



The Scientific Revolution

MAIN IDEA

SCIENCE AND TECHNOLOGY In the mid-1500s, scientists began to question accepted beliefs and make new theories based on experimentation.

WHY IT MATTERS NOW

Such questioning led to the development of the scientific method still in use today.

TERMS & NAMES

- geocentric theory
- heliocentric theory
- Scientific Revolution
- Galileo Galilei
- scientific method
- Isaac Newton

SETTING THE STAGE As you recall, the period between 1300 and 1600 was a time of great change in Europe. The Renaissance, a rebirth of learning and the arts, inspired a spirit of curiosity in many fields. Scholars began to question ideas that had been accepted for hundreds of years. Meanwhile, the religious movement known as the Reformation prompted followers to challenge accepted ways of thinking about God and salvation. While the Reformation was taking place, another revolution in European thought had begun, one that would permanently change how people viewed the physical world.

The Roots of Modern Science

Before 1500, scholars generally decided what was true or false by referring to an ancient Greek or Roman author or to the Bible. Few European scholars challenged the scientific ideas of the ancient thinkers or the church by carefully observing nature for themselves.

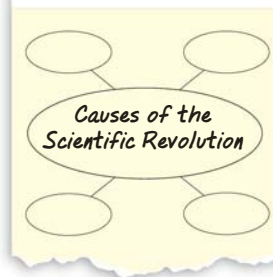
The Medieval View During the Middle Ages, most scholars believed that the earth was an immovable object located at the center of the universe. According to that belief, the moon, the sun, and the planets all moved in perfectly circular paths around the earth. Common sense seemed to support this view. After all, the sun appeared to be moving around the earth as it rose in the morning and set in the evening.

This earth-centered view of the universe was called the **geocentric theory**. The idea came from Aristotle, the Greek philosopher of the fourth century B.C. The Greek astronomer Ptolemy (TOL•a•mee) expanded the theory in the second century A.D. In addition, Christianity taught that God had deliberately placed the earth at the center of the universe. Earth was thus a special place on which the great drama of life unfolded.

A New Way of Thinking Beginning in the mid-1500s, a few scholars published works that challenged the ideas of the ancient thinkers and the church. As these scholars replaced old assumptions with new theories, they launched a change in European thought that historians call the **Scientific Revolution**. The Scientific Revolution was a new way of thinking about the natural world. That way was based upon careful observation and a willingness to question accepted beliefs.

TAKING NOTES

Analyzing Causes Use a diagram to list the events and circumstances that led to the Scientific Revolution.



A combination of discoveries and circumstances led to the Scientific Revolution and helped spread its impact. During the Renaissance, European explorers traveled to Africa, Asia, and the Americas. Such lands were inhabited by peoples and animals previously unknown in Europe. These discoveries opened Europeans to the possibility that there were new truths to be found. The invention of the printing press during this period helped spread challenging ideas—both old and new—more widely among Europe’s thinkers.

The age of European exploration also fueled a great deal of scientific research, especially in astronomy and mathematics. Navigators needed better instruments and geographic measurements, for example, to determine their location in the open sea. As scientists began to look more closely at the world around them, they made observations that did not match the ancient beliefs. They found they had reached the limit of the classical world’s knowledge. Yet, they still needed to know more.

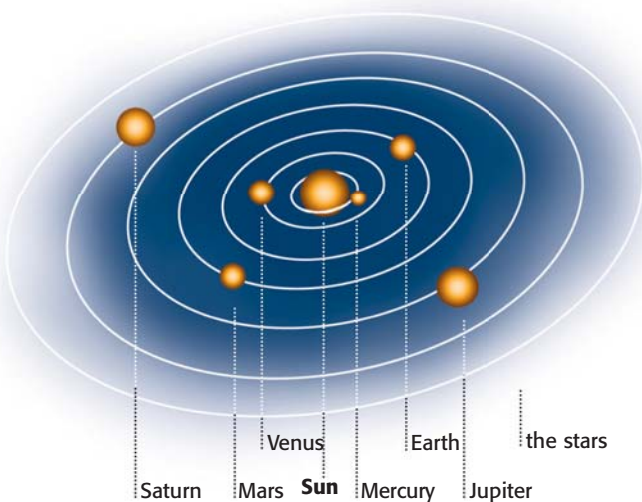
A Revolutionary Model of the Universe

An early challenge to accepted scientific thinking came in the field of astronomy. It started when a small group of scholars began to question the geocentric theory.

The Heliocentric Theory Although backed by authority and common sense, the geocentric theory did not accurately explain the movements of the sun, moon, and planets. This problem troubled a Polish cleric and astronomer named Nicolaus

Copernicus (koh•PUR•nuh•kuhs). In the early 1500s, Copernicus became interested in an old Greek idea that the sun stood at the center of the universe. After studying planetary movements for more than 25 years, Copernicus reasoned that indeed, the stars, the earth, and the other planets revolved around the sun.

Copernicus’s **heliocentric**, or sun-centered, **theory** still did not completely explain why the planets orbited the way they did. He also knew that most scholars and clergy would reject his theory because it contradicted their religious views.



▲ This model shows how Copernicus saw the planets revolving around the sun.

Fearing ridicule or persecution, Copernicus did not publish his findings until 1543, the last year of his life. He received a copy of his book, *On the Revolutions of the Heavenly Bodies*, on his deathbed.

While revolutionary, Copernicus’s book caused little stir at first. Over the next century and a half, other scientists built on the foundations he had laid. A Danish astronomer, Tycho Brahe (TEE•koh brah), carefully recorded the movements of the planets for many years. Brahe produced mountains of accurate data based on his observations. However, it was left to his followers to make mathematical sense of them.

After Brahe’s death in 1601, his assistant, a brilliant mathematician named Johannes Kepler, continued his work. After studying Brahe’s data, Kepler concluded that certain mathematical laws govern planetary motion. One of these laws showed that the planets revolve around the sun in elliptical orbits instead of circles, as was previously thought. Kepler’s laws showed that Copernicus’s basic ideas were true. They demonstrated mathematically that the planets revolve around the sun. **A**

MAIN IDEA

Recognizing Effects

A How did Kepler’s findings support the heliocentric theory?

Galileo's Discoveries An Italian scientist named **Galileo Galilei** built on the new theories about astronomy. As a young man, Galileo learned that a Dutch lens maker had built an instrument that could enlarge far-off objects. Galileo built his own telescope and used it to study the heavens in 1609.

Then, in 1610, he published a small book called *Starry Messenger*, which described his astonishing observations. Galileo announced that Jupiter had four moons and that the sun had dark spots. He also noted that the earth's moon had a rough, uneven surface. This shattered Aristotle's theory that the moon and stars were made of a pure, perfect substance. Galileo's observations, as well as his laws of motion, also clearly supported the theories of Copernicus.

Conflict with the Church Galileo's findings frightened both Catholic and Protestant leaders because they went against church teaching and authority. If people believed the church could be wrong about this, they could question other church teachings as well.

In 1616, the Catholic Church warned Galileo not to defend the ideas of Copernicus. Although Galileo remained publicly silent, he continued his studies. Then, in 1632, he published *Dialogue Concerning the Two Chief World Systems*. This book presented the ideas of both Copernicus and Ptolemy, but it clearly showed that Galileo supported the Copernican theory. The pope angrily summoned Galileo to Rome to stand trial before the Inquisition.

Galileo stood before the court in 1633. Under the threat of torture, he knelt before the cardinals and read aloud a signed confession. In it, he agreed that the ideas of Copernicus were false.

MAIN IDEA

Analyzing Primary Sources

B In what two ways does Galileo seek to appease the Church?

PRIMARY SOURCE **B**

With sincere heart and unpretended faith I abjure, curse, and detest the aforesaid errors and heresies [of Copernicus] and also every other error . . . contrary to the Holy Church, and I swear that in the future I will never again say or assert . . . anything that might cause a similar suspicion toward me.

GALILEO GALILEI, quoted in
The Discoverers

Galileo was never again a free man. He lived under house arrest and died in 1642 at his villa near Florence. However, his books and ideas still spread all over Europe. (In 1992, the Catholic Church officially acknowledged that Galileo had been right.)



▲ Galileo stands before the papal court.

The Scientific Method

The revolution in scientific thinking that Copernicus, Kepler, and Galileo began eventually developed into a new approach to science called the **scientific method**. The scientific method is a logical procedure for gathering and testing ideas. It begins with a problem or question arising from an observation. Scientists next form a hypothesis, or unproved assumption. The hypothesis is then tested in an experiment or on the basis of data. In the final step, scientists analyze and interpret their data to reach a new conclusion. That conclusion either confirms or disproves the hypothesis.

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Major Steps in the Scientific Revolution



▲ Nicolaus Copernicus began the Scientific Revolution with his heliocentric theory.

1566 Marie de Coste Blanche publishes *The Nature of the Sun and Earth*.

1609 Kepler publishes first two laws of planetary motion.

1610 Galileo publishes *Starry Messenger*.

1520

1570

1620

1543 Copernicus publishes heliocentric theory. Vesalius publishes human anatomy textbook.

1590 Janssen invents microscope.


1620 Bacon's book *Novum Organum* (New Instrument) encourages experimental method.



Bacon and Descartes The scientific method did not develop overnight. The work of two important thinkers of the 1600s, Francis Bacon and René Descartes (day•KAHRT), helped to advance the new approach.

Francis Bacon, an English statesman and writer, had a passionate interest in science. He believed that by better understanding the world, scientists would generate practical knowledge that would improve people's lives. In his writings, Bacon attacked medieval scholars for relying too heavily on the conclusions of Aristotle and other ancient thinkers. Instead of reasoning from abstract theories, he urged scientists to experiment and then draw conclusions. This approach is called empiricism, or the experimental method.


In France, René Descartes also took a keen interest in science. He developed analytical geometry, which linked algebra and geometry. This provided an important new tool for scientific research.

Like Bacon, Descartes believed that scientists needed to reject old assumptions and teachings. As a mathematician, however, he approached gaining knowledge differently than Bacon. Rather than using experimentation, Descartes relied on mathematics and logic. He believed that everything should be doubted until proved by reason. The only thing he knew for certain was that he existed—because, as he wrote, “I think, therefore I am.” From this starting point, he followed a train of strict reasoning to arrive at other basic truths. 

Modern scientific methods are based on the ideas of Bacon and Descartes. Scientists have shown that observation and experimentation, together with general laws that can be expressed mathematically, can lead people to a better understanding of the natural world.

MAIN IDEA

Contrasting

 How did Descartes's approach to science differ from Bacon's?

Newton Explains the Law of Gravity

By the mid-1600s, the accomplishments of Copernicus, Kepler, and Galileo had shattered the old views of astronomy and physics. Later, the great English scientist [Isaac Newton](#) helped to bring together their breakthroughs under a single theory of motion.

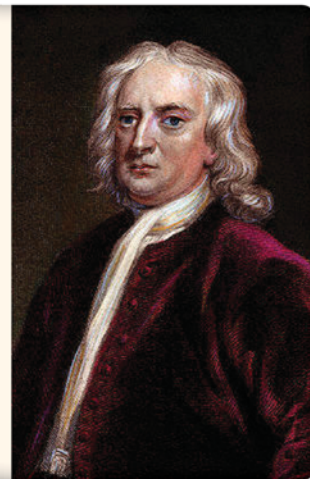
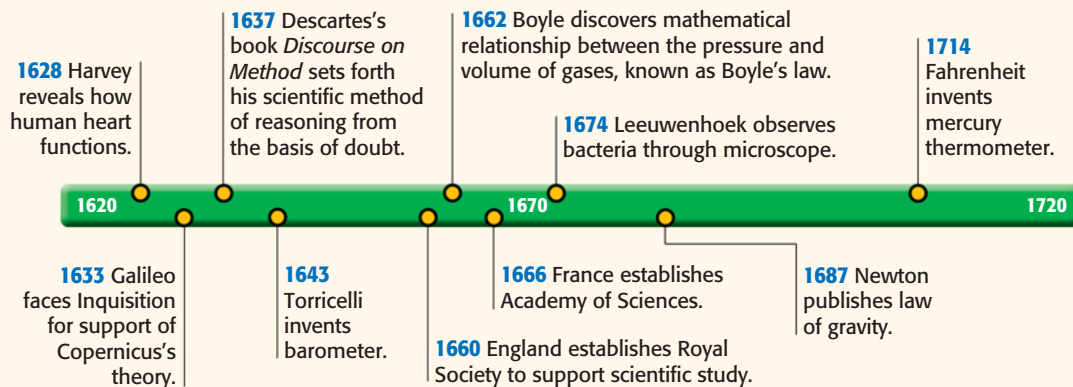
Changing Idea: Scientific Method

Old Science

Scholars generally relied on ancient authorities, church teachings, common sense, and reasoning to explain the physical world.

New Science

In time, scholars began to use observation, experimentation, and scientific reasoning to gather knowledge and draw conclusions about the physical world.



▲ Isaac Newton's law of gravity explained how the same physical laws governed motion both on earth and in the heavens.

Newton studied mathematics and physics at Cambridge University. By the time he was 26, Newton was certain that all physical objects were affected equally by the same forces. Newton's great discovery was that the same force ruled motion of the planets and all matter on earth and in space. The key idea that linked motion in the heavens with motion on the earth was the law of universal gravitation. According to this law, every object in the universe attracts every other object. The degree of attraction depends on the mass of the objects and the distance between them.

In 1687, Newton published his ideas in a work called *The Mathematical Principles of Natural Philosophy*. It was one of the most important scientific books ever written. The universe he described was like a giant clock. Its parts all worked together perfectly in ways that could be expressed mathematically. Newton believed that God was the creator of this orderly universe, the clockmaker who had set everything in motion. **D**

MAIN IDEA

Clarifying

D Why was the law of gravitation important?

The Scientific Revolution Spreads

As astronomers explored the secrets of the universe, other scientists began to study the secrets of nature on earth. Careful observation and the use of the scientific method eventually became important in many different fields.

Scientific Instruments Scientists developed new tools and instruments to make the precise observations that the scientific method demanded. The first microscope was invented by a Dutch maker of eyeglasses, Zacharias Janssen (YAHN•suhn), in 1590. In the 1670s, a Dutch drapery merchant and amateur scientist named Anton van Leeuwenhoek (LAY•vuhn•HUK) used a microscope to observe bacteria swimming in tooth scrapings. He also examined red blood cells for the first time.

In 1643, one of Galileo's students, Evangelista Torricelli (TAWR•uh•CHEHL•ee), developed the first mercury barometer, a tool for measuring atmospheric pressure and predicting weather. In 1714, the German physicist Gabriel Fahrenheit (FAR•uhn•HYT) made the first thermometer to use mercury in glass. Fahrenheit's thermometer showed water freezing at 32°. A Swedish astronomer, Anders Celsius (SEHL•see•uhs), created another scale for the mercury thermometer in 1742. Celsius's scale showed freezing at 0°.

Medicine and the Human Body During the Middle Ages, European doctors had accepted as fact the writings of an ancient Greek physician named Galen. However, Galen had never dissected the body of a human being. Instead, he had studied the anatomy of pigs and other animals. Galen assumed that human anatomy was much the same. A Flemish physician named Andreas Vesalius proved Galen's assumptions wrong. Vesalius dissected human corpses and published his observations. His



▲ The famous Dutch painter Rembrandt painted *Anatomy Lesson of Dr. Tulp* in 1632 from an actual anatomy lesson. The corpse was that of a criminal.

book, *On the Structure of the Human Body* (1543), was filled with detailed drawings of human organs, bones, and muscle.

In the late 1700s, British physician Edward Jenner introduced a vaccine to prevent smallpox. Inoculation using live smallpox germs had been practiced in Asia for centuries. While beneficial, this technique could also be dangerous. Jenner discovered that inoculation with germs from a cattle disease called cowpox gave permanent protection from smallpox for humans. Because cowpox was a much milder disease, the risks for this form of inoculation were much lower. Jenner used cowpox to produce the world's first vaccination.

Vocabulary

Inoculation is the act of injecting a germ into a person's body so as to create an immunity to the disease.

Discoveries in Chemistry Robert Boyle pioneered the use of the scientific method in

chemistry. He is considered the founder of modern chemistry. In a book called *The Sceptical Chymist* (1661), Boyle challenged Aristotle's idea that the physical world consisted of four elements—earth, air, fire, and water. Instead, Boyle proposed that matter was made up of smaller primary particles that joined together in different ways. Boyle's most famous contribution to chemistry is Boyle's law. This law explains how the volume, temperature, and pressure of gas affect each other.

The notions of reason and order, which spurred so many breakthroughs in science, soon moved into other fields of life. Philosophers and scholars across Europe began to rethink long-held beliefs about the human condition, most notably the rights and liberties of ordinary citizens. These thinkers helped to usher in a movement that challenged the age-old relationship between a government and its people, and eventually changed forever the political landscape in numerous societies.

SECTION

1

ASSESSMENT

TERMS & NAMES 1. For each term or name, write a sentence explaining its significance.

- geocentric theory
- Scientific Revolution
- heliocentric theory
- Galileo Galilei
- scientific method
- Isaac Newton

USING YOUR NOTES

2. Which event or circumstance do you consider to be the most significant? Why?



MAIN IDEAS

3. Before the 1500s, who and what were the final authorities with regard to most knowledge?
4. How did the heliocentric theory of the universe differ from the geocentric theory?
5. What are the main steps of the scientific method?

CRITICAL THINKING & WRITING

6. **DRAWING CONCLUSIONS** "If I have seen farther than others," said Newton, "it is because I have stood on the shoulders of giants." Could this be said of most scientific accomplishments? Explain.
7. **ANALYZING MOTIVES** Why might institutions of authority tend to reject new ideas?
8. **FORMING AND SUPPORTING OPINIONS** Do you agree with Galileo's actions during his Inquisition? Explain.
9. **WRITING ACTIVITY** **SCIENCE AND TECHNOLOGY** Create a television **script** for a discovery of the Scientific Revolution. Include key people, ideas, and accomplishments.

CONNECT TO TODAY CREATING A GRAPHIC

Research a modern-day invention or new way of thinking and then describe it and its impact on society to the class in a **poster** or **annotated diagram**.



The Enlightenment in Europe

MAIN IDEA

POWER AND AUTHORITY A revolution in intellectual activity changed Europeans' view of government and society.

WHY IT MATTERS NOW

The various freedoms enjoyed in many countries today are a result of Enlightenment thinking.

TERMS & NAMES

- Enlightenment
- social contract
- John Locke
- philosophe
- Voltaire
- Montesquieu
- Rousseau
- Mary Wollstonecraft

SETTING THE STAGE In the wake of the Scientific Revolution, and the new ways of thinking it prompted, scholars and philosophers began to reevaluate old notions about other aspects of society. They sought new insight into the underlying beliefs regarding government, religion, economics, and education. Their efforts spurred the **Enlightenment**, a new intellectual movement that stressed reason and thought and the power of individuals to solve problems. Known also as the Age of Reason, the movement reached its height in the mid-1700s and brought great change to many aspects of Western civilization.

Two Views on Government

The Enlightenment started from some key ideas put forth by two English political thinkers of the 1600s, Thomas Hobbes and John Locke. Both men experienced the political turmoil of England early in that century. However, they came to very different conclusions about government and human nature.

Hobbes's Social Contract Thomas Hobbes expressed his views in a work called *Leviathan* (1651). The horrors of the English Civil War convinced him that all humans were naturally selfish and wicked. Without governments to keep order, Hobbes said, there would be “war . . . of every man against every man,” and life would be “solitary, poor, nasty, brutish, and short.”

Hobbes argued that to escape such a bleak life, people had to hand over their rights to a strong ruler. In exchange, they gained law and order. Hobbes called this agreement by which people created a government the **social contract**. Because people acted in their own self-interest, Hobbes said, the ruler needed total power to keep citizens under control. The best government was one that had the awesome power of a leviathan (sea monster). In Hobbes's view, such a government was an absolute monarchy, which could impose order and demand obedience.

TAKING NOTES

Outlining Use an outline to organize main ideas and details.

Enlightenment in Europe

I. Two Views on Government

- A.
- B.

II. The Philosophes Advocate Reason

- A.
- B.

Changing Idea: The Right to Govern

Old Idea

A monarch's rule is justified by divine right.

New Idea

A government's power comes from the consent of the governed.

Locke's Natural Rights The philosopher [John Locke](#) held a different, more positive, view of human nature. He believed that people could learn from experience and improve themselves. As reasonable beings, they had the natural ability to govern their own affairs and to look after the welfare of society. Locke criticized absolute monarchy and favored the idea of self-government.

According to Locke, all people are born free and equal, with three natural rights—life, liberty, and property. The purpose of government, said Locke, is to protect these rights. If a government fails to do so, citizens have a right to overthrow it. Locke's theory had a deep influence on modern political thinking. His belief that a government's power comes from the consent of the people is the foundation of modern democracy. The ideas of government by popular consent and the right to rebel against unjust rulers helped inspire struggles for liberty in Europe and the Americas. **A**

MAIN IDEA

Contrasting

A How does Locke's view of human nature differ from that of Hobbes?

The Philosophes Advocate Reason

History Makers



Voltaire
1694–1778

Voltaire befriended several European monarchs and nobles. Among them was the Prussian king Frederick II. The two men seemed like ideal companions. Both were witty and preferred to dress in shabby, rumpled clothes.

Their relationship eventually soured, however. Voltaire disliked editing Frederick's mediocre poetry, while Frederick suspected Voltaire of shady business dealings. Voltaire eventually described the Prussian king as "a nasty monkey, perfidious friend, [and] wretched poet." Frederick in turn called Voltaire a "miser, dirty rogue, [and] coward."

INTEGRATED TECHNOLOGY

RESEARCH LINKS For more on Voltaire, go to [classzone.com](#)

The Enlightenment reached its height in France in the mid-1700s. Paris became the meeting place for people who wanted to discuss politics and ideas. The social critics of this period in France were known as [philosophes](#) (FIHL•uh•SAHFS), the French word for philosophers. The philosophes believed that people could apply reason to all aspects of life, just as Isaac Newton had applied reason to science. Five concepts formed the core of their beliefs:

1. **Reason** Enlightened thinkers believed truth could be discovered through reason or logical thinking.
2. **Nature** The philosophes believed that what was natural was also good and reasonable.
3. **Happiness** The philosophes rejected the medieval notion that people should find joy in the hereafter and urged people to seek well-being on earth.
4. **Progress** The philosophes stressed that society and humankind could improve.
5. **Liberty** The philosophes called for the liberties that the English people had won in their Glorious Revolution and Bill of Rights.

Voltaire Combats Intolerance Probably the most brilliant and influential of the philosophes was François Marie Arouet. Using the pen name [Voltaire](#), he published more than 70 books of political essays, philosophy, and drama.

Voltaire often used satire against his opponents. He made frequent targets of the clergy, the aristocracy, and the government. His sharp tongue made him enemies at the French court, and twice he was sent to prison. After his second jail term, Voltaire was exiled to England for more than two years.

Although he made powerful enemies, Voltaire never stopped fighting for tolerance, reason, freedom of religious belief, and freedom of speech. He used his quill pen as if it were a deadly weapon in a thinker's war against humanity's worst enemies—intolerance, prejudice, and superstition. He summed up his staunch defense of liberty in one of his most famous quotes: "I do not agree with a word you say but will defend to the death your right to say it."

Vocabulary

Satire is the use of irony, sarcasm, or wit to attack folly, vice, or stupidity.

Montesquieu and the Separation of Powers Another influential French writer, the Baron de **Montesquieu** (MAHN•tuh•SKYOO), devoted himself to the study of political liberty. Montesquieu believed that Britain was the best-governed and most politically balanced country of his own day. The British king and his ministers held executive power. They carried out the laws of the state. The members of Parliament held legislative power. They made the laws. The judges of the English courts held judicial power. They interpreted the laws to see how each applied to a specific case. Montesquieu called this division of power among different branches separation of powers.

Montesquieu oversimplified the British system. It did not actually separate powers this way. His idea, however, became a part of his most famous book, *On the Spirit of Laws* (1748). In his book, Montesquieu proposed that separation of powers would keep any individual or group from gaining total control of the government. “Power,” he wrote, “should be a check to power.” This idea later would be called checks and balances.

MAIN IDEA

Analyzing Issues

B What advantages did Montesquieu see in the separation of powers?

Montesquieu’s book was admired by political leaders in the British colonies of North America. His ideas about separation of powers and checks and balances became the basis for the United States Constitution. **B**


Rousseau: Champion of Freedom A third great philosophe, Jean Jacques **Rousseau** (roo•SOH), was passionately committed to individual freedom. The son of a poor Swiss watchmaker, Rousseau won recognition as a writer of essays. A strange, brilliant, and controversial figure, Rousseau strongly disagreed with other

> Analyzing Primary Sources

Laws Protect Freedom

Both Montesquieu and Rousseau believed firmly that fair and just laws—not monarchs or unrestrained mobs—should govern society. Here, Rousseau argues that laws established by and for the people are the hallmark of a free society.

PRIMARY SOURCE




I . . . therefore give the name “Republic” to every state that is governed by laws, no matter what the form of its administration may be: for only in such a case does the public interest govern, and the *res publica* rank as a *reality*. . . . Laws are, properly speaking, only the conditions of civil association. The people, being subject to the laws, ought to be their author: the conditions of the society ought to be regulated . . . by those who come together to form it.

JEAN JACQUES ROUSSEAU, *The Social Contract*

Laws Ensure Security

While laws work to protect citizens from abusive rulers, Montesquieu argues that they also guard against anarchy and mob rule.

PRIMARY SOURCE



It is true that in democracies the people seem to act as they please; but political liberty does not consist in an unlimited freedom. . . . We must have continually present to our minds the difference between independence and liberty. Liberty is a right of doing whatever the laws permit, and if a citizen could do what they [the laws] forbid he would be no longer possessed of liberty, because all his fellow-citizens would have the same power.

BARON DE MONTESQUIEU, *The Spirit of Laws*

DOCUMENT-BASED QUESTIONS

- Analyzing Issues** Why should citizens be the authors of society’s laws, according to Rousseau?
- Making Inferences** Why does Montesquieu believe that disobeying laws leads to a loss of liberty?

Enlightenment thinkers on many matters. Most philosophes believed that reason, science, and art would improve life for all people. Rousseau, however, argued that civilization corrupted people's natural goodness. "Man is born free, and everywhere he is in chains," he wrote.

Rousseau believed that the only good government was one that was freely formed by the people and guided by the "general will" of society—a direct democracy. Under such a government, people agree to give up some of their freedom in favor of the common good. In 1762, he explained his political philosophy in a book called *The Social Contract*.

Rousseau's view of the social contract differed greatly from that of Hobbes. For Hobbes, the social contract was an agreement between a society and its government. For Rousseau, it was an agreement among free individuals to create a society and a government.

Like Locke, Rousseau argued that legitimate government came from the consent of the governed. However, Rousseau believed in a much broader democracy than Locke had promoted. He argued that all people were equal and that titles of nobility should be abolished. Rousseau's ideas inspired many of the leaders of the French Revolution who overthrew the monarchy in 1789.

Beccaria Promotes Criminal Justice An Italian philosophe named Cesare Bonesana Beccaria (BAYK•uh•REE•ah) turned his thoughts to the justice system. He believed that laws existed to preserve social order, not to avenge crimes. Beccaria regularly criticized common abuses of justice. They included torturing of witnesses and suspects, irregular proceedings in trials, and punishments that were arbitrary or cruel. He argued that a person accused of a crime should receive a speedy trial, and that torture should never be used. Moreover, he said, the degree of punishment should be based on the seriousness of the crime. He also believed that capital punishment should be abolished.

Beccaria based his ideas about justice on the principle that governments should seek the greatest good for the greatest number of people. His ideas influenced criminal law reformers in Europe and North America.

Major Ideas of the Enlightenment

Idea	Thinker	Impact
Natural rights—life, liberty, property	Locke	Fundamental to U.S. Declaration of Independence
Separation of powers	Montesquieu	France, United States, and Latin American nations use separation of powers in new constitutions
Freedom of thought and expression	Voltaire	Guaranteed in U.S. Bill of Rights and French Declaration of the Rights of Man and Citizen; European monarchs reduce or eliminate censorship
Abolishment of torture	Beccaria	Guaranteed in U.S. Bill of Rights; torture outlawed or reduced in nations of Europe and the Americas
Religious freedom	Voltaire	Guaranteed in U.S. Bill of Rights and French Declaration of the Rights of Man and Citizen; European monarchs reduce persecution
Women's equality	Wollstonecraft	Women's rights groups form in Europe and North America


SKILLBUILDER: Interpreting Charts

- Analyzing Issues** What important documents reflect the influence of Enlightenment ideas?
- Forming Opinions** Which are the two most important Enlightenment ideas? Support your answer with reasons.

Women and the Enlightenment

The philosophes challenged many assumptions about government and society. But they often took a traditional view toward women. Rousseau, for example, developed many progressive ideas about education. However, he believed that a girl's education should mainly teach her how to be a helpful wife and mother. Other male social critics scolded women for reading novels because they thought it encouraged idleness and wickedness. Still, some male writers argued for more education for women and for women's equality in marriage.

Women writers also tried to improve the status of women. In 1694, the English writer Mary Astell published *A Serious Proposal to the Ladies*. Her book addressed the lack of educational opportunities for women. In later writings, she used Enlightenment arguments about government to criticize the unequal relationship between men and women in marriage. She wrote, "If absolute sovereignty be not necessary in a state, how comes it to be so in a family? . . . If all men are born free, how is it that all women are born slaves?"

During the 1700s, other women picked up these themes. Among the most persuasive was **Mary Wollstonecraft**, who published an essay called *A Vindication of the Rights of Woman* in 1792. In the essay, she disagreed with Rousseau that women's education should be secondary to men's. Rather, she argued that women, like men, need education to become virtuous and useful. Wollstonecraft also urged women to enter the male-dominated fields of medicine and politics. 

Women made important contributions to the Enlightenment in other ways. In Paris and other European cities, wealthy women helped spread Enlightenment ideas through social gatherings called salons, which you will read about later in this chapter.

One woman fortunate enough to receive an education in the sciences was Emilie du Châtelet (shah•tlay). Du Châtelet was an aristocrat trained as a mathematician and physicist. By translating Newton's work from Latin into French, she helped stimulate interest in science in France.

Legacy of the Enlightenment

Over a span of a few decades, Enlightenment writers challenged long-held ideas about society. They examined such principles as the divine right of monarchs, the union of church and state, and the existence of unequal social classes. They held these beliefs up to the light of reason and found them in need of reform.

The philosophes mainly lived in the world of ideas. They formed and popularized new theories. Although they encouraged reform, they were not active revolutionaries. However, their theories eventually inspired the American and French revolutions and other revolutionary movements in the 1800s. Enlightenment thinking produced three other long-term effects that helped shape Western civilization.

Belief in Progress The first effect was a belief in progress. Pioneers such as Galileo and Newton had discovered the key for unlocking the mysteries of nature in the 1500s and 1600s. With the door thus opened, the growth of scientific knowledge

History Makers



Mary Wollstonecraft
1759–1797

A strong advocate of education for women, Wollstonecraft herself received little formal schooling. She and her two sisters taught themselves by studying books at home. With her sisters, she briefly ran a school. These experiences shaped much of her thoughts about education.

Wollstonecraft eventually took a job with a London publisher. There, she met many leading radicals of the day. One of them was her future husband, the writer William Godwin. Wollstonecraft died at age 38, after giving birth to their daughter, Mary. This child, whose married name was Mary Wollstonecraft Shelley, went on to write the classic novel *Frankenstein*.

INTEGRATED TECHNOLOGY

RESEARCH LINKS For more on Mary Wollstonecraft, go to classzone.com

MAIN IDEA

Drawing Conclusions

 Why do you think the issue of education was important to both Astell and Wollstonecraft?

seemed to quicken in the 1700s. Scientists made key new discoveries in chemistry, physics, biology, and mechanics. The successes of the Scientific Revolution gave people the confidence that human reason could solve social problems. Philosophes and reformers urged an end to the practice of slavery and argued for greater social equality, as well as a more democratic style of government.

A More Secular Outlook A second outcome was the rise of a more secular, or non-religious, outlook. During the Enlightenment, people began to question openly their religious beliefs and the teachings of the church. Before the Scientific Revolution, people accepted the mysteries of the universe as the workings of God. One by one, scientists discovered that these mysteries could be explained mathematically. Newton himself was a deeply religious man, and he sought to reveal God's majesty through his work. However, his findings often caused people to change the way they thought about God.

Meanwhile, Voltaire and other critics attacked some of the beliefs and practices of organized Christianity. They wanted to rid religious faith of superstition and fear and promote tolerance of all religions.

Importance of the Individual Faith in science and in progress produced a third outcome, the rise of individualism. As people began to turn away from the church and royalty for guidance, they looked to themselves instead.

The philosophes encouraged people to use their own ability to reason in order to judge what was right or wrong. They also emphasized the importance of the individual in society. Government, they argued, was formed by individuals to promote their welfare. The British thinker Adam Smith extended the emphasis on the individual to economic thinking. He believed that individuals acting in their own self-interest created economic progress. Smith's theory is discussed in detail in Chapter 9.

During the Enlightenment, reason took center stage. The greatest minds of Europe followed each other's work with interest and often met to discuss their ideas. Some of the kings and queens of Europe were also very interested. As you will learn in Section 3, they sought to apply some of the philosophes' ideas to create progress in their countries.

SECTION

2

ASSESSMENT

TERMS & NAMES 1. For each term or name, write a sentence explaining its significance.

• Enlightenment • social contract • John Locke • philosophe • Voltaire • Montesquieu • Rousseau • Mary Wollstonecraft

USING YOUR NOTES

2. Which impact of the Enlightenment do you consider most important? Why?

Enlightenment in Europe
I. Two Views on Government

A.

B.

II. The Philosophes Advocate Reason

A.

B.

MAIN IDEAS

3. What are the natural rights with which people are born, according to John Locke?

4. Who were the philosophes and what did they advocate?

5. What was the legacy of the Enlightenment?

CRITICAL THINKING & WRITING

6. **SYNTHESIZING** Explain how the following statement reflects Enlightenment ideas: "Power should be a check to power."

7. **ANALYZING ISSUES** Why might some women have been critical of the Enlightenment?

8. **DRAWING CONCLUSIONS** Do you think the philosophes were optimistic about the future of humankind? Explain.

9. **WRITING ACTIVITY** **POWER AND AUTHORITY** Compare the views of Hobbes, Locke, and Rousseau on government. Then write one **paragraph** about how their ideas reflect their understanding of human behavior.

CONNECT TO TODAY PRESENTING AN ORAL REPORT

Identify someone considered a modern-day social critic. Explore the person's beliefs and methods and present your findings to the class in a brief **oral report**.

European Values During the Enlightenment

Writers and artists of the Enlightenment often used satire to comment on European values. Using wit and humor, they ridiculed various ideas and customs. Satire allowed artists to explore human faults in a way that is powerful but not preachy. In the two literary excerpts and the painting below, notice how the writer or artist makes his point.

A PRIMARY SOURCE

Voltaire

Voltaire wrote *Candide* (1759) to attack a philosophy called Optimism, which held that all is right with the world. The hero of the story, a young man named Candide, encounters the most awful disasters and human evils. In this passage, Candide meets a slave in South America, who explains why he is missing a leg and a hand.

“When we’re working at the sugar mill and catch our finger in the grinding-wheel, they cut off our hand. When we try to run away, they cut off a leg. I have been in both of these situations. This is the price you pay for the sugar you eat in Europe. . . .

“The Dutch fetishes [i.e., missionaries] who converted me [to Christianity] tell me every Sunday that we are all the sons of Adam, Whites and Blacks alike. I’m no genealogist, but if these preachers are right, we are all cousins born of first cousins. Well, you will grant me that you can’t treat a relative much worse than this.”

B PRIMARY SOURCE

Jonathan Swift

The narrator of *Gulliver’s Travels* (1726), an English doctor named Lemuel Gulliver, takes four disastrous voyages that leave him stranded in strange lands. In the following passage, Gulliver tries to win points with the king of Brobdingnag—a land of giants—by offering to show him how to make guns and cannons.

The king was struck with horror at the description I had given of those terrible engines. . . . He was amazed how so impotent and grovelling an insect as I (these were his expressions) could entertain such inhuman ideas, and in so familiar a manner as to appear wholly unmoved at all the scenes of blood and desolation, which I had painted as the common effects of those destructive machines; whereof, he said, some evil genius, enemy to mankind, must have been the first contriver [inventor].

C PRIMARY SOURCE

William Hogarth

The English artist William Hogarth often used satire in his paintings. In this painting, *Canvassing for Votes*, he comments on political corruption. While the candidate flirts with the ladies on the balcony, his supporters offer a man money for his vote.



Document-Based QUESTIONS

1. What is the main point that Voltaire is making in Source A? What technique does he use to reinforce his message?
2. What does the king’s reaction in Source B say about Swift’s view of Europe’s military technology?
3. Why might Hogarth’s painting in Source C be difficult for modern audiences to understand? Does this take away from his message?



The Enlightenment Spreads

MAIN IDEA

POWER AND AUTHORITY

Enlightenment ideas spread through the Western world and profoundly influenced the arts and government.

WHY IT MATTERS NOW

An “enlightened” problem-solving approach to government and society prevails in modern civilization today.

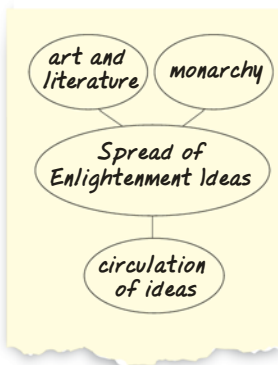
TERMS & NAMES

- salon
- baroque
- neoclassical
- enlightened despot
- Catherine the Great

SETTING THE STAGE The philosophes’ views about society often got them in trouble. In France it was illegal to criticize either the Catholic Church or the government. Many philosophes landed in jail or were exiled. Voltaire, for example, experienced both punishments. Nevertheless, the Enlightenment spread throughout Europe with the help of books, magazines, and word of mouth. In time, Enlightenment ideas influenced everything from the artistic world to the royal courts across the continent.

TAKING NOTES

Summarizing Use a web diagram to list examples of each concept related to the spread of ideas.



A World of Ideas

In the 1700s, Paris was the cultural and intellectual capital of Europe. Young people from around Europe—and also from the Americas—came to study, philosophize, and enjoy the culture of the bustling city. The brightest minds of the age gathered there. From their circles radiated the ideas of the Enlightenment.

The buzz of Enlightenment ideas was most intense in the mansions of several wealthy women of Paris. There, in their large drawing rooms, these hostesses held regular social gatherings called **salons**. At these events, philosophers, writers, artists, scientists, and other great intellects met to discuss ideas.

Diderot’s *Encyclopedia* The most influential of the salon hostesses in Voltaire’s time was Marie-Thérèse Geoffrin (zhuh•frehn). She helped finance the project of a leading philosophe named Denis Diderot (DEE•duh•ROH). Diderot created a large set of books to which many leading scholars of Europe contributed articles and essays. He called it *Encyclopedia* and began publishing the first volumes in 1751.

The Enlightenment views expressed in the articles soon angered both the French government and the Catholic Church. Their censors banned the work. They said it undermined royal authority, encouraged a spirit of revolt, and fostered “moral corruption, irreligion, and unbelief.” Nonetheless, Diderot continued publishing his *Encyclopedia*.

The salons and the *Encyclopedia* helped spread Enlightenment ideas to educated people all over Europe. Enlightenment ideas also eventually spread through newspapers, pamphlets, and even political songs. Enlightenment ideas about government and equality attracted the attention of a growing literate middle class, which could afford to buy many books and support the work of artists.

Cybercafés

These days, when people around the world gather to explore new ideas and discuss current events, many do so at Internet cafés. These are coffee shops or restaurants that also provide access to computers for a small fee.

Internet cafés originated in the United States, but today they are more popular overseas. In China, for instance, there are roughly 113,000 licensed Internet cafés; and tens of thousands of unlicensed cafés have been shut down.

Like the French in the 1700s, the Chinese recognize the power of ideas and have tried to limit their spread. Licensed Internet cafés are monitored by video, and must register customers and keep records of all websites viewed. As well, an estimated 30,000–40,000 Internet police are employed by the government to monitor and censor Internet traffic.



New Artistic Styles

The Enlightenment ideals of order and reason were reflected in the arts—music, literature, painting, and architecture.

Neoclassical Style Emerges European art of the 1600s and early 1700s had been dominated by the style called **baroque**, which was characterized by a grand, ornate design. Baroque styles could be seen in elaborate palaces such as Versailles (see page 166) and in numerous paintings.

Under the influence of the Enlightenment, styles began to change. Artists and architects worked in a simple and elegant style that borrowed ideas and themes from classical Greece and Rome. The artistic style of the late 1700s is therefore called **neoclassical** (“new classical”).

Changes in Music and Literature Music styles also changed to reflect Enlightenment ideals. The music scene in Europe had been dominated by such composers as Johann Sebastian Bach of Germany and George Friedrich Handel of England. These artists wrote dramatic organ and choral music. During the Enlightenment, a new, lighter, and more elegant style of music known as *classical* emerged. Three composers in Vienna, Austria, rank among the greatest figures of the classical period in music. They were Franz Joseph Haydn, Wolfgang Amadeus Mozart, and Ludwig van Beethoven.

Writers in the 18th century also developed new styles and forms of literature. A number of European authors began writing novels, which are lengthy works of prose fiction. Their works had carefully crafted plots, used suspense, and explored characters’ thoughts and feelings. These books were popular with a wide middle-class audience, who liked the entertaining stories written in everyday language. Writers, including many women, turned out a flood of popular novels in the 1700s.

Samuel Richardson’s *Pamela* is often considered the first true English novel. It tells the story of a young servant girl who refuses the advances of her master. Another English masterpiece, *Tom Jones*, by Henry Fielding, tells the story of an orphan who travels all over England to win the hand of his lady.

Enlightenment and Monarchy

From the salons, artists' studios, and concert halls of Europe, the Enlightenment spirit also swept through Europe's royal courts. Many philosophes, including Voltaire, believed that the best form of government was a monarchy in which the ruler respected the people's rights. The philosophes tried to convince monarchs to rule justly. Some monarchs embraced the new ideas and made reforms that reflected the Enlightenment spirit. They became known as **enlightened despots**. Despot means "absolute ruler."

The enlightened despots supported the philosophes' ideas. But they also had no intention of giving up any power. The changes they made were motivated by two desires: they wanted to make their countries stronger and their own rule more effective. The foremost of Europe's enlightened despots were Frederick II of Prussia, Holy Roman Emperor Joseph II of Austria, and Catherine the Great of Russia. **A**

Frederick the Great Frederick II, the king of Prussia from 1740 to 1786, committed himself to reforming Prussia. He granted many religious freedoms, reduced censorship, and improved education. He also reformed the justice system and abolished the use of torture. However, Frederick's changes only went so far. For example, he believed that serfdom was wrong, but he did nothing to end it since he needed the support of wealthy landowners. As a result, he never tried to change the existing social order.

Perhaps Frederick's most important contribution was his attitude toward being king. He called himself "the first servant of the state." From the beginning of his reign, he made it clear that his goal was to serve and strengthen his country. This attitude was clearly one that appealed to the philosophes.

Joseph II The most radical royal reformer was Joseph II of Austria. The son and successor of Maria Theresa, Joseph II ruled Austria from 1780 to 1790. He introduced legal reforms and freedom of the press. He also supported freedom of worship, even for Protestants, Orthodox Christians, and Jews. In his most radical reform, Joseph abolished serfdom and ordered that peasants be paid for their labor with cash. Not surprisingly, the nobles firmly resisted this change. Like many of Joseph's reforms, it was undone after his death.

Catherine the Great The ruler most admired by the philosophes was Catherine II, known as **Catherine the Great**. She ruled Russia from 1762 to 1796. The well-educated empress read the works of philosophes, and she exchanged many letters with Voltaire. She ruled with absolute authority but also sought to reform Russia.

In 1767, Catherine formed a commission to review Russia's laws. She presented it with a brilliant proposal for reforms based on the ideas of Montesquieu and Beccaria. Among other changes, she recommended allowing religious toleration and abolishing torture and capital punishment. Her commission, however, accomplished none of these lofty goals.

Catherine eventually put in place limited reforms, but she did little to improve the life of the Russian peasants. Her views about enlightened ideas changed after a massive uprising of serfs in 1773. With great brutality, Catherine's army crushed the



▲ Joseph II

MAIN IDEA

Analyzing Motives

A Why did the enlightened despots undertake reforms?

Vocabulary

Serfdom was a system in which peasants were forced to live and work on a landowner's estate.

Changing Idea: Relationship Between Ruler and State

Old Idea

The state and its citizens exist to serve the monarch. As Louis XIV reportedly said, "I am the state."

New Idea

The monarch exists to serve the state and support citizens' welfare. As Frederick the Great said, a ruler is only "the first servant of the state."

MAIN IDEA**Synthesizing**

B How accurately does the term enlightened despot describe Catherine the Great? Explain.

rebellion. Catherine had previously favored an end to serfdom. However, the revolt convinced her that she needed the nobles' support to keep her throne. Therefore, she gave the nobles absolute power over the serfs. As a result, Russian serfs lost their last traces of freedom. **B**

Catherine Expands Russia Peter the Great, who ruled Russia in the early 1700s, had fought for years to win a port on the Baltic Sea. Likewise, Catherine sought access to the Black Sea. In two wars with the Ottoman Turks, her armies finally won control of the northern shore of the Black Sea. Russia also gained the right to send ships through Ottoman-controlled straits leading from the Black Sea to the Mediterranean Sea.

Catherine also expanded her empire westward into Poland. In Poland, the king was relatively weak, and independent nobles held the most power. The three neighboring powers—Russia, Prussia, and Austria—each tried to assert their influence over the country. In 1772, these land-hungry neighbors each took a piece of Poland in what is called the First Partition of Poland. In further partitions in 1793 and 1795, they grabbed up the rest of Poland's territory. With these partitions, Poland disappeared as an independent country for more than a century.

By the end of her remarkable reign, Catherine had vastly enlarged the Russian empire. Meanwhile, as Russia was becoming an international power, another great power, Britain, faced a challenge from its North American colonies. Inspired by Enlightenment ideas, colonial leaders decided to do the unthinkable: break away from their ruling country and found an independent republic.

History Makers

Catherine the Great
1729–1796

The daughter of a minor German prince, Catherine was 15 when she was handed over to marry the Grand Duke Peter, heir to the Russian throne.

Peter was mentally unstable. Catherine viewed her husband's weakness as her chance for power. She made important friends among Russia's army officers and became known as the most intelligent and best-informed person at court. In 1762, only months after her husband became czar, Catherine had him arrested and confined. Soon afterward, Peter conveniently died, probably by murder.

SECTION**3****ASSESSMENT**

TERMS & NAMES 1. For each term or name, write a sentence explaining its significance.

- salon
- baroque
- neoclassical
- enlightened despot
- Catherine the Great

USING YOUR NOTES

2. What are two generalizations you could make about the spread of Enlightenment ideas?

**MAIN IDEAS**

3. What were the defining aspects of neoclassical art?
4. What new form of literature emerged during the 18th century and what were its main characteristics?
5. Why were several rulers in 18th century Europe known as enlightened despots?

CRITICAL THINKING & WRITING

6. **DRAWING CONCLUSIONS** What advantages did salons have over earlier forms of communication in spreading ideas?
7. **ANALYZING ISSUES** In what way were the enlightened despots less than true reformers? Cite specific examples from the text.
8. **MAKING INFERENCES** How did the *Encyclopedia* project reflect the age of Enlightenment?
9. **WRITING ACTIVITY** **POWER AND AUTHORITY** Imagine you are a public relations consultant for an enlightened despot. Write a **press release** explaining why your client is "Most Enlightened Despot of the 1700s."

INTEGRATED TECHNOLOGY INTERNET ACTIVITY

Use the Internet to find out more about a composer or writer mentioned in this section. Then write a brief **character sketch** on that artist, focusing on interesting pieces of information about his or her life.

INTERNET KEYWORDS

biography European Enlightenment