Name _____ Class _____ Date _____

CHAPTER 1 The World of Earth Science

SECTION 3

Scientific Models

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How do scientists use models?
- What are three kinds of scientific models?

What Are Models?

Why do scientists use crash-test dummies to learn how safe cars are? By using crash-test dummies, scientists can learn how to make cars safer without putting real people in danger. A crash-test dummy is a model of a person. A **model** is something scientists use to represent an object or event in order to make it easier to study.

Scientists use models to study things that are very small, like atoms, or things that are very large, like Earth. Some scientists use models to predict things that haven't happened yet, or to study events that happened long ago. Some models, like crash-test dummies, allow scientists to study events without affecting or harming the things they are studying. ☑

Models are very useful for scientists. However, you cannot learn everything by studying a model, because models are not exactly like the objects they represent.

STUDY TIP

Compare As you read, make a table to show the features of physical models and mathematical models.

READING CHECK

1. Identify Give two reasons scientists use models.

_____

_____

PHYSICAL MODELS

Physical models are models that you can see or touch. Many physical models look like the things they represent. Other physical models may look different from the things they represent. For example, a map is a physical model of Earth. However, a flat map looks very different from the round Earth! ☑

A globe is a physical model of the Earth.

READING CHECK

2. Define What is a physical model?

_____

_____

MATHEMATICAL MODELS

A *mathematical model* is made up of data and mathematical equations. A *mathematical equation* shows how data are related to each other. Some mathematical models are simple. They can help you calculate things such as how far a car will travel in an hour. Other models are more complicated. These models can contain a lot of data related by complicated equations. ☑

READING CHECK

3. Define What is a mathematical model?

_____

_____

Meteorologists often use mathematical models called *climate models* to help them study the Earth's climate. Most climate models include large amounts of data. The data may be measurements of temperatures or amounts of rainfall.

Climate models use equations to represent different parts of Earth's climate. For example, some equations represent the way that ocean water moves. Others represent the way that the amount of carbon dioxide in the air changes with time.

You may wonder how scientists can use models that contain so many data and equations. Scientists use computers to help them process these complicated models. Because computers can deal with large amounts of data, they can solve many mathematical problems at once. Computers can do complicated calculations more quickly and accurately than people can. ☑

READING CHECK

4. Explain Why do scientists use computers to process many mathematical models?

_____

_____

_____

Climate models, like most mathematical models, do not make exact predictions. Instead, they estimate what may happen. Scientists and lawmakers can use the estimates to help them plan for the future.

The climate model in this picture was produced by a computer. The computer combined huge amounts of data and equations into the climate model. Without computers, scientists would not be able to use complicated models like this.

TAKE A LOOK

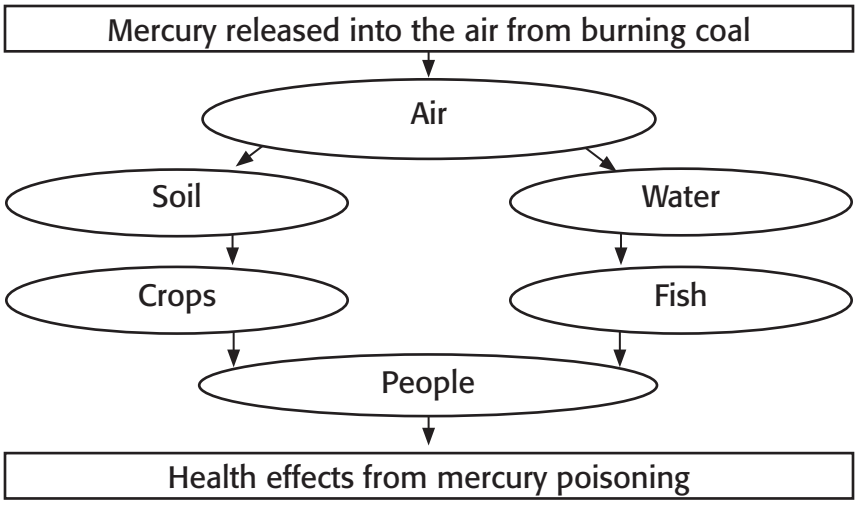
5. Identify What are two kinds of data that may be part of a climate model?

_____

_____

CONCEPTUAL MODELS

A *conceptual model* is a diagram, drawing, or spoken description of how something works or is put together. Conceptual models may be made of many different hypotheses. Each hypothesis is supported by scientific methods. For example, the conceptual model below shows how mercury moves through the environment. Scientists have used scientific methods to learn how mercury from coal burning can affect humans.



Why Do Scientists Use Models?

Scientists often use models to help explain or support scientific laws and theories. A scientific *law* is a statement or equation that can predict what will happen in certain situations. A scientific **theory** is an explanation that connects and explains many observations.

Name	What it is
Scientific theory	an explanation that connects and explains evidence and observations
Scientific law	a statement or equation that predicts what will happen in a certain situation

Scientific theories are based on observations. They explain all of the observations about a topic that scientists have at a certain time. However, scientists are always discovering new information. This new information may show that a theory is incorrect. When this happens, the theory must be changed so that it explains the new information. Sometimes, scientists have to develop a totally new theory to explain the new and old information.

TAKE A LOOK

6. Use a Model Use a colored pen or marker to trace two different ways that mercury in the air can affect people.

Critical Thinking

7. Compare How is a scientific theory different from a scientific law?

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Section 3 Review

SECTION VOCABULARY

model a pattern, plan, representation, or description designed to show the structure or workings of an object, system, or concept	**theory** a system of ideas that explains many related observations and is supported by a large body of evidence acquired through scientific investigation

1. **Identify** How are scientific theories related to observations and evidence?

2. **Explain** Why do scientists use models?

3. **Describe** What effect can new observations have on a scientific theory?

4. **List** Give one example of a physical model and one example of a mathematical model.

5. **Explain** Why do scientists use computers to process climate models?

6. **Infer** A globe is a model of the Earth. Give two ways a globe is like the Earth and two ways a globe is not like the Earth.

Chapter 1 The World of Earth Science

SECTION 1 BRANCHES OF EARTH SCIENCE

1. earthquakes
2. oceans
3. the study of Earth's atmosphere, weather, and climate
4. Meteorologists can predict severe weather in time for people to get out of the way.
5. Unlike other branches of Earth science, astronomy deals with the study of objects and materials not found on Earth.
6. Preserve the environment; use resources wisely.
7. the chemicals that make up Earth materials

Review

1. astronomy, geology, meteorology, oceanography
2. a meteorologist, because meteorologists study weather
3. Many astronomers use information from other bodies in the universe to learn more about the Earth and our solar system.
4. Environmental science is the study of how humans interact with the environment. Ecology is the study of how all organisms, not just humans, interact with their environments.
5. The objects they study are very far away, so astronomers use technology to see them.
6. the study of the surface features of the Earth

SECTION 2 SCIENTIFIC METHODS IN EARTH SCIENCE

1. Answers will vary. For a person 5 feet tall, the fraction is about 0.06.
2. a series of steps scientists use to answer questions and to solve problems
3. Answers will vary.
4. a possible answer to a question
5.

Step in scientific methods	How did David Gillette apply this step?
Forming a hypothesis	He thought that the bones came from a new kind of dinosaur.

6. pieces of information gathered by experimentation or observation
7. A controlled experiment is set up by a scientist to study one variable at a time. When scientists use observation to collect data, they cannot control the variables.
8.

Step in scientific methods	How did David Gillette apply this step?
Testing hypotheses	He made many measurements of the bones.

9. to help them form explanations based on the data
10.

Step in scientific methods	How did David Gillette apply this step?
Analyzing results	He made a table to compare the shapes and sizes of his bones with the bones of known dinosaurs.

11. Answers will vary. In general, negative results can tell scientists that they are looking in the wrong spot or can point them in new directions.
12.

Step in scientific methods	How did David Gillette apply this step?
Drawing conclusions	He concluded that the dinosaur was a new species.

13. Sharing results allows other scientists to test them and determine whether they are reliable.

Review

1. The scientist can make observations about the natural world and collect data from the observations.
2. Scientists ask questions to guide their research. The questions help them to plan experiments that focus on the most important things they want to learn.
3. Answers will vary but should be reasonable.
4. Write a paper, give a talk, or publish on the Internet.
5. Answers include: A scientist might share his or her findings several times. He or she might repeat an experiment if the results are questioned or to obtain more data.

SECTION 3 SCIENTIFIC MODELS

1. to study very large or very small things
2. a model that you can see or touch
3. a model made of equations and data
4. Computers can do many calculations quickly and accurately.

5. temperatures, rainfall amounts
6. Answers will vary.
7. A theory explains and connects evidence and observations. A law only predicts what will happen in certain situations.

Review

1. Scientific theories are based on observations and evidence. A theory explains all observations and evidence about a certain topic.
2. Scientists use models to help them study things in detail. Models can help scientists to study things that are too large, too small, too fast, too slow, or too dangerous for them to study in reality. They use models to help explain or support scientific laws or theories.
3. New observations can support a scientific theory. They can also indicate that the theory is incorrect.
4. Physical: globe, map

   Mathematical: equation, graph
5. Climate models are very complicated.
6. Possible answer: Both are roughly spherical and have visible features on their surfaces. They do not have the same internal structure, and they are not the same size.

SECTION 4 MEASUREMENT AND SAFETY

1. It would be much harder for scientists to compare and share their data.
2. the meter
3. Multiply its width by its length.
4. the amount of space an object takes up
5. 100,000
6. kilogram
7. a measure of how hot or cold something is
8. Answers include: eye protection in the lab area, heating safety near hot plates

Review

1. °C and K
2. All measurements use the same units, so it is easy to compare measurements. Units are based on the number 10, so it is easy to convert between units.
3. Multiply its length, width, and height together.
4.

Type of measurement	Examples of units used for this measurement
Length	meter, centimeter
Area	square centimeter, square meter
Mass	kilogram, gram
Volume	cubic centimeter, milliliter

5. 2 g/cm^3
6. Follow teacher's directions; follow written directions; do not take shortcuts.

Chapter 2 Maps as Models of the Earth

SECTION 1 YOU ARE HERE

1. locations that do not change and that can be used to define directions
2. the North Pole and the South Pole
3. north, south, east, west
4. north
5. the direction of the geographic north pole
6. Answers include: northwest, 8°W
7. Answers will vary.
8. imaginary lines on Earth's surface that are parallel to the equator
9. They are the same distance from the equator.
10. You need to know the latitude at which the distance is measured, because meridians are not the same distance apart everywhere on Earth.
11. Pierre, SD, should be circled.

Review

1. A compass needle points toward the geographic north pole (true north), but it is offset by a few degrees (magnetic declination). If you know the magnetic declination of an area, you can correct the direction in which the compass needle points and learn the direction of true north.
2.

Name	What it is	Measured in	Distance apart
Latitude	distance north or south of the equator	degrees	always the same
Longitude	distance east or west of the prime meridian	degrees	closest at the poles, farthest at the equator

3. Latitude of the North Pole is 90°N; the South Pole is 90°S.