mauna Loa, Hawaii



1 Gathering Data The graphs shown above are taken from a study on climate change. Identify trends or patterns that you observe in the graphs.

2 Making a Conclusion Draw a conclusion that is supported by the data you describe. Summarize your conclusion in a single paragraph.

3 Analyzing Data Which conclusions are supported by the data in the graphs? Which conclusions are not supported by the data?

4 Making Predictions What other data do you need to further support your conclusion?

Take It Home

Find an article that makes a conclusion based on a scientific study. Evaluate the conclusion and determine whether the evidence given supports the conclusion. Bring the article to class and be prepared to discuss.