

The Scientific Revolution and the Enlightenment

Lesson 1 The Scientific Revolution

ESSENTIAL QUESTION

How do new ideas change the way people live?

GUIDING QUESTIONS

1. *How were the scientific ideas of early thinkers passed on to later generations?*
2. *Why did European ideas about the universe change during the 1500s and 1600s?*
3. *Which discoveries did scientists make during the 1600s and 1700s?*
4. *How did Europeans of the 1600s and 1700s develop new ways of gaining knowledge?*

Terms to Know

geocentric an earth-centered theory; having or relating to the earth as the center

Scientific Revolution a period from the 1500s to the 1700s in which many scientific advances changed people's traditional beliefs about science

heliocentric having or relating to the sun as the center

ellipses shapes like stretched circles; ovals

gravity the attraction that the Earth or another celestial body has on an object on or near its surface

elements substances that consist of atoms of only one kind

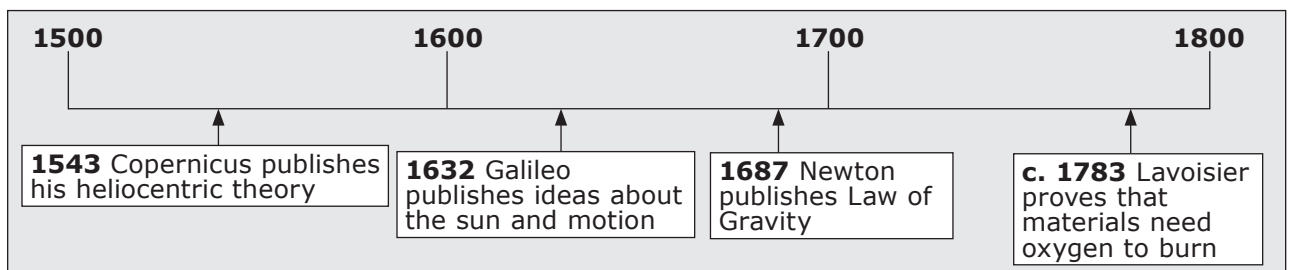
rationalism the belief that reason and experience must be present for the solution of problems

scientific method the steps for an orderly search for knowledge

Where in the world?



When did it happen?



The Scientific Revolution and the Enlightenment

Lesson 1 The Scientific Revolution, *Continued*

Early Science

Science is any organized study of the natural world. During ancient times, people used science to solve problems. For example, they used mathematics to keep records.

The ancient Greeks used reason to learn about nature. They also used common sense. As they studied the world, they developed theories, or ideas about how and why things worked. However, a theory is not always correct. It must be proven many times. The Greeks did not use experiments to test their theories. As a result, many of their theories were wrong. For example, Ptolemy said that the sun and the planets move around the Earth. People believed this **geocentric**, or Earth-centered, theory for 1,400 years.

During the Middle Ages, most Europeans were interested in religion. Not many people wanted to learn about nature. They did not think they needed to do research. They relied on copies of old writings that sometimes contained errors.

Outside of Europe, in the Islamic Empire, Arabs and Jews had saved much Greek knowledge. They also learned a number system used in India. This system is called the Indian-Arabic system. Also, Arabs and Jews built on Greek ideas to make their own advances in science.

During the 1100s, thinkers in Europe began to have more contact with the world of Islam. As a result, they became interested in science again. Some thinkers showed that Christianity and reason could work together. One of these thinkers was Thomas Aquinas. Students began to study science. They did this at schools called universities.

theory an explanation of how or why something happens

experiment a test to see if a theory is true

research the collection of information on a certain subject

In the 1400s, people started to explore the world. Because of this, Europeans were able to make better maps. These maps helped explorers reach far-away lands. They brought back new information about oceans, continents, animals, plants, and diseases. Scientists organized it all.

FOLDABLES®

Describing

- Place a three-tab Foldable along the dotted line to cover the text titled *Early Science*. Label the three tabs *Advancements*, *Losses*, and *Advancements*.

Use both sides of the tabs to explain how the study of science advanced, lost ground, and advanced again over hundreds of years.

Identifying

- In what way was the geocentric theory of the universe wrong?

Reading Check

- How was science practiced in ancient and medieval times?

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Lesson 1 The Scientific Revolution, *Continued*



Visualizing

4. Below, draw the sun and the elliptical path of a planet around it.



Reading Check

5. How did Galileo go about making scientific discoveries?



Identifying

6. What scientific contribution did Robert Hooke make?

New Ideas About the Universe

In the 1500s, scientists in Europe began to experiment and started the **Scientific Revolution**. The Scientific Revolution changed how Europeans understood science.

Astronomy is the study of planets, stars, and other bodies in space. Astronomer Nicolaus Copernicus disagreed with Ptolemy's theory. Copernicus believed that the Earth and other planets moved around the sun. This sun-centered view is called **heliocentric**.

Johannes Kepler corrected some of the findings of Copernicus. Kepler said that the planets move in oval paths. Such paths are called **ellipses**.

Galileo Galilei believed that conducting experiments was the correct way to achieve scientific knowledge. He developed a telescope that allowed him to find evidence that supported the heliocentric view. He also proved that all objects fall to the ground at the same speed.

Contributions in Astronomy

Nicolaus Copernicus	<ul style="list-style-type: none"> • Stated that the Earth and other planets move around the sun
Johannes Kepler	<ul style="list-style-type: none"> • Stated that planets move in ellipses
Galileo Galilei	<ul style="list-style-type: none"> • Used telescope to support the heliocentric view of the universe

New Scientific Advances

Isaac Newton figured out some scientific laws. In science, laws are well-tested theories. Newton came up with the law of **gravity**. Gravity is the pull of the Earth and other bodies in space on objects that are on or near them.

Andreas Vesalius studied how the human body works by dissecting, or cutting open, dead bodies. His findings replaced many wrong ideas about the human body.

Robert Hooke began to use a microscope. A microscope makes large images of small objects. Hooke discovered cells, which are the smallest units of living matter.

Antonie van Leeuwenhoek improved the microscope by adding more powerful lenses. He became the first person to see bacteria. Bacteria are tiny living organisms.

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Robert Boyle proved that matter is made up of **elements**. An element is a basic material that cannot be broken down into simpler parts.

In the 1700s, scientists in Europe discovered gases, such as oxygen and hydrogen. French scientist Antoine Lavoisier showed that materials need oxygen to burn.

The Triumph of Reason

René Descartes studied the problem of knowing what is true. He used mathematics and reason to search for truth. In mathematics, the answers are always true. Descartes' ideas became known as **rationalism**. This is the belief that reason is the source of learning.

Blaise Pascal thought that reason and science could be used to solve problems in everyday life. Yet, he thought that Christianity must be used to find spiritual truth.

Francis Bacon came up with the **scientific method**. This method is an orderly way to collect and study facts.

Steps of the Scientific Method

- **Observation:** The scientist collects facts by studying an aspect of the world.
- **Hypothesis:** The scientist explains these facts with a theory.
- **Prediction:** The scientist makes a prediction.
- **Experiment:** The scientist does experiments to prove that the theory is true.
- **Theory:** If the theory seems true, the scientist develops it into scientific law.

Check for Understanding

Name two important astronomers during the Scientific Revolution.

1. _____
2. _____

List two advances made during the Scientific Revolution that are still taught today.

3. _____
4. _____

Reading Check

7. According to Newton, how are the planets held in orbit?

Reading Check

8. Why did Descartes believe that mathematics is the source of scientific truth?



9. Place a three-tab Foldable to cover the Check for Understanding. Write *Scientific Revolution* on the anchor tab. Label the three tabs *1500s*, *1600s*, and *1700s*.

Use both sides of the tabs to record information you remember about the Scientific Revolution during these centuries.

The Scientific Revolution and the Enlightenment

Lesson 2 The Enlightenment

ESSENTIAL QUESTION

How do governments change?

GUIDING QUESTIONS

1. *How did European thinkers apply scientific ideas to government?*
2. *How did French thinkers influence Europe during the Enlightenment?*
3. *How did European monarchs model their countries on Enlightenment ideas?*

Terms to Know

Age of Enlightenment a period of time in which a European philosophical movement developed, based on reason and experience rather than on traditional thinking

absolutism a political system in which a ruler has total power

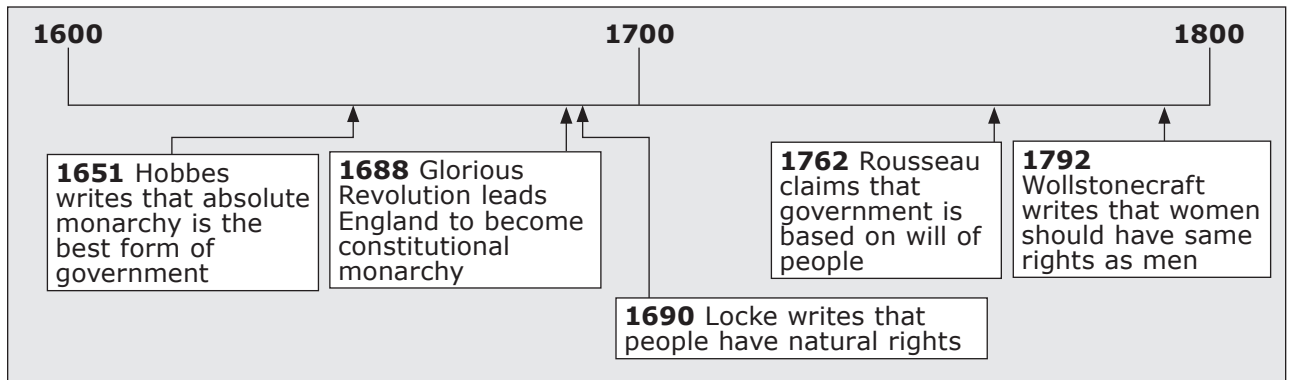
social contract an agreement between the people and their government

Glorious Revolution the overthrow of King James II of England

constitutional monarchy a political system in which a king or queen rules according to a constitution

separation of powers a government structure that has three distinct branches: legislative, executive, and judicial

When did it happen?



What do you know?

In the K column, list what you already know about the Enlightenment. In the W column, list what you want to know. After reading the lesson, fill in the L column with the information that you learned.

K	W	L

The Scientific Revolution and the Enlightenment

Lesson 2 The Enlightenment, *Continued*

Reason and Politics

The Scientific Revolution used reason to solve problems. During the 1700s, educated Europeans saw reason as a "light" that could reveal truth. As a result, this time period became known as the **Age of Enlightenment**.

Some thinkers used reason to improve government. They claimed that government should be based on natural law. This is a body of law that applies to everyone.

The English thinker Thomas Hobbes wrote *Leviathan* in 1651. In this book, he argued that people were naturally violent and selfish. Hobbes believed that natural law meant people needed strong rulers to tell them what to do. His theory became known as **absolutism**, since it called for a ruler with absolute, or total, power.

John Locke was another English thinker. He believed that natural law gave all people basic rights from birth. These included the right to life, liberty, and to own property. Locke thought that government should protect people's rights as part of a **social contract**. This is an agreement between the people and their leaders. If a government broke the contract, then the people had the right to replace that government. In 1690, Locke wrote his ideas in a book called *Two Treatises of Government*.

Ideas of Hobbes	Ideas of Locke
<ul style="list-style-type: none"> • Government should be based on natural law. • Natural law supports having an absolute ruler. • People by themselves cannot make good decisions. • People need to obey a wise, powerful ruler. 	<ul style="list-style-type: none"> • Government should be based on natural law. • All people have basic rights from birth, including right to life and liberty. • Government should protect people's rights. • If government fails to protect these rights, it can be replaced.

In the late 1600s, King James II of England wanted to be a total ruler. He left the country when civil war threatened. Parliament replaced him with a new king and queen. This event became known as the **Glorious Revolution**. The new rulers, William and Mary, agreed to a Bill of Rights. They made England a **constitutional monarchy**, a form of government in which laws limit the power of the ruler.

Determining Cause and Effect

1. What effect did the Scientific Revolution have on thinkers during the 1700s?

Explaining

2. How did Thomas Hobbes view people?

Defining

3. What is a *constitutional monarchy*?

The Scientific Revolution and the Enlightenment

Lesson 2 The Enlightenment, *Continued*

 **Reading Check**

4. How did Hobbes and Locke differ in their ideas about government and the people?

 **Summarizing**

5. Who were the philosophes and what did they believe?

 **Identifying**

6. Who wrote *A Vindication of the Rights of Woman*?

 **Reading Check**

7. What was Diderot's *Encyclopedia*?

In France, Baron Montesquieu wrote a book called *The Spirit of Laws*. Montesquieu said England had the best government because it had a **separation of powers**. Separation of powers means that the government's power should be divided into three equal branches.

- Legislative branch—makes laws
- Executive branch—puts the laws into effect
- Judicial branch—interprets the laws

Separating these powers stops any one part of government from getting too powerful.

The Philosophes of France

During the 1700s, France became the center of the Enlightenment. Thinkers in France and elsewhere were called philosophes. *Philosophe* is a French word that means "philosopher." A philosopher is a person who searches for wisdom. Philosophes wanted to use reason to improve society. They supported science and freedom of speech. Their ideas spread across Europe.

The Philosophes	
Voltaire	<ul style="list-style-type: none"> • Wrote plays, novels, and essays • Supported freedom of religion • Supported deism, a religious belief based on reason
Denis Diderot	<ul style="list-style-type: none"> • Wanted to spread Enlightenment ideas • Created a 28-volume encyclopedia, which covered religion, government, the sciences, history, and the arts
Mary Wollstonecraft	<ul style="list-style-type: none"> • Wrote <i>A Vindication of the Rights of Woman</i> • Believed that women should have the same rights as men • Started the modern effort for equal rights for women
Jean-Jacques Rousseau	<ul style="list-style-type: none"> • Wrote <i>The Social Contract</i> • Believed that government comes from what the people want

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Lesson 2 The Enlightenment, *Continued*

Absolute Monarchs

In the 1600s and 1700s, some kings and queens liked Enlightenment ideas. They used these ideas to improve their societies. Yet, they refused to give up any power.

In 1643 Louis XIV became the king of France. Known as the Sun King, he fought wars that gained land for France. However, the great cost of fighting weakened his country.

Other Enlightenment rulers supported a variety of reforms inspired by Enlightenment ideas.

Country	Absolute Monarch	Enlightenment Ideas
Prussia	Frederick the Great	<ul style="list-style-type: none"> • Dedicated himself to the good of his people • Allowed some freedom of speech and religion
Austria	Maria Theresa	<ul style="list-style-type: none"> • Set up schools • Tried to make the lives of serfs better
Austria	Joseph II	<ul style="list-style-type: none"> • Freed the serfs • Tried to reform taxes
Russia	Peter the Great	<ul style="list-style-type: none"> • Made reforms to government and military
Russia	Catherine the Great	<ul style="list-style-type: none"> • Supported some Enlightenment ideas • Considered freeing the serfs

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Check for Understanding

Name two ways the Enlightenment changed the government of England.

1. _____
2. _____

List two ways absolute monarchs responded to the Enlightenment.

3. _____
4. _____

? Comparing

8. How were the reforms of Maria Theresa similar to the reforms of Joseph II?

✓ Reading Check

9. How was Frederick the Great influenced by the Enlightenment?



10. Place a one-tab Foldable along the dotted line to cover the Check for Understanding. Write *The Enlightenment* on the anchor tab.

Use both sides of the tab to list words and phrases you remember about how governments changed during the Enlightenment.