Name _____ Class _____ Date _____

CHAPTER 1 The World of Earth Science

SECTION 2

Scientific Methods in Earth Science

BEFORE YOU READ

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

- What are the steps used in scientific methods?
- How is a hypothesis tested?
- Why do scientists share their findings with others?

How Do Scientists Learn About the World?

Imagine you are standing in a thick forest. Suddenly, you hear a booming noise, and you feel the ground shake. You notice a creature's head looming over the treetops.

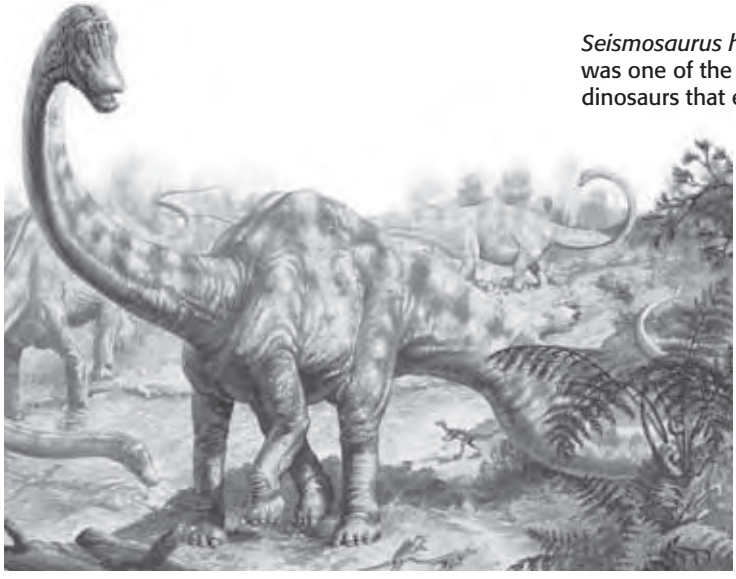
The creature's head is so high that its neck must be 20 m long! Then, the whole animal comes into view. Now you know why the ground is shaking. The giant animal is *Seismosaurus hallorum*, the "earthquake lizard."

This description of *Seismosaurus hallorum* is not just from someone's imagination. Since the 1800s, scientists have gathered information about dinosaurs and their environment. Using this knowledge, scientists can infer what dinosaurs may have been like hundreds of millions of years ago.

How do scientists piece all the information together? How do they know if they have discovered a new species of dinosaur? Asking these questions is the first step in using scientific methods to learn more about the world.

STUDY TIP

Outline As you read this section, make a chart showing the ways that David Gillette used the steps in scientific methods to learn more about the dinosaur bones he studied.



Seismosaurus hallorum was one of the largest dinosaurs that ever lived.

Math Focus

1. Make Comparisons
When a *Seismosaurus* held its head up as high as it could, it could have been 25 m tall. What fraction of Seismosaurus's height is your height? Give your answer as a decimal.

_____

What Are Scientific Methods?

Scientific methods are a series of steps that scientists use to answer questions and to solve problems. Although each question is different, scientists can use the same methods to find answers. ☑

Scientific methods have several steps. Scientists may use all of the steps or just some of them. They may even repeat some of the steps.

The goal of scientific methods is to come up with reliable answers and solutions. These answers and solutions must be able to stand up to the testing of other scientists.

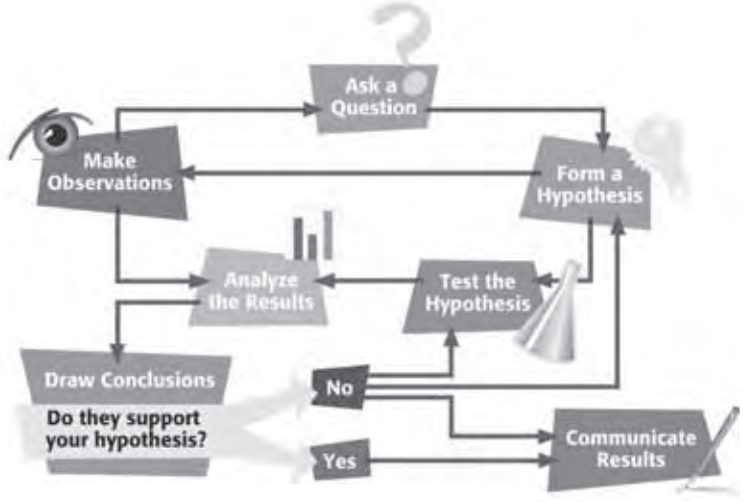
READING CHECK

2. Define What are scientific methods?

_____

_____

_____



There are many steps in scientific methods. Notice that there are many ways to move through the different steps.

TAKE A LOOK

3. Use Models Starting with "Ask a question," trace two different paths through the figure to "Communicate results." Use a colored pen or marker to trace your paths.

Why Is It Important to Ask a Question?

Asking a question helps scientists focus on the most important things they want to learn. The question helps to guide the research that the scientist does.

David D. Gillette is a scientist who studies fossils. In 1979, he began to study some fossil bones from New Mexico. He knew they came from a dinosaur, but he did not know which kind.

Gillette began his study by asking, "What kind of dinosaur did these bones come from?" We will use a table to follow Gillette as he tried to answer his question using scientific methods.

Step in scientific methods	How did David Gillette apply this step?
Asking questions	He wondered what kind of dinosaur the bones came from.

How Do Scientists Form a Hypothesis?

When scientists want to investigate a question, they form a hypothesis. A **hypothesis** (plural, *hypotheses*) is a possible answer to a question. It is sometimes called an educated guess. ☑

The hypothesis is a scientist's best answer to the question. However, a scientist can't just assume that a hypothesis is the correct answer. The scientists must test the hypothesis to see if it is true.

From his observations and knowledge about dinosaurs, Gillette formed a hypothesis about the bones. He thought that the bones came from a kind of dinosaur that had not been discovered yet. To test his hypothesis, Gillette had to do a lot of research.

READING CHECK

4. Define What is a hypothesis?

_____

_____

Step in scientific methods	How did David Gillette apply this step?
Forming a hypothesis	

TAKE A LOOK

5. Identify Fill in the blank spot in the table with David Gillette's hypothesis.

How Do Scientists Test a Hypothesis?

To see if an idea can be proven scientifically, scientists must test the hypothesis. They do this by gathering data. *Data* (singular, *datum*) are pieces of information gathered through observation or experimentation. Scientists use data to learn if their hypotheses are correct. ☑

READING CHECK

6. Define What are data?

_____

_____

_____

_____

TESTING WITH EXPERIMENTS

To test a hypothesis, a scientist may perform a controlled experiment. A *controlled experiment* tests only one factor, or *variable*, at a time. No other variables change. By changing only one variable, scientists can see the results of changing just one thing.

For example, suppose a scientist does an experiment to learn the temperature that a rock melts at. The scientist uses several samples of the same kind of rock. She heats each sample to a different temperature and records whether the rock melts. The type of rock does not change, but the temperature does. Therefore, temperature is the variable.

KEEPING ACCURATE RECORDS

During experiments, scientists must keep accurate records of everything that they do and observe. This includes failed attempts, too. Keeping detailed records helps scientists to show that their results are accurate. Accurate records can also help other scientists to repeat an experiment.

Critical Thinking

7. Compare and Contrast What is the difference between a controlled experiment and observation?

_____

_____

_____

_____

TESTING WITHOUT EXPERIMENTS

Sometimes, it is not possible to do a controlled experiment. In such cases, scientists depend on observation to test their hypotheses. By observing nature, scientists can collect large amounts of data. If the data support a hypothesis, the hypothesis is probably correct.

To test his hypothesis, Gillette took hundreds of measurements of bones. He also visited museums and talked with other scientists.

To test his hypothesis, Gillette took hundreds of measurements of the sizes and shapes of the bones.

TAKE A LOOK

8. Identify In the table, fill in the way that David Gillette tested his hypothesis.

Step in scientific methods	How did David Gillette apply this step?
Testing hypotheses	

How Do Scientists Analyze Results?

When scientists finish collecting data, they must analyze the results. Analyzing results helps scientists explain their observations. Their explanations are based on the evidence they collect. ☑

READING CHECK

9. Explain Why do scientists analyze their data?

_____

_____

_____

To arrange their data, scientists often make tables and graphs. Gillette organized his data in a table that compared the sizes and shapes of his dinosaur bones. He compared his measurements to measurements of bones from known dinosaurs. When he analyzed his results, he found that the mystery dinosaur's bones did not match the bones of any known dinosaur.

Step in scientific methods	How did David Gillette apply this step?
Analyzing results	

TAKE A LOOK

10. Identify In the table, fill in the way that David Gillette analyzed his results.

What Are Conclusions?

After analyzing results, a scientist must decide if the results agree with, or support, the hypotheses. This is called *drawing conclusions*. Finding out that a hypothesis is not true can be as valuable as finding out that a hypothesis is true.

Sometimes, the results do not support the hypothesis. When this happens, scientists may repeat the investigation to check for mistakes. Scientists may repeat experiments hundreds of times. Another option is to ask another question and make a new hypothesis.

From all his work, Gillette concluded that the bones found in New Mexico were from an unknown dinosaur. From his data, he learned that the new dinosaur was about 35 m long and had a mass of 30 to 70 metric tons. The dinosaur definitely fits the name Gillette gave it—*Seismosaurus hallorum*, or the "earthquake lizard."

Critical Thinking

11. Infer How can finding out that a hypothesis is not true be useful for a scientist?

_____

_____

_____

_____

_____

Step in scientific methods	How did David Gillette apply this step?
Drawing Conclusions	

TAKE A LOOK

12. Identify In the table, fill in David Gillette's conclusions about his dinosaur bones.

Why Do Scientists Share Their Findings?

After finishing a study, scientists share their results with others. They write reports and give presentations. They can also put their results on the Internet.

Sharing information gives other scientists the chance to repeat the experiments for themselves. If other scientists get different results, more studies must be done to find out if the differences are important. ☑

In many cases, the results of an investigation are reviewed year after year as new evidence is found. In the case of *Seismosaurus*, the debate still continues. Some scientists think that *Seismosaurus* is a new genus of dinosaur. Other scientists think that it belongs to the genus *Diplodocus*. As scientists gather more data on the fossil bones, they may change their conclusions.

READING CHECK

13. Describe Why is it important for scientists to share their results?

_____

_____

_____

_____

Name _____ Class _____ Date _____

Section 2 Review

SECTION VOCABULARY

hypothesis a testable idea or explanation that leads to scientific investigation	**scientific methods** a series of steps followed to solve problems

1. **Describe** How can a scientist test a hypothesis if it is not possible to do a controlled experiment?

2. **Explain** Why is it important for scientists to ask questions?

3. **Apply Procedures** You observe that your tongue sticks to a very cold ice pop when you lick it. You ask yourself, "Why does my tongue stick to the ice pop?" Make a hypothesis about why your tongue sticks to the ice pop.

4. **Identify** How could you share the results of an experiment with the rest of your class? Give three ways.

5. **Infer** Why might a scientist need to repeat a step in scientific methods?

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.