CHAPTER 1 | The World of Earth Science

SECTION 3 | # Scientific Models

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.

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! ☑

> **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.
>
> _____
>
> _____
>
> _____

> ☑ **READING CHECK**
>
> **2. Define** What is a physical model?
>
> _____
>
> _____

A globe is a physical model of the Earth.

SECTION 3 Scientific Models *continued*

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. ☑

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. ☑

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.
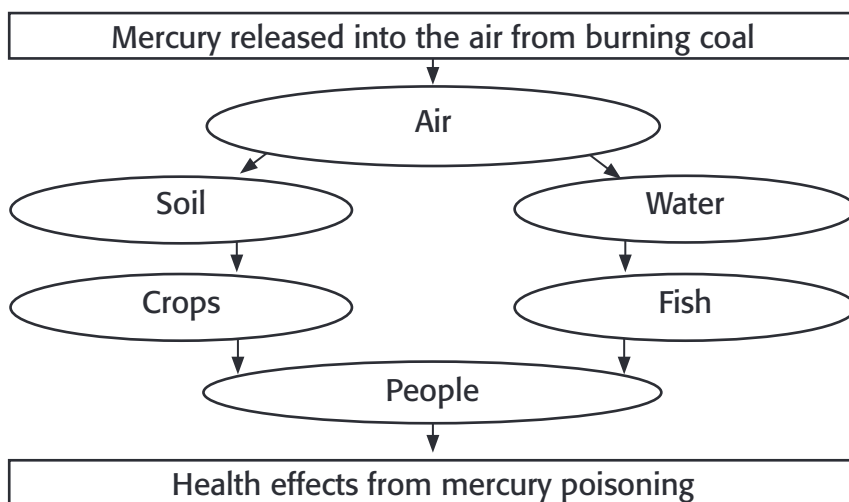
> ☑ **READING CHECK**
>
> **3. Define** What is a mathematical model?
>
> _____
>
> _____

> ☑ **READING CHECK**
>
> **4. Explain** Why do scientists use computers to process many mathematical models?
>
> _____
>
> _____
>
> _____

TAKE A LOOK

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

_____

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.

SECTION 3 Scientific Models *continued*

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.

```
Mercury released into the air from burning coal
                        |
                        v
                       Air
                     /      \
                    v        v
                 Soil       Water
                   |          |
                   v          v
                 Crops       Fish
                    \        /
                     v      v
                    People
                      |
                      v
      Health effects from mercury poisoning
```

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.

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.

Critical Thinking

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

_____
_____
_____
_____
_____

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.

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.

_____

_____

_____

_____