

Chapter Resources

The Nature of Science

Includes:

Reproducible Student Pages

ASSESSMENT

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- ✓ Chapter Review

HANDS-ON ACTIVITIES

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Teacher Support and Planning

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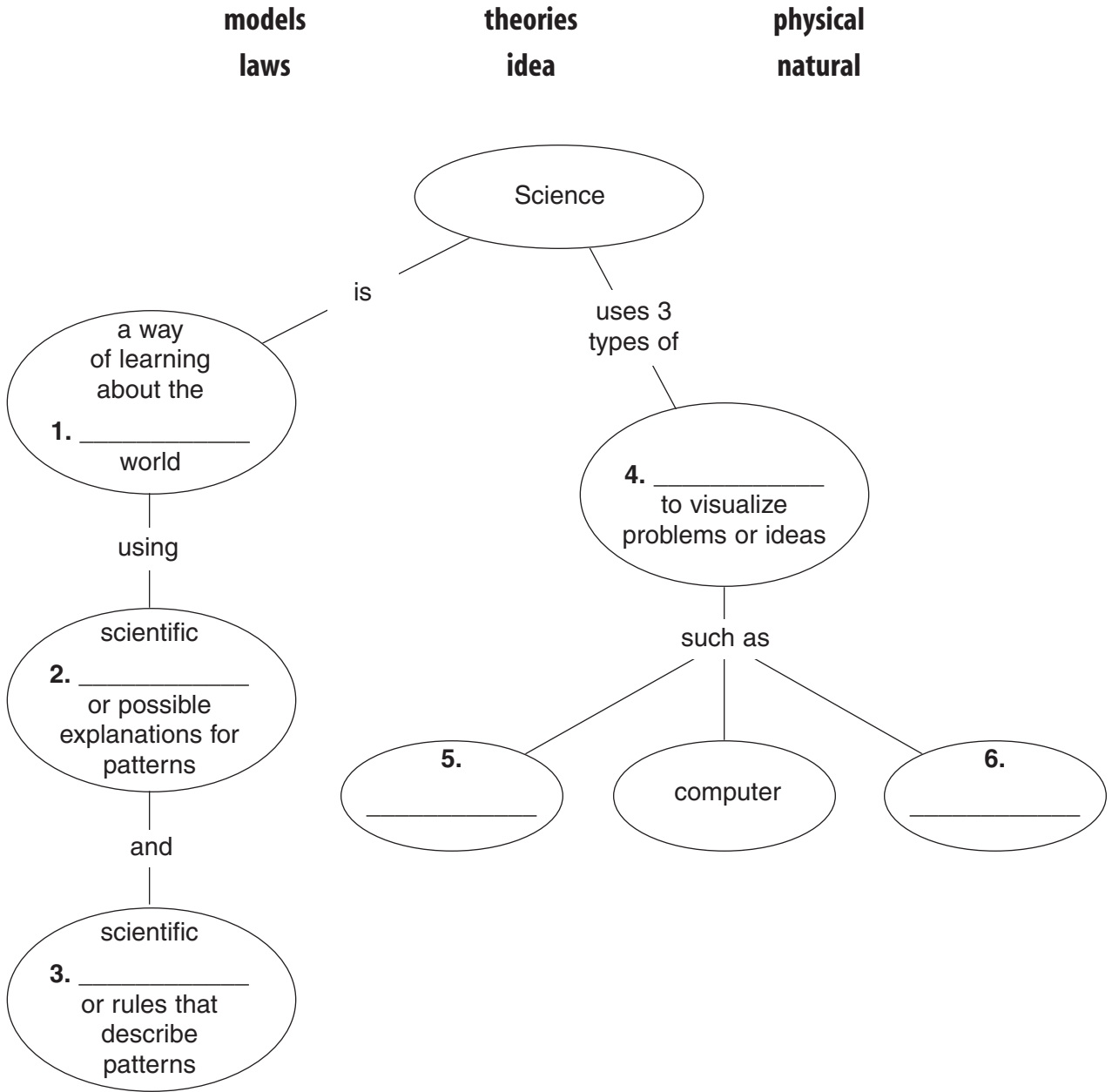


Glencoe



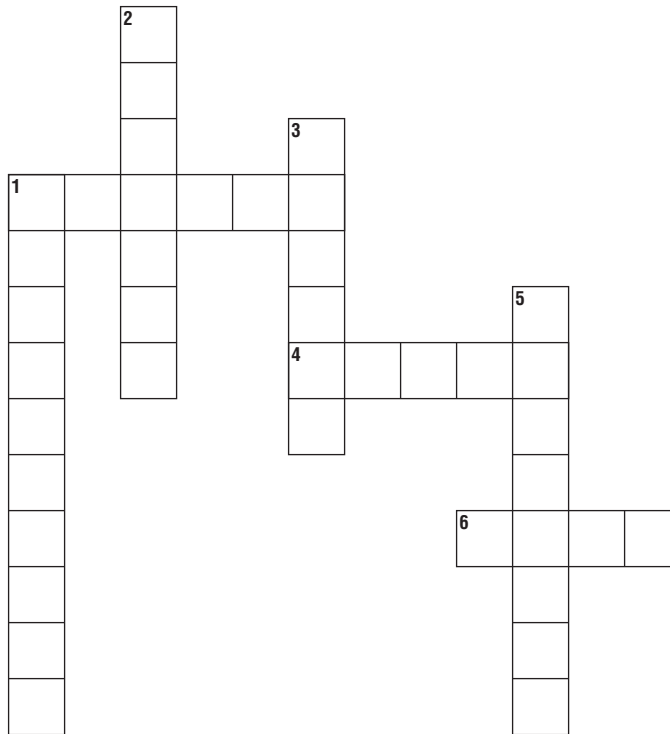
Overview The Nature of Science

Directions: Complete the concept map using the terms listed below.




Section 1 ■ What is science?

Directions: Use the clues below to complete the crossword puzzle.


Across

1. A scientific _____ is a possible explanation for a pattern observed repeatedly in the natural world.
4. The study of Earth systems and the systems in space is called _____ science.
6. The study of living systems and the way they interact is called _____ science.

Down

1. The practical use of science; applied science
2. A way of learning more about the natural world
3. A collection of structures, cycles, and processes that relate to and interact with one another
5. The study of matter and energy is _____ science.



Directed Reading for
Content Mastery

Section 2 ■ Science in Action
Section 3 ■ Models in Science
Section 4 ■ Evaluating Scientific Explanation

Directions: Draw a line to connect the description on the left with the correct term on the right.

- | | |
|---|------------------------|
| 1. a model built using computer software | physical model |
| 2. a model you can see and touch | chart |
| 3. ways scientists solve problems | scientific methods |
| 4. using knowledge and thinking skills to decide if you agree with an explanation | variables |
| 5. a variable that remains the same | constant |
| 6. a prediction that can be tested | controlled experiment |
| 7. an explanation based on observations | inference |
| 8. concepts that describe how someone thinks about something in the natural world | computer model |
| 9. factors that can be changed in an experiment | hypothesis |
| 10. an experiment where one factor is changed, and its effects on another factor are observed | idea model |
| 11. a way to organize scientific data from an experiment | independent laboratory |
| 12. a laboratory not hired by or related in any way to a company that is selling a product | critical thinking |
| 13. wearing an apron and goggles in the laboratory | safety habit |



Directed Reading for
Content Mastery

Key Terms

The Nature of Science

Directions: Use the terms in the list below to fill in the blanks below.

scientific theory

observing

science

law

systems

life science

Earth science

energy

technology

Anyone who tries to learn something about things around them is a scientist.

1. _____ is a way of learning more about the natural world. This learning process often begins by 2. _____, or watching something in nature, then asking questions about it.

A 3. _____ is a possible explanation for those patterns that a scientist might see when observing nature. Theories are usually supported by the results from many investigations. When a pattern in nature is observed time and time again, it becomes a scientific 4. _____, and it stands until someone makes an observation that does not fit the pattern.

Many scientists are interested in studying 5. _____, or collections of structures, cycles, and processes that relate to and interact with one another. The study of living systems is called 6. _____. Scientists who study living systems often ask questions like “How do vaccines help prevent disease?” or “What kind of organisms live in a swamp?” Other scientists study 7. _____, which is the study of Earth and the systems in space. These scientists might study asteroids, clouds, or volcanoes. Still other scientists study the physical sciences, which study matter and 8. _____.

Science has many uses in the daily world. When you use a computer, a toaster, or a radio, you are using 9. _____, or applied science. Many scientists and engineers study the practical applications of science.

SECTION
1**Reinforcement****What is science?**

Directions: Answer the following questions on the lines provided.

1. What is the difference between science and technology?

2. Technology often is used to do things that people cannot do. List three types of activities that scientists might use technology for.

a. _____

b. _____

c. _____

3. Give examples of professions in each of the three branches of science discussed in the chapter.

a. life science _____

b. Earth science _____

c. physical science _____

Directions: Answer the following questions using complete sentences.

4. What kind of questions can science answer? What kind of questions can't science answer?

5. How does an observation become a scientific law? Give an example.

SECTION

2

Reinforcement

Science in Action

Directions: Circle the term in the puzzle that fits each clue. Then write the term on the line. In the puzzle, terms read across or down.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | E | O | B | S | E | R | V | A | T | I | O | N |
| M | Q | R | D | Y | B | X | K | H | E | T | P | I |
| E | K | G | X | I | E | J | N | L | S | B | Y | H |
| P | Y | A | F | W | Z | S | H | A | T | R | M | Y |
| N | R | N | C | M | J | A | H | T | L | N | J | P |
| F | Q | I | R | R | W | O | J | I | V | A | D | O |
| U | S | Z | D | F | V | Z | B | L | G | C | O | T |
| P | R | E | D | I | C | T | I | O | N | F | M | H |
| L | H | G | K | D | W | C | G | U | S | X | O | E |
| V | T | C | O | N | C | L | U | S | I | O | N | S |
| Y | Q | W | A | O | M | U | C | T | U | P | N | I |
| P | G | I | E | Q | V | S | X | K | Z | B | E | S |

- Using your senses to gather information is called _____.
- A reasonable and educated guess based on what you know and observe is called a(n) _____.
- Making an educated guess on the results of an experiment based on observations and the hypothesis is called making a(n) _____.
- In any good experiment, the scientist needs to _____ the hypothesis.
- You can use a table or a graph to _____ your findings.
- After your investigation, you can use the results of your experiments to draw _____.

Directions: Answer the following question on the lines provided.

- What is a controlled experiment? Give an example.

SECTION
3**Reinforcement****Models in Science**

Directions: Complete the following sentences using the correct terms.

1. A model built using software that you can see on a computer screen is a _____ model.
2. $E = mc^2$ is Einstein's _____ model of the theory of relativity.
3. A mobile that shows our solar system is a _____ model.
4. Some models are used to communicate _____ to other people.
5. Some models are used because testing with a model is _____ and less expensive than the real thing.

Directions: Answer the following questions on the lines provided.

6. List one example of a model used to test a prediction.

7. List one way a computer model could help a scientist studying plants.

8. What are the limitations of models?

9. Ancient scientists thought that Earth was the center of the universe, and imagined the sky as a blanket that covered the planet. Why did this early model change?


 SECTION
4

Reinforcement

Evaluating Scientific Explanation

Directions: Fill in the blanks with the following terms.

repeatable explanations laboratory changing
 evaluate inferences data critical thinking conclusions

Scientists often have to evaluate scientific explanations in two parts. Scientists evaluate the observations that are made, and evaluate the 1. _____ made from those observations. To make a decision, scientists use their 2. _____ skills to evaluate the evidence. Scientists have to be careful whenever they are collecting any type of 3. _____. Measurements must be accurate and instruments must be properly calibrated, as scientists cannot afford to be careless in their data collection.

Valid scientific explanations must be 4. _____ by other scientists. If a scientist's experiment cannot be recreated accurately by other scientists, it might mean that the experiment is invalid. Once the experiments and evidence have been tested and examined, the scientist might draw 5. _____ based on the observations. However, when drawing conclusions, scientists should ask themselves if they considered all of the possible 6. _____. It is important to keep an open mind when drawing conclusions from scientific information. It is also important to remember that scientific information is constantly 7. _____, and that all scientific models are subject to change.

It is important to know that scientific reasoning is used not only in the 8. _____. Scientific reasoning and critical thinking skills are used every day. These skills will help you 9. _____ claims and make good decisions about the world around you.

Directions: Answer the following questions on the lines provided.

10. Why is it important for a scientist to write down every observation, including unexpected observations? _____

11. How is evaluating an advertising claim a use of the scientific process?

12. Does an advertiser's claim that its results have been verified by an independent laboratory impress you?

SECTION
1**Enrichment****All Kinds of Scientists**

A scientist is a person who tries to learn about the natural world. A scientist's understanding comes from collecting information through observation and experimentation. A scientist then forms ideas and tests those ideas to prove or disprove them. There are many kinds of scientists. For example, you've already learned that a volcanologist is an Earth scientist who studies volcanoes. Listed below are additional kinds of scientists.

Directions: Use dictionaries, encyclopedias, and library books to define what the following scientists study. Also, list the branch of science—**life, Earth, or physical**—in which the scientist specializes.

1. Zoologist _____

2. Astronomer _____

3. Ethnobotanist _____

4. Paleontologist _____

5. Meteorologist _____

6. Ichthyologist _____

7. Ornithologist _____

8. Entomologist _____

9. Chemist _____

10. Anthropologist _____

11. Herpetologist _____

SECTION
2

Enrichment

Would you keep secrets in science?

The scientific method is a formal process used by scientists to help them understand our world. Most scientific investigations follow a general pattern in which scientists observe something, make a hypothesis, test the hypothesis, and come to a conclusion. Without scientific methods, science would have no rhyme or reason. That's how it was centuries ago when it was very common for scientists to keep their findings to themselves or, at best, to publish their findings in books that were both expensive and unavailable to most people.

New Technologies

With the invention of new technologies, like the microscope and the telescope, scientists were making so many new discoveries that it was hard for them to know what to do with the information. Robert Boyle, a seventeenth-century chemist, tried, unsuccessfully, to get other scientists to provide clear descriptions of their findings. He also tried to make them see the importance of being able to repeat an experiment and get the same results. But Boyle wasn't the only one to try to make sense of science. Francis Bacon, a seventeenth-century philosopher, said that ordering large amounts of data would allow scientists to develop theories and ideas about their findings.

1. Define scientific methods in your own words.

2. Why do you think scientists were not willing to listen to Robert Boyle's ideas?

3. What influence did the scientific societies of the 1600s have on the scientists of today?

Galileo (1564–1642) was also an early pioneer of scientific methods. While studying falling objects, he observed that when heavy objects fall, they pick up speed. He formed a hypothesis that speed is in direct proportion to distance. He deduced that objects falling from unequal distances need the same amount of time. This proved false. So, Galileo formed a new hypothesis: speed is achieved in direct proportion to the time, not the distance traversed. He tested this hypothesis and confirmed it. This was, perhaps, the first use of scientific methods.

Societies Formed

In the mid-1600, it became clear that something had to be done with the vast amounts of information scientists were gathering. So the first scientific societies were formed to allow scientists to get together to discuss others' findings, and develop new ideas. The first society, the Royal Society of London for the Promotion of Natural Knowledge, was formed in 1662, followed by the Académie des Sciences of Paris in 1666. Then the first scientific journal, the Royal Society's *Philosophical Transactions*, was born, followed by the Académie's *Mémoires*. These scientific journals opened up a scientific revolution that led to the development of scientific methods, including sharing methods and reporting failures.

SECTION
3

Enrichment

Are computer models more accurate?

Because of advances in technology, scientists now use computer models to help them study everything from solar eclipses to weather patterns to ocean temperatures. Computer models also can help scientists make predictions.

Ocean Modeling

For example, the National Oceanic and Atmospheric Administration (NOAA) has been using computer models to study ocean temperatures and make predictions about global warming. NOAA scientists spent years studying temperature data from the Atlantic, Pacific, and Indian oceans. They discovered that the oceans have become warmer over the past several decades—confirming that Earth is, indeed, heating up.

Using computer models, NOAA scientists quantified temperature changes in the oceans.

Perhaps even more surprising, they found that computer models showed more significant warming than historical data alone. That's because the computer models took into account a factor the historical data did not—heat is trapped in the oceans. The computer models showed that oceans absorb heat and transfer it to subsurface depths, thereby separating the heat from the atmosphere. The computer models provided more accurate findings than temperature data taken over a nearly 50-year-period.

Nobody expected the computer models to be more accurate. That's because, until now, scientists, forecasters, and others have had to modify computer model output and take into account model biases, strengths, and weaknesses. Since computer models use software, the models are only as dependable as the information and data that's built into them.

1. Do you think computer models are an accurate way for scientists to make predictions? Explain.

2. What was the one thing that led NOAA scientists to realize that the computer models were more accurate than the historical data?

3. What could critics of computer models say about the accuracy of the NOAA findings about global warming?

4. Name two weather-related events that could be predicted by computer models.

SECTION
4

Enrichment

Science Notebooks: Now and Then

Although today's generation of scientists is the first to use technology to record data, observations, and field notes, most still do their record-keeping the old-fashioned way—with a paper notebook.

There's much debate over whether electronic or paper science notebooks are better. Some say electronic data are more likely to be altered than paper data. Others say electronic data are safer because the records can be dated, certified, and sealed. Some say paper notebooks should be loose-leaf pages. Others say bound books are the only way to prevent data from being lost.

Most Famous of All

No matter which method of record-keeping they choose, scientists agree that the most well-known scientific notebook belonged to Leonardo daVinci, a sixteenth century Italian painter, scientist, and civil engineer.

Of his 30 notebooks, daVinci's most famous science-only notebook, the *Codex Leicester*, has been called "one of the world's great art treasures" and "a scientific journal of epic proportions." The codex contains specific information about daVinci's ideas and includes data and detailed drawings.

Historians who've studied the codex say most of daVinci's scientific theories are correct. For example, daVinci believed that the glow of a crescent moon comes from sunlight reflected from Earth. His theory was proven 100 years later by the German astronomer Johannes Kepler.

He Wrote sdrawkcaB

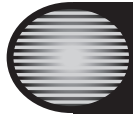
The codex is a 72-page manuscript that contains 360 fingernail-sized, pen-and-ink sketches. The pages are made of pure linen and daVinci wrote in brown ink and red chalk. What's most interesting is the way in which daVinci wrote—backwards! Using mirror-writing (which is read by holding the text up to a mirror), daVinci also started each notebook by writing on what we would think of as the last page.

Nobody knows why daVinci used mirror-writing. Perhaps he did it to protect his ideas from people who might want to steal them. Maybe he liked the challenge of writing that way. Or, possibly he wrote backwards because he was left-handed and didn't want to smudge the ink on the paper as he wrote.

1. Practice mirror-writing by writing an observation about today's weather. Would you use this technique in your own science notebook? Why or why not?

2. DaVinci's fingernail-sized sketches are called mechanical illustrations. What is a mechanical illustration and how might it improve the information contained in a science notebook?

3. Use library resources to find out which of daVinci's scientific ideas, theories, or explanations proved to be true or were later invented by others. List eight of them here.

**Note-taking
Worksheet****The Nature of Science****Section 1 What is science?**

- A. _____—a way of learning about the natural world
1. Scientists ask _____ about the natural world, but questions about art, politics, personal preferences, or morality can't be answered by science.
 2. Answers are _____ because new knowledge and discoveries are continually being made.
 3. **Scientific** _____—an attempted explanation for repeatedly observed patterns in the natural world
 4. A rule that describes a pattern in nature is a **scientific** _____.
- B. Scientists study _____—collections of structures, cycles, and processes that relate to and interact with each other.
- C. Science is divided into _____ main branches that study different systems.
1. _____ **science** studies living things and how they interact.
 2. Earth and space systems are studied in _____ **science**.
 3. _____ **science** studies matter and energy.
 4. The practical use of science is called _____.

Section 2 Science in Action

- A. The _____ includes observing, questioning, and researching; forming a **hypothesis**; predicting an outcome; investigating; analyzing; forming conclusions, communicating findings; and repeating the process.
- B. Scientists _____ conclusions based on observations.
- C. A _____ is one type of scientific investigation.
1. Factors that can be changed in an experiment are _____.
 2. _____ are variables that remain unchanged.
- D. _____ is important for both laboratory and field scientists.

Note-taking Worksheet (continued)**Section 3 Models in Science**

- A. _____—representation of an object or event used as a tool for understanding the natural world
- B. Models come in _____ basic types.
1. _____ models can be seen and touched.
 2. _____ models can be seen on a computer screen but not touched.
 3. _____ models are concepts that describe how someone thinks about something in the natural world.
- C. Models have several _____.
1. Models _____ observations and ideas.
 2. Models can _____ predictions.
 3. Models can _____ time, money, and lives.
- D. Models _____ over time as new observations and discoveries are made.

Section 4 Evaluating Scientific Explanation

- A. _____—using what is known to decide if new facts should be agreed with or believed
- B. _____ should be evaluated.
1. The data should be _____ and exact.
 2. Observations should be carefully, accurately, and completely _____.
 3. Data must be _____ to be reliable.
- C. _____ should be evaluated.
1. Conclusions should _____.
 2. _____ should be considered before a single conclusion is reached.
- D. _____ claims should be carefully analyzed, since they are designed to sell products rather than to promote scientific evidence impartially.