Lesson 2

MAIN IDEAS

1 Science and Technology Several scientists developed new ideas based on close observation of the world and precise mathematical calculations.

2 Science and Technology New inventions helped scientists make more precise observations and measurements.

3 Science and Technology Philosophers proposed a new way to view the universe and to develop scientific theories.

TAKING NOTES

Reading Skill: Categorizing
To categorize means to sort information. As you read Lesson 2, take notes about the Scientific Revolution. Use a diagram like the one below to categorize your information.

Galileo’s Telescope
Galileo was the first person to use a telescope—an instrument that magnifies distant objects—to study the skies.

Galileo’s Telescope

Skillbuilder Handbook, page R6

CALIFORNIA STANDARDS

7.10.2 Understand the significance of the new scientific theories (e.g., those of Copernicus, Galileo, Kepler, Newton) and the significance of new inventions (e.g., the telescope, microscope, thermometer, barometer).

7.10.3 Understand the scientific method advanced by Bacon and Descartes, the influence of new scientific rationalism on the growth of democratic ideas, and the coexistence of science with traditional religious beliefs.

REP 2 Students distinguish fact from opinion in historical narratives and stories.
The Scientific Revolution

Build on What You Know  Influenced by humanism, scholars began to question classical scientific ideas and Christian beliefs. This new spirit of questioning accepted views of the world became known as the **Scientific Revolution**.

New Scientific Theories

1. **ESSENTIAL QUESTION**  What new ideas did scientists develop?

In the 1500s, scholars began to look at old scientific beliefs in a different way. This change led to an explosion of new ideas.

**A Heliocentric Universe**  In the early 1500s, a Polish astronomer named Nicolaus Copernicus (koh•PUR•nuh•kuhs) challenged Ptolemy’s geocentric theory. Copernicus reasoned that the stars, Earth, and other planets revolved around the sun, which did not move. This view of the universe is called **heliocentric**, or sun-centered.

Almost 100 years later, German astronomer Johannes Kepler refined and built on Copernicus’ theories. He used mathematical laws to prove that the planets did indeed move around the sun. One law showed that the planets revolved in elliptical orbits, and not circular orbits as Copernicus believed. Elliptical orbits are oval in shape.
Galileo Challenges Accepted Beliefs  The Italian scientist Galileo (1564–1642) made many scientific advances that challenged classical ideas. For example, his observations made with the telescope clearly supported Copernicus’ ideas. This, however, brought him into conflict with the Church. Copernicus’ view contradicted official Church beliefs that said the universe was geocentric. Church leaders denounced Galileo. They forced him to publicly deny his findings. But Galileo knew he was right, and so did other scientists.

Newton’s Universal Law  In the late 1600s, the English scientist Sir Isaac Newton combined the ideas of Copernicus, Kepler, and Galileo into one single theory. It stated that all physical objects were affected by the same force—gravity. This natural force tends to draw objects toward each other. Gravity is the force that keeps planets revolving around the sun. It also keeps people from flying off Earth’s surface and into space. Since gravity acts on all objects throughout the universe, Newton called his theory the law of universal gravitation.

Discoveries in Medicine  Some scientists sought to understand the universe. Others wanted to know how the human body worked. In 1628, English physician William Harvey published an accurate description of how blood circulates through the body. He based his findings on human dissections he had performed. His observations showed that the heart, not the liver as Galen believed, pumped blood through living creatures.

REVIEW  How did Copernicus’ view of the universe differ from Ptolemy’s?

Blood Circulation  In this 19th-century painting, William Harvey explains to King Charles I how blood circulates. Below is an illustration from Harvey’s study of blood circulation. ▼
New Scientific Inventions

**ESSENTIAL QUESTION** What new inventions helped scientists make more precise observations and measurements?

In the 1600s and 1700s, scientific investigation was made easier by the invention of such instruments as the microscope, the thermometer, and the barometer.

**The Microscope** In the 1670s, a Dutch amateur scientist named Anton van Leeuwenhoek built a microscope. This brass tube containing curved glass lenses magnified objects between 250 and 300 times. Using the microscope, van Leeuwenhoek observed bacteria, or tiny moving matter, in fluids. He also observed the flow of blood through tiny blood vessels called capillaries.

**The Thermometer** In the early 1600s, Galileo invented the thermometer, an instrument that measures temperature. Galileo’s thermometer was an open glass tube with a bulb containing water at the bottom. The water rose in the tube as it warmed and sank as it cooled. Some 100 years later in 1714, German scientist Gabriel Daniel Fahrenheit made the first mercury thermometer. He also proposed the first formal temperature measurement system. Fahrenheit’s measurement scale showed water freezing at a temperature of 32º and boiling at 212º.

**The Barometer** In 1643, a friend and supporter of Galileo, Evangelista Torricelli, invented the barometer. This instrument measures the pressure of Earth’s atmosphere. Later, scientists used the barometer to predict the weather.

**REVIEW** Why might instruments such as the microscope and the thermometer be useful to scientists?
**The Scientific Method**

**ESSENTIAL QUESTION** What new ways of viewing the universe did philosophers propose?

In the 1600s, two philosophers, René Descartes (day-KAHRT) and Francis Bacon, had a huge impact on how scientists studied the world.

**Descartes and Rationalism** Frenchman René Descartes believed in questioning the opinions of recognized authorities. He also believed that every idea should be doubted until it had been proved through reason. Descartes based his approach on a simple statement: “I think, therefore I am.” He argued that God created two realities. The first was physical reality. The other was the mind, or what people think. Descartes claimed that people could use their rational mind to understand the “truths” of the physical world.

**Bacon and the Scientific Method** Englishman Sir Francis Bacon also believed in using rational, organized thought. However, Bacon felt that scientists should use experiments and observation rather than abstract reasoning to understand the world. This approach, called the **scientific method**, had specific steps.

1. Observing and describing a subject
2. Forming a hypothesis—an unproved assumption about the subject
3. Testing the hypothesis in an experiment
4. Interpreting results to draw a conclusion
The Impact of Scientific Rationalism  The ideas of Descartes and Bacon became known as scientific rationalism. By the 1700s, the influence of scientific rationalism had begun to erode the power of the Church. Why did this happen? Scientific rationalism encouraged people to think for themselves instead of relying on church authority.

Some political thinkers applied scientific rationalism to government. For example, political thinker John Locke believed people have the natural ability to be in charge of their own affairs. He viewed this ability as a natural law or right. Such beliefs planted seeds of democracy that soon blossomed in nations such as the United States.

REVIEW What are the four steps involved in the scientific method?

Lesson Summary
- Scientists developed new theories about the universe.
- The invention of new scientific instruments helped to prove new theories and to change some old beliefs.
- The scientific rationalism of Descartes and Bacon had a major impact on religion and politics.

Why It Matters Now . . .
The Scientific Revolution established a rational method of looking at scientific questions that is still used today.

Terms & Names
1. Explain the importance of
   - Scientific Revolution
   - heliocentric
   - universal gravitation
   - scientific method

Using Your Notes
Categorizing Use your completed diagram to answer the following question:
2. What idea or event do you think had the strongest impact on the Scientific Revolution? Explain. (7.10.2)

Main Ideas
3. How do the geocentric and heliocentric theories differ? (7.10.2)
4. What was the importance of the new scientific instruments discussed in this lesson? (7.10.2)
5. How did scientific rationalism affect European religion and politics? (7.10.3)

Critical Thinking
6. Making Inferences Why do you think church authorities forced Galileo to deny his ideas on the universe? (7.10.2)
7. Drawing Conclusions Why was the law of universal gravitation such an important step in understanding the universe? (7.10.2)

Creating an Experiment Devise an experiment to test a hypothesis. (For example, a feather holds more weight than a piece of cardboard.) Use the scientific method to conduct research and determine your answer. (7.10.3)