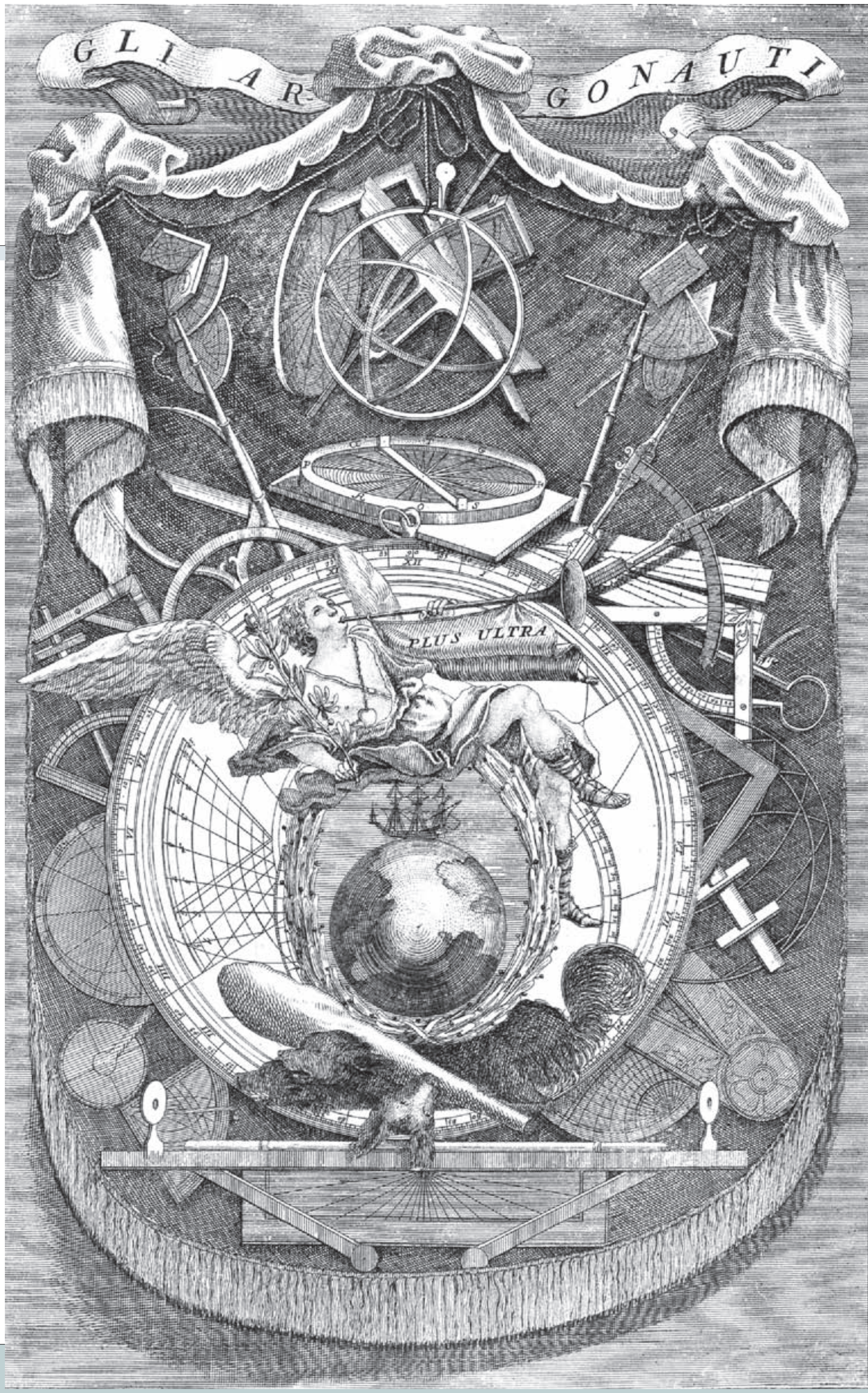


FRONTISPIECE TO MARCO VINCENZO CORONELLI'S ATLAS, 1691

In this frontispiece from an atlas, a globe and ship occupy center stage and represent the West's exploration of the world. Just above, the banner of a trumpeting angel reads, "Yet farther"—words that contrast sharply with the traditional medieval expression "No farther." Drawings of the numerous instruments that characterized the new age of exploration and science occupy the periphery of the image.

A New World of Reason and Reform

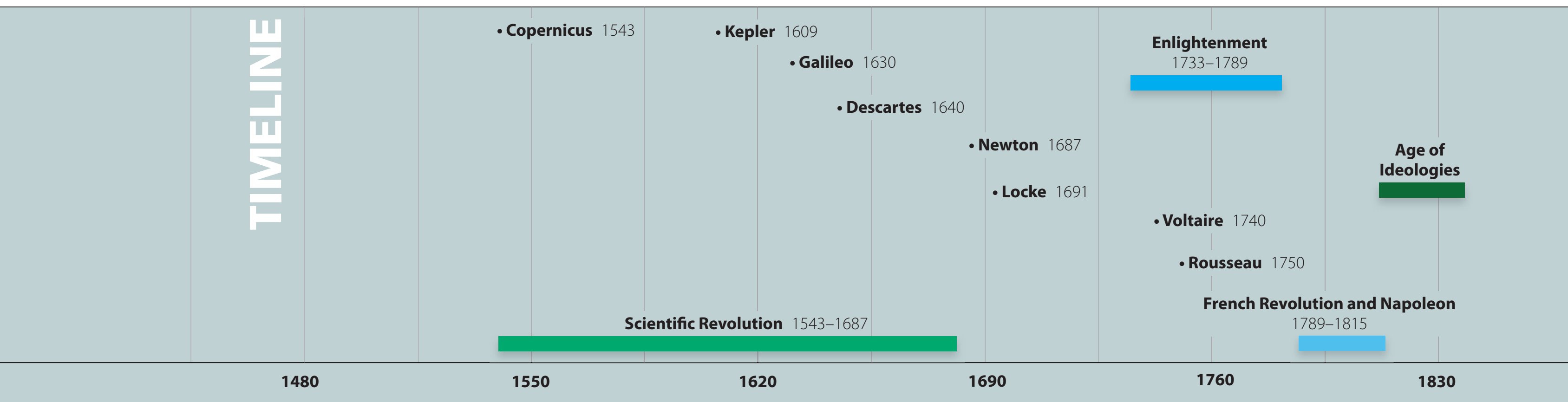
14

The Scientific Revolution and the Enlightenment, 1600–1800

In 1655, French scientist Blaise Pascal (1623–1662) retired from his studies and began recording his thoughts in writing. “Man is but a reed, the most feeble thing in nature; but he is a thinking reed,” he wrote. “All our dignity consists, then, in thought . . . by thought I comprehend the world.” Pascal’s words hint at the changes emerging in scholars’ thinking about ideas, the world, and the place of humans in it.

We can detect more clues about these changes in the artwork on page 424. The 1691 world atlas itself, published by the accomplished Venetian mapmaker and mathematician Marco Coronelli (1650–1718), echoes the overseas expansion of Europe, already two centuries old. It also reveals the underlying culture of the Renaissance, which stressed learning and exploration through reading and art. Coronelli chose this illustration to open his new atlas. With the images of a ship, the earth, and scientific instruments and the provocative phrasing “Yet farther,” he declared the end of limits to the search for knowledge. The entire illustration suggests a people proudly using science to fuel their growing power—over other peoples as well as nature itself.

Buoyed by the accumulation of scientific discoveries, this optimism about the power of thought and the search for knowledge grew and spread throughout the West during the eighteenth century. Widening circles of intellectuals and the reading public learned about the new ways of thinking being applied to all fields, from politics and religion to economics and criminology. At the heart of this movement lay a growing conviction that humans should be free to reason publicly, and that reason should determine our understanding of the world and the rules of social life. This way of thinking also stressed individualism and a strong belief in progress. Despite resistance from church and state, this dawning of what became known as the Age of Reason would gather strength, filter down through the ranks of society, and form the intellectual foundation for life in the modern West.



PREVIEW

QUESTIONING TRUTH AND AUTHORITY
Learn why the old view of the physical universe changed.

DEVELOPING A MODERN SCIENTIFIC VIEW
Study the elements of the modern scientific view.

SUPPORTING AND SPREADING SCIENCE
Trace the spread of the Scientific Revolution.

LAYING THE FOUNDATIONS FOR THE ENLIGHTENMENT
Examine the roots of the Enlightenment.

THE ENLIGHTENMENT IN FULL STRIDE
Investigate how the Enlightenment developed.

QUESTIONING TRUTH AND AUTHORITY

On June 22, 1633, the well-known Italian scientist Galileo Galilei (1564–1642) knelt in a Roman convent before the cardinals who served as judges of the Inquisition. The cardinals informed Galileo that he was "vehemently suspected of heresy." They also showed him the customary instruments of torture, though they did not use them. Next, they ordered him to deny "the false opinion that the sun is the center of the universe and immovable, and that the earth is not the center of the same"—views that Galileo had supported in a book he published the previous year. Threatened with being tried and burned as a heretic, Galileo had to denounce his views as heresy. The court and papacy sentenced Galileo to house arrest in Florence for the rest of his life and forbade him to publish on the topic again. Nevertheless, Galileo would not change his mind. The sequence of events leading to Galileo's trial and conviction is a story of its own, but the conflict lay at the core of a major development of the age: the Scientific Revolution.

Reasoning and Technology: East and West

The West was not unique in reasoning about the world. In the centuries preceding Europe's Renaissance, the Chinese had made many scholarly and scientific advances. Paper, movable type, gunpowder, the compass, and the blast furnace were Chinese inventions, as were important improvements in ship and canal building. The Arabs not only had prized learning and science but also had provided Europeans with tools such as translations of Greek science and Arabic numerals that were essential for Europe's scientists. On the other hand, by the sixteenth century most European scientists had university educations, whereas non-Western civilizations lacked institutions comparable to the medieval universities in places such as Bologna, Paris, and Oxford. Moreover, during the seventeenth and eighteenth centuries, the Islamic, Chinese, Japanese, and other civilizations of the world declined to question their traditional ways. Only Westerners challenged the standard assumptions of their civilization. The power and attitudes that the West gained from this intellectual exploration helped redefine Western civilization and distinguish it from the non-Western world.

The Old View

Until the sixteenth century, most European scholars shared the standard medieval understanding of the physical nature of the earth and the universe. This understanding was based on a long legacy stretching back to the views of the fourth-century B.C.E. Greek philosopher Aristotle. His ideas had been modified in the second century C.E. by Ptolemy of Alexandria and then passed on through Byzantine and Arab scholars to medieval European thinkers. After the thirteenth century, Europeans translated Aristotle's works into Latin and merged his thinking with Christian ideas about the universe.

The earth-centered universe

According to this Christian medieval understanding, illustrated in the woodcut in **Figure 14.1,** the earth

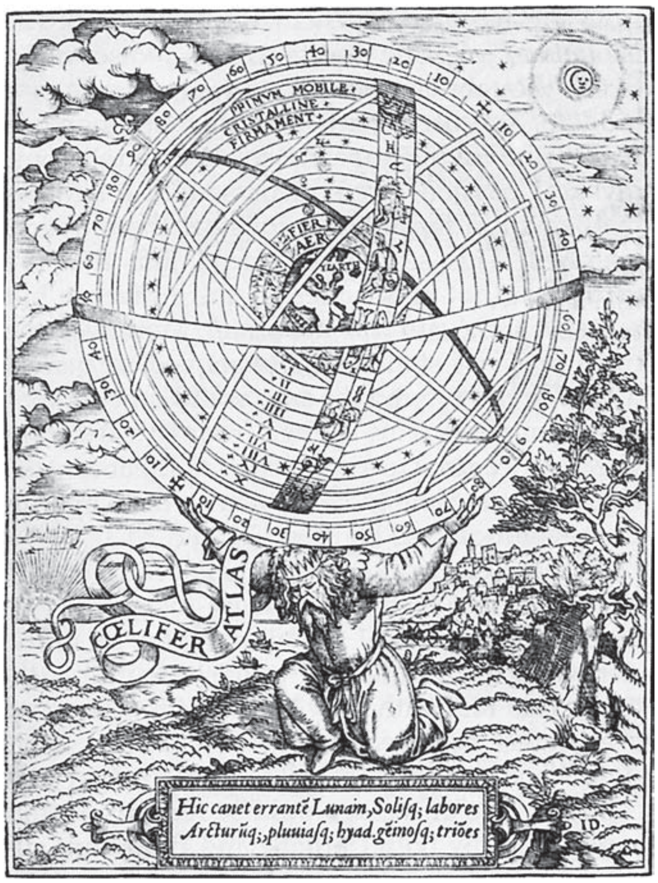


FIGURE 14.1 The Medieval View of the Universe, 1559
This woodcut shows the earth at the center of a stable, finite universe. A band with signs of the zodiac suggests the importance of astrology within this Christian understanding.

rested at the center of an unchanging universe. Around it in ascending order rose the perfect spheres of air, fire, the sun, the planets, and the stars (the firmament), with God (the prime mover) just beyond. The signs of the zodiac are recorded on one band in the illustration, revealing the importance of astrology. Westerners accounted for the succession of day and night by explaining that this finite universe rotated in precise circles around the earth once every twenty-four hours. The heavenly abode of angels consisted of pure matter, and the earthly home of humans was made of changeable, corrupt matter. This universe was clear, finite, and satisfyingly focused on the earthly center of God's concern.

Common sense supported this worldview. A glance at the sky confirmed that the sun and stars indeed circled around the earth each day. Under foot, the earth felt motionless. To careful observers, the motion of planets, whose position often changed, was more perplexing. To explain this mystery, Ptolemy and others had modified their theories, concluding that planets moved in small, individual orbits as they traveled predictably around the earth. People had lived by the wisdom of the ancients and authoritative interpretations of the Bible for centuries. Accordingly, investigation of the physical universe generally consisted of making deductions from these long-accepted guides.

Undermining the Old View

During the fifteenth and sixteenth centuries, new problems began undermining this traditional view. Authorities of all kinds—including Aristotle—came into question during the Renaissance. Some of this questioning stemmed from the Renaissance search for classical writings, which led scholars to discover and read the works of Greek authorities who contradicted Aristotle. **Neoplatonism,** based on the ideas of Plato, stressed the belief that one should search beyond appearances for true knowledge; truth about both nature and God could be found in abstract reasoning and be best expressed by mathematics. Neoplatonic **Hermetic doctrine** provided especially powerful alternatives to Aristotelian thought.

According to Hermetic doctrine, based on writings mistakenly attributed to Hermes Trismegistus (supposedly an ancient Egyptian priest), all matter contained the divine spirit, which humans ought to seek to understand. Among many scholars, this doctrine stimulated intense interest in botany, chemistry, metallurgy, and other studies that promised to help people unlock the secrets of nature. The Hermetic approach also held that mathematical harmonies helped explain the divine spirit and represented a crucial pathway to understanding God's physical world. This approach encouraged scholars to use mathematics and to measure, map, and quantify nature. Moreover, Hermetic doctrine also held that the sun was the most important agency for transmission of the divine spirit and thus rightly occupied the center of the universe. Finally, these beliefs fostered the idea of the natural magician who could unleash the powers of nature through alchemy (the study of how to purify and transform metals, such as turning common minerals into gold), astrology (the study of how stars affect people), and magic. Scholars often saw no distinction between seeking to understand the harmony, oneness, and spiritual aspects of the natural world and what we would call scientific observation and experimentation. Although Hermetic doctrine often proved not useful, all these ideas encouraged investigators to question traditionally accepted knowledge.

Hermetic doctrine

Figure 14.2, an illustration from a book on alchemy by the German Heinrich Khunrath, shows these close connections between spiritual beliefs and the "science" or "Hermetic art" of alchemy. At the left, the author prays in a small chapel. Lettering on the drapery of the chapel states, "When we attend strictly to our work, God himself will help us." At the center, musical instruments and a pair of scales rest on a table, representing the links among music, harmony, and numbers so characteristic in alchemy.

FIGURE 14.2 Heinrich Khunrath, *The Laboratory and the Chapel,* 1609
Amid the tools of his trade, an alchemist prays in a small chapel. This seventeenth-century illustration reveals the close connections between spiritual beliefs and alchemy.

The inscription on the table reads, "Sacred music disperses sadness in evil spirits." On the floor lie containers and other apparatus used to mix materials, and at the upper right are flasks and other storage containers.

In addition to new ideas and beliefs, geographic exploration during the Renaissance also upset traditional assumptions. The discovery of the New World, for example, disproved Ptolemaic geography. Furthermore, overseas voyages stimulated demand for new instruments and precise measurements for navigation. This demand, in turn, encouraged research, especially in astronomy and mathematics.

Exploration

Finally, the recently invented printing press enabled even out-of-favor scholars to publish their findings, which spread new ideas and discoveries even further. Renaissance rulers supported all these efforts in hopes of gaining prestige as well as practical tools for war, construction, and mining. Church authorities did the same at times, especially backing research in astronomy in the hopes of improving the calendar to date Easter more accurately.

The printing press

Like the Renaissance, the Reformation unleashed forces that provoked the questioning of long-held views. Most researchers had religious motives for their work, though those motives were not necessarily grounded in tradition. In particular, they yearned for insights into the perfection of God's universe. As we read in Chapter 11, the Reformation shattered confidence in religious authorities. By upsetting hallowed certainties, sixteenth- and seventeenth-century scholars hoped to establish new, even sounder certainties and thereby regain a sense of mastery over nature.

DEVELOPING A MODERN SCIENTIFIC VIEW

Even with these rumblings of change, no sudden breakthrough cleared away the centuries-old understanding of nature. Most scientific work still proceeded slowly, as did scholarly and public acceptance of its findings. Investigators had to demonstrate the effectiveness of their new methods again and again to convince even their colleagues. Indeed, few scholars suggested a wholesale rejection of traditional authorities; most simply chipped away at old notions. By the end of the seventeenth century, however, an entirely new scientific view of reality, initiated by just a handful of scholars, had replaced the traditional view. To understand this startling shift, we need to trace developments in astronomy, physics, and scientific methodology.

Astronomy and Physics: From Copernicus to Newton

During the sixteenth and seventeenth centuries, astronomy and physics attracted the most systematic attention from scholars. Researchers in these fields became particularly dissatisfied with the inability of Aristotelian theory to explain, simply and efficiently, careful observations and mathematical calculations of the stars. The Ptolemaic system for predicting planetary movements seemed overly complex and cumbersome to these scholars. Their findings would dramatically alter Westerners' perceptions of nature and of the earth's place in the universe. As the English poet John Donne complained in 1611, "New philosophy calls all in doubt."

Nicolaus Copernicus (1473–1543), a Polish clergyman with an interest in astronomy, astrology, mathematics, and church law, took the first steps in this intellectual adventure. Like so many other northern European scholars, he crossed the Alps to study in an Italian university. There he became influenced by the rediscovery of Greek scholarship, Neoplatonism, and the Hermetic doctrine. Copernicus sought a simpler mathematical formulation to explain how the universe operated. His search convinced him that the earth was *not* at the center of the universe. Instead, he believed that the sun "sits upon a royal throne" in that location, "ruling his children, the planets which circle around him." Moreover, Copernicus concluded that the earth was not stationary: "What appears to be a motion of the sun is in truth a motion of the earth." According to Copernicus, the earth moved in perfect, "divine" circles around the sun, as did other bodies in the universe. Day passed into night because the earth turned on its axis. **Figure 14.3** shows this view of the universe. At the center is the sun, circled by the earth (showing night and day) and the other planets (note Jupiter and its moons on the right). The signs of the zodiac are on the outer band, suggesting continuing beliefs in astrology. The figure on the lower right, holding a globe and a scientific instrument, is Copernicus. This change from an earth-centered (geocentric) to a sun-centered (heliocentric) universe would become known as the **Copernican revolution.**

Nicolaus Copernicus

Copernicus worked on his **heliocentric model** of the universe for almost twenty-five years. However, fearing ridicule and disapproval from the clergy, he waited until 1543—what became the year of his death—to publish it. Few people outside a limited circle of scholars knew of his views, and even fewer accepted them. Nevertheless, Catholic and Protestant authorities who were wedded to the earth-centered system soon recognized the threat to the Christian conception of the universe that these ideas represented. They denounced

FIGURE 14.3 Andrea Cellarius, *The Copernican System,* 1661
This page from Cellarius's *Celestian Atlas* shows the "Copernican System of Planets," with the sun at the center of the universe and the planets circling around it.

the Copernican system as illogical, unbiblical, and unsettling to the Christian faith. One Protestant associate of Martin Luther complained that "certain men . . . have concluded that the earth moves. . . . It is want of honesty and decency to assert such notions publicly. . . . It is part of a good mind to accept the truth as revealed by God and to acquiesce in it."

Still, Copernicus's thinking had some supporters. An Italian monk, Giordano Bruno (1548–1600), tested Catholic authorities by openly teaching and extending Copernican thought, arguing that "the universe is entirely infinite because it has neither edge, limit, nor surfaces." Bruno also professed a series of unusual religious notions. Outraged, the Catholic Inquisition burned Bruno at the stake. Nevertheless, Copernicus's views began to influence other scholars who were investigating the physical nature of the universe.

Tycho Brahe

The Danish aristocrat Tycho Brahe (1546–1601) did not share Copernicus's belief in a heliocentric universe, nor did he grasp the sophisticated mathematics of the day. Still, he became the next most important astronomer of the sixteenth century. He persuaded the king of Denmark to build for him the most advanced astronomy laboratory in Europe. There he recorded thousands of unusually accurate, detailed observations about the planets and stars over a period of twenty years—all without a telescope. His discoveries of a new star in 1572 and a comet in 1577 undermined the Aristotelian belief in a sky of fixed, unalterable stars moving in crystalline spheres. Although Brahe mistakenly concluded that some planets revolved around the sun, which itself moved around the earth, other astronomers with better understandings of mathematics would use his observations to draw very different conclusions.

Johannes Kepler

Tycho Brahe's assistant, Johannes Kepler (1571–1630), built on Brahe's observations to support the Copernican heliocentric theory. A German Lutheran from an aristocratic family, Kepler—like other Hermetic scholars—believed in an underlying mathematical harmony of mystical significance to the physical universe. He sought one harmony that would fit with Brahe's observations. Between 1609 and 1619, he announced his most important findings: the three laws of planetary motion. After determining the first law—which stated that the planets moved in ellipses around the sun—he excitedly wrote, "It was as if I had awakened from a sleep." The second law declared that the planets' velocity varied according to their distance from the sun. The third law concluded that the physical relationship between the moving planets could be expressed mathematically. Kepler thus showed "that the celestial machine . . . is the likeness of [a] clock," further undermining the Aristotelian view and extending the Copernican revolution.

Galileo Galilei

Document 14.1 reveals that in 1597, Kepler responded to a letter from Galileo Galilei, the Italian astronomer, physicist, and mathematician discussed at the beginning of this chapter. Although Galileo expressed a reluctance to publicize his beliefs in Copernican ideas, Kepler encouraged him to take the risk. "Be of good cheer, Galileo, and appear in public. If I am not mistaken there are only a few among the distinguished mathematicians of Europe who would dissociate themselves from us. So great is the power of truth."

Galileo already believed that the world could be described in purely mathematical terms. "Philosophy," he wrote, "is written in this grand book, the universe, which stands continually open to our gaze. . . . It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it. . . ." Galileo also felt that harmonies could be discovered through experimentation and mathematics. By conducting controlled experiments such as rolling balls down inclines, he demonstrated how motion could be described mathematically. He rejected the old view that objects in their natural state were at rest and that all motion needed a purpose. Instead, he formulated the principle of inertia, showing that bodies, once set into motion, will tend to stay in motion. He thus overturned Aristotelian ideas and established rules for experimental physics.

Galileo, hearing about the recent invention of the telescope, then studied the skies through a telescope

thinking about sources
DOCUMENTS

DOCUMENT 14.1

Kepler and Galileo Exchange Letters About Science

Many leading European scholars of the Scientific Revolution feared publishing their views, which were often unpopular with religious authorities. Such scholars sometimes turned to each other for support, as the following late-sixteenth-century letters between Kepler and Galileo suggest. Here the two men discuss their beliefs in Copernican theory.

Galileo to Kepler: "Like you, I accepted the Copernican position several years ago. I have written up many reasons on the subject, but have not dared until now to bring them into the open. I would dare publish my thoughts if there were many like you; but, since there are not, I shall forbear."

Kepler's Reply: "I could only have wished that you, who have so profound an insight, would choose another way. You advise us to retreat before the general ignorance and not to expose ourselves to the violent attacks of the mob of scholars. But after a tremendous task has been begun in our time, first by Copernicus and then by many very learned mathematicians, and when the assertion that the Earth moves can no longer be considered something new, would it not be much better to pull the wagon to its goal by our joint efforts, now that we have got it under way, and gradually, with powerful voices, to shout down the common herd? Be of good cheer, Galileo, and come out publicly! If I judge correctly, there are only a few of the distinguished mathematicians of Europe who would part company with us, so great is the power of truth. If Italy seems a less favorable place for your publication, perhaps Germany will allow us this freedom."

FROM: Giorgio de Santillana, *The Crime of Galileo* (Chicago: University of Chicago Press, 1955), pp. 11, 14–15.

Analyze the Source

1. Why is Galileo reluctant to publish his views on the Copernican position?
2. In what ways does Kepler's reply suggest that the Scientific Revolution was already a growing movement by the end of the sixteenth century?

that he built in 1609 out of a long tube and magnifying lenses. He saw that the moon's surface, instead of being a perfect heavenly body, was rugged (like the earth's), with craters and mountains indicated by lines and shading. The telescope also revealed that Jupiter had moons and that the sun had spots. These observations confirmed the view that other heavenly bodies besides the earth were imperfect and further convinced him of the validity of Copernicus's hypothesis. For years, Galileo had feared the disapproval of the Catholic Church. Now, however, he was ready to publicly argue that "in discussions of physical problems we ought to begin not from the authority of scriptural passages, but from sense-experiences and necessary demonstrations." Galileo published his findings in 1610.

Six years later, the church attacked his proposition that "the earth is not the center of the world nor immovable, but moves as a whole, and also with a daily motion." This statement, the church said, was "foolish and absurd philosophically, and formally heretical." To back up its claim, the church cited the authority of both the Bible and itself. For the next several years, Galileo kept his thoughts to himself. In 1632, believing that the church might be more open, he decided again to present his views. To avoid challenging the church, he submitted his book to the official church censors and agreed to some changes they demanded. Finally he published his *Dialogue on the Two Chief Systems of the World*—in Italian rather than the less-accessible Latin. This text advocated Copernicanism, portrayed opponents of the Copernican system (such as the Jesuits) as simpletons, and brought Galileo directly into public conflict with conservative forces in the Catholic Church. Because Galileo could show that his book had already been approved by church officials, prosecutors had to use questionable evidence against him. **Figure 14.4**, painted by an anonymous artist, shows Galileo, wearing a black suit and hat, sitting alone facing church officials. Behind him a man records the trial, while surrounding them are observers—some members of the clergy, others laypeople. In the lower left, two men discuss or argue the issues being decided within; above them some members of the audience look out toward the viewers and the greater world. As we saw at the beginning of the chapter, the Roman Inquisition ultimately forced Galileo to renounce his views.

News of Galileo's sensational trial spread throughout Europe, as did fear of publishing other radical views. Soon, however, his book was translated and published elsewhere in Europe, and his views began to win acceptance by other scientists. Even though Galileo admitted that the new science was beyond the grasp of "the shallow minds of the common people," he effectively communicated its ideas to his peers. By the time of his death in 1642, Europe's intellectual elite had begun to embrace the Copernican outlook.

Isaac Newton

In England, Isaac Newton (1642–1727) picked up the trail blazed by Copernicus, Brahe, Kepler, and Galileo. Late in life, Newton described his career modestly: "I do

DOCUMENT 14.2

Isaac Newton: God in a Scientific Universe

Like Galileo and Descartes, Newton was well aware that his ideas had profound implications for theology. His views, he realized, might even be considered contrary to religious doctrine. Yet Newton was a deeply spiritual man and took pains to distinguish the appropriate realms of science and religion. In the following selection from Opticks (1704), his analysis of light, Newton emphasizes that his ideas and systems still allow room for God in the universe.

All these things being consider'd, it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the End for which he form'd them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear or break in pieces; no ordinary Power being able to divide what God himself made one in the first Creation. . . .

It seems to me farther, that these Particles have not only a *Vis inertiae,* accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active Principles, such as is that of Gravity, and that which cause Fermentation, and the Cohesion of Bodies. These Principles I consider, not as occult Qualities, supposed to result from the specifick Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd; their Truth appearing to us by Phaenomena, though their Causes be not yet discover'd. . . .

Now by the help of these Principles, all material Things seem to have been composed of the hard and solid Particles above-mention'd, variously associated in the first Creation by the Counsel of an intelligent Agent. For it became him who created them to set them in order. And if he did not, it's unphilosophical to seek for any other Origin of the World, or to pretend that it might arise out of a Chaos by the mere Laws of Nature; though being once form'd, it may continue by those Laws for many Ages.

FROM: Sir Isaac Newton, *Opticks,* 4th ed. (London, 1730), pp. 400–402.

Analyze the Source

1. What is Newton's view of God's role in the universe?
2. What objections might scientists today have to these ideas?

not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me." Newton may have held himself in humble regard, but his accomplishments were astonishing.

In 1661, Newton entered Cambridge University, where he studied the ideas of Copernicus and Galileo as well as the advantages of scientific investigation. He distinguished himself enough in mathematics to be chosen to stay on as a professor after his graduation. Like most other figures of the Scientific Revolution, Newton was profoundly religious and, as indicated by Document 14.2, hoped to harmonize his Christian beliefs with the principles of science. He also believed in alchemy and elements of Hermeticism.

FIGURE 14.4 Anonymous, *Trial of Galileo Before the Inquisition*
In 1632, Galileo came into conflict with conservative forces in the Catholic Church over his Copernican views. In this painting by an anonymous artist, Galileo sits facing the church officials who will judge him.

Starting in his early 20s, Newton made some of the most important discoveries in the history of science. He developed calculus and investigated the nature of light; he also formulated and mathematically described three laws of motion: inertia, acceleration, and action/reaction. Yet he is best known for discovering the law of universal attraction, or gravitation. After working on the concept for years, he finally published it in 1687 in his great work *Principia (The Mathematical Principles of Natural Knowledge).* In the book, he stated the law

Newton's Principia

with simplicity and precision: "Every particle of matter in the universe attracts every other particle with a force varying inversely as the square of the distance between them and directly proportional to the product of their masses." In his view, this law applied equally to all objects, from the most massive planet to a small apple falling from a tree.

Newton had managed to synthesize the new findings in astronomy and physics into a systematic explanation of physical laws that applied to the earth as well as the heavens. This Newtonian universe was infinite and had no center. Uniform and mathematically describable, it was held together by explainable forces and was atomic in nature. Essentially, everything in the universe consisted of only one thing: matter in motion.

The Revolution Spreads: Medicine, Anatomy, and Chemistry

Although astronomy and physics led the way in dramatic scientific findings, researchers in other fields made important discoveries as well. Many of these advances also had roots in the sixteenth century. For example, several scholars developed new ideas in the related fields of medicine, anatomy, and chemistry.

Paracelsus

In medicine, a flamboyant Swiss alchemist-physician known as Paracelsus (1493–1541) strongly influenced the healing arts. A believer in Hermetic doctrine, Paracelsus openly opposed medical orthodoxy and taught that healers should look for truth not in libraries ("the more learned, the more perverted," he warned) but in the Book of Nature. "I have not been ashamed to learn from tramps, butchers, and barbers," he boasted. As a teacher and wandering practitioner, he treated patients, experimented with chemicals, recorded his observations, and developed new theories. Paracelsus concluded that all matter was composed of salt, sulfur, and mercury—not the traditional earth, water, fire, and air. Rejecting the standard view that an imbalance in the humors of the body caused disease, he instead looked to specific chemical imbalances to explain what caused each illness. He also encouraged research and experimentation to find natural remedies for bodily disorders, such as administering mercury or arsenic at astrologically correct moments. Though rejected by most established physicians, Paracelsus's ideas became particularly popular among common practitioners and would later influence the study of chemistry.

Andreas Vesalius

Other researchers founded the modern science of anatomy. In the sixteenth century, Andreas Vesalius (1514–1564), a Fleming living in Italy, wrote the first comprehensive textbook on the structure of the human body based on careful observation. **Figure 14.5**

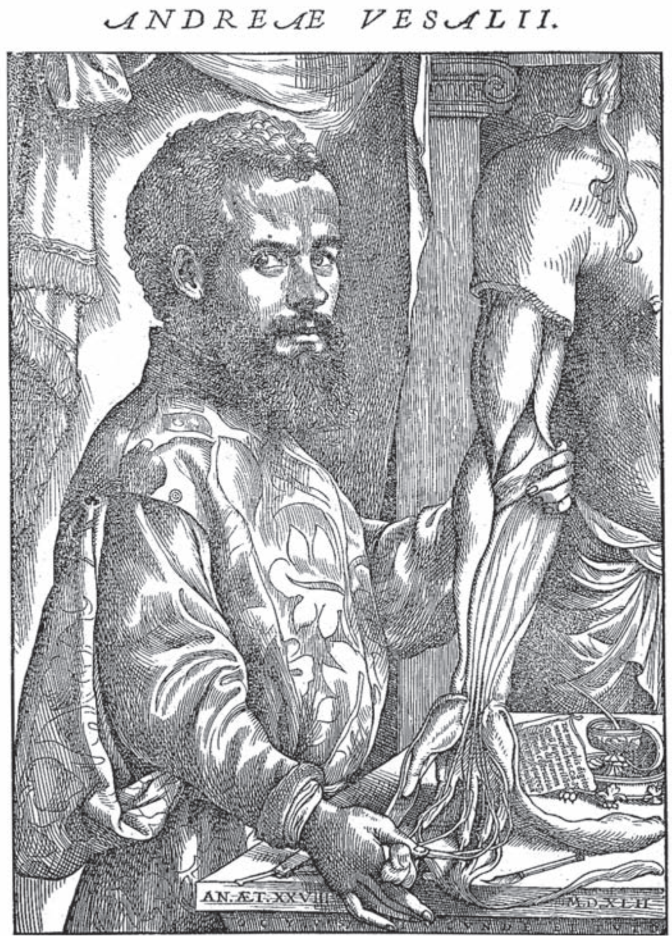


FIGURE 14.5 Andreas Vesalius, from *On the Fabric of the Human Body,* 1543
Vesalius looks boldly out at the viewer while displaying one of his studies of human anatomy.

shows the 28-year-old Vesalius displaying one of his studies on human anatomy from his 1543 treatise, *On the Fabric of the Human Body.* This figure is one of more than two hundred woodcut illustrations showing the composition of the body, stage by stage. Vesalius himself dissected cadavers, as suggested by the scalpel resting on the table. A notable aspect of this illustration is that Vesalius boldly looks the viewer in the eye, perhaps to challenge directly the old, authoritative assumptions about human anatomy. Nevertheless, his dissections of human bodies brought him into conflict with traditional physicians and scholars. Disgusted, he finally gave up his scientific studies and became the personal physician to Emperor Charles V.

Despite relentless criticism, other scholars continued anatomical research. A line from a poem written for the opening of the Amsterdam Anatomical Theatre in the early seventeenth century reflects the sense that this research needed special justification: "Evil doers who while living have done damage are of benefit after

William Harvey

their death." In other words, the body parts of criminals "afford a lesson to you, the Living." The most important of these researchers was William Harvey (1578–1657), an Englishman who, like Vesalius, studied at the University of Padua in Italy. Harvey dissected hundreds of animals, including dogs, pigs, lobsters, shrimp, and snakes. He discovered that the human heart worked like a pump, with valves that allowed blood to circulate through the body: "The movement of the blood occurs constantly in a circular manner and is the result of the beating of the heart." Yet, despite this mechanistic view, he also considered the heart the physical and spiritual center of life—in his words, "the sovereign of everything."

By the seventeenth century, anatomists and others benefited from several newly invented scientific instruments, such as the microscope. Anton van Leeuwenhoek (1632–1723), a Dutchman, became the chief pioneer in the use of this instrument. In observations during the 1670s, he described seeing "little animals or animalcules" in water from a lake. "It was wonderful to see: and I judge that some of these little creatures were above a thousand times smaller than the smallest ones I have ever yet seen, upon the rind of cheese, in wheaten flour, mould and the like." Leeuwenhoek discovered what would later be identified as bacteria in his own saliva: "little eels or worms, lying all huddled up together and wriggling. . . . This was for me, among all the marvels that I have discovered in nature, the most marvellous of all."

Anton van Leeuwenhoek

Around this same time, Robert Boyle (1627–1691), an Irish nobleman particularly interested in medical chemistry, helped lay the foundations for modern chemistry. Drawing inspiration from Paracelsus, Boyle attacked many assumptions inherited from the ancients and began a systematic search for the basic elements of matter. Relying on the experimental method and using new instruments, he argued that all matter was composed of indestructible atoms that behaved in predictable ways. Boyle also discovered a law—which still bears his name—that governs the pressure of gases. His exacting procedures set a standard for the scientific practice of chemistry.

Robert Boyle

The Methodology of Science Emerges

The scientists who challenged traditional views in their fields also used new methods of discovery—of uncovering how things worked and of determining "truth." Indeed, this innovative methodology lay at the heart of the Scientific Revolution. Earlier techniques for ascertaining the truth—by referring to long-trusted authorities and making deductions from their propositions—became unacceptable to the new scientists. They instead emphasized systematic skepticism, experimentation, and reasoning based solely on observed facts and mathematical laws. The two most important philosophers of this methodology were Francis Bacon and René Descartes.

Francis Bacon (1561–1626), an English politician who was once lord chancellor of England under James I, took a passionate interest in the new science. He rejected reliance on ancient authorities and advocated the collection of data without preconceived notions. From such data, he explained, scientific conclusions could be reached through inductive reasoning—drawing general conclusions from particular concrete observations. "Deriv[ing] axioms from . . . particulars, rising by gradual and unbroken ascent, so that it arrives at the most general axioms of all. This is the true way," he proclaimed. In addition, Bacon argued that scientific knowledge would be useful knowledge: "I am laboring to lay the foundation not of any sect or doctrine, but of human utility and power." He believed that science would benefit commerce and industry and improve the human condition by giving people unprecedented power over their environment.

Francis Bacon

Figure 14.6, the title page from Bacon's 1620 book, *New Instrument*, graphically depicts these views. The illustration shows a ship of discovery sailing out from the western end of the Mediterranean Sea into the unknown. Below is the quotation "Many shall venture forth and science shall be increased." Here is an optimistic assertion that knowledge is limitless and that science constitutes a voyage of discovery—a view that would be echoed again and again, as we saw in the picture at the beginning of this chapter. As **Figure 14.6** suggests, Bacon thus became a noted propagandist for the new science as well as a proponent of the **empirical method.**

Despite his brilliance, Bacon did not have a thorough understanding of mathematics and the role it could play in the new science. His contemporary René Descartes (1596–1650) would be the one to excel in this arena. Born in France, Descartes received training in scholastic philosophy and mathematics at one of France's best Jesuit schools and took a degree in law. He entered military service and served during the Thirty Years' War. During his travels, he met a Dutch mathematician and became interested in the new science. An ecstatic experience in 1619 convinced him to commit to a life of the mind. He spent his most productive years as a mathematician, physicist, and metaphysical philosopher in Holland. In 1637, he published his philosophy and scientific methodology in the *Discourse on Method*—in French, not Latin. The book presented an eloquent defense of skepticism and of abstract **deductive reasoning**—deriving conclusions that logically flowed from a

René Descartes

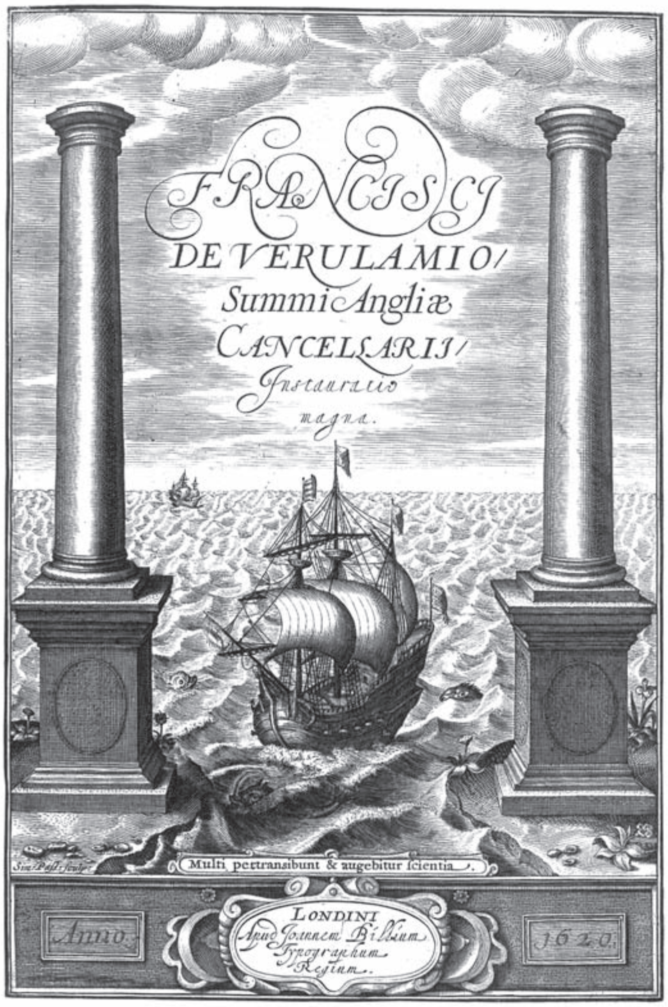


FIGURE 14.6 The New Science
The title page of Francis Bacon's book *New Instrument* (1620) asserts optimistically that science is like a voyage of discovery with almost limitless potential.

premise. "Inquiries should be directed, not to what others have thought, nor to what we ourselves conjecture, but to what we can clearly and perspicuously behold and with certainty deduce; for knowledge is not won in any other way."

Descartes questioned all forms of authority, no matter how venerable—be it Aristotle or even the Bible. He tried to remove systematically all assumptions about knowledge and advocated doubting the senses, which he claimed could be deceptive. Taken to its logical conclusion, his argument left him with one God-given experiential fact—that he was thinking. "I think, therefore I am" became his starting point. From there he followed a rigorous process of deductive reasoning to draw a variety of conclusions, including the existence of God and the physical world. He argued that there were two kinds of reality: mind, or subjective thinking and experiencing; and body, or objective physical matter. According to this philosophy, known as **Cartesian dualism,** the objective physical universe could be understood in terms of extension (matter occupying space) and motion (matter in motion). "Give me extension and motion," vowed Descartes, "and I will create the universe." He considered the body nothing more than "an earthen machine." In his opinion, only the mind was exempt from mechanical laws.

Descartes emphasized the power of the detached, reasoning individual mind to discover truths about nature. Unlike Bacon, he put his faith in mathematical reasoning, not in empirical investigation. By challenging all established authority, by accepting as truth only what could be known by reason, and by assuming a purely mechanical physical universe, Descartes established a philosophy and methodology that became the core of the new science.

KEY DATES

THE SCIENTIFIC REVOLUTION

1543	Copernicus's heliocentric model published
1543	Vesalius, *On the Fabric of the Human Body*
1609–1619	Kepler, three laws of planetary motion
1620	Bacon, *New Instrument*
1633	Trial of Galileo
1637	Descartes, *Discourse on Method*
1662	English Royal Society founded
1687	Newton, *Principia*
1690	Locke, *Essay Concerning Human Understanding*
1697	Bayle, *Historical and Critical Dictionary*

SUPPORTING AND SPREADING SCIENCE

Only a small group of people actually participated in the **Scientific Revolution.** Of these, a handful of women managed to overcome barriers to take part as patrons for scientists or as scientists themselves. Men ignored or discounted their work, and scientific societies usually excluded them. The few women engaged in science, such as the naturalist Maria Sibylla Merian (see Biography, page 383) and the Germany astronomer Maria Winkelmann (1647–1717), had to rely on their own resources or work in collaboration with their husbands.

Few scientific scholars—whether male or female—got far without calling on a network of peers and soliciting the support of wealthy patrons. To spread their ideas, these scientists needed to publish their works, interact with like-minded colleagues, and gain the backing of prestigious elites. Fortunately for them, these elites were eager to comply.

Courts and Salons

Governments and wealthy aristocrats served as benefactors and employers of scientists. Kepler, for example, received help from the imperial court, serving in Bohemia as Rudolf II's official mathematician. Galileo became court mathematician to Cosimo de' Medici in Tuscany. Vesalius served as physician to Holy Roman Emperor Charles V, and Harvey as royal physician in England.

Queen Christina of Sweden, like several other monarchs, invited scholars and artists to her court. **Figure 14.7** shows her in 1649 with the French philosopher and mathematician René Descartes (on the right, pointing to papers). Books, papers, and instruments attest to the importance of the new science at this meeting. In this Protestant country, the religious figure on the far right seems to indicate that there is little conflict between science and religion. The artist portrays Christina, a deeply religious person (who would later become a Catholic), as an interested and gracious benefactor helping to bring to light scientific findings.

Rulers had their own motives—namely, practicality and prestige—for assisting scholars and scientists. Royals especially hoped that scholarship and scientific inquiry would yield discoveries that would enhance the strength and prosperity of the state. For example, they sought experts in building projects, armaments, mapmaking, navigation, and mining. They also tried to burnish their own reputations as powerful, educated people by patronizing scholarship, science, and the arts. In this way, support of science became a supposed hallmark of good government. Enticed by this assistance, learned people gathered at royal courts, which gradually filled rooms with new tools, machines, exotic plants and animals, and books.

Beyond the court, people formed private salons and local academies where those interested in science could meet. In the 1540s, the first academy for scientific study was established, in Naples. Women ran several important salons where scientists discussed their findings along with literature, art, and politics. Some scientists even found benefactors at these meetings.

FIGURE 14.7 Queen Christina and Descartes
The Swedish queen Christina displays her support of science in this depiction of a 1649 meeting with the French philosopher René Descartes.

The Rise of Royal Societies

During the second half of the seventeenth century, central governments stepped up their support of scientific experimentation, publications, and academies. In 1662, for example, Charles II chartered the Royal Society in England; four years later, Louis XIV's finance minister, Jean-Baptiste Colbert, founded the Académie des Sciences in France. These organizations, and others patterned after them, furnished laboratories, granted subsidies, brought scientists together to exchange ideas, published their findings, and honored scientific achievements. This governmental support of science added to the growing prestige of science and the scientific community.

Religion and the New Science

Religious organizations played a mixed role in the spread of the new science. Traditionally, the Catholic Church supported scholarship and learning in general, including, in natural science. Moreover, religious orders staffed most universities, and many key figures of the Scientific Revolution held university positions. Numerous leading scholars also felt a profound sense of spirituality. Copernicus, for example, who dedicated his work to the pope, was a cleric, as were many other natural scientists. Although we may be tempted to assume that the skepticism inherent in the scientific method would lead to atheism, the great scientists attacked neither faith nor established religion. Nor were they dispassionate investigators holding themselves apart from the spiritual nature of their age. They often believed in magic, ghosts, and witchcraft and typically considered alchemy, astrology, and numerology (predicting events from numbers) valuable components of natural science. Galileo, though he later decried his trial as the triumph of "ignorance, impiety, fraud and deceit," remained a believing Catholic. Even Robert Boyle, who like others came to think of the universe as a machine, attributed its origin to God: "God, indeed, gave motion to matter . . . and established those rules of motion, and that order amongst things . . . which we call the laws of nature." Newton agreed: "This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being. . . . He endures forever, and is everywhere present. . . ."

Nevertheless, the new science did challenge certain tenets of faith and the traditional Christian conception of God's place in the ordering of the world. Neither Protestant nor Catholic leaders welcomed Copernican ideas and the implications of the new science. The Catholic Church, itself ordered in a hierarchy that paralleled the old view of the universe, stayed particularly committed to established authorities. Moreover, the church's condemnation of Galileo in 1633 discouraged scientific investigations throughout much of Catholic Europe. Descartes was not alone in deciding not to publish ideas incorporating Copernican assumptions. As he explained in 1634, "It is not my temperament to set sail against the wind. . . . I want to be able to live in peace . . . out of sight." Although the French government would actively promote science, after the mid-seventeenth century most scientific work and publishing took place in Protestant areas—particularly in England and the Netherlands.

The New Worldview

By the end of the seventeenth century, the accumulation of convincing scientific findings and the support for those findings among the educated elites had broken the Aristotelian-medieval worldview and replaced it with the Copernican-Newtonian paradigm. According to the new view, the earth, along with the planets, moved around the sun in an infinite universe of other similar bodies. The natural order consisted of matter in motion, acting according to mathematically expressible laws. Scientific truths came from observing, measuring, experimenting, and making reasoned conclusions through the use of sophisticated mathematics. Religious truths still had their place, and the orderliness of nature reflected God's design (see Document 14.2, on page 431). However, science now claimed precedence in explaining the material world.

The Copernican-Newtonian paradigm

In the sixteenth and early seventeenth centuries, great thinkers such as Copernicus and Galileo had been ridiculed and persecuted for their ideas. By the late seventeenth and early eighteenth centuries, Isaac Newton's fate revealed the acceptance of the new paradigm among educated elites. Famous and popular, Newton became a member of Parliament, served for many years as director of the Royal Mint, and was knighted by Queen Anne.

LAYING THE FOUNDATIONS FOR THE ENLIGHTENMENT

In the course of the eighteenth century, the ideas of the Scientific Revolution spread widely and were applied in stunning new ways. With this broadening, the eighteenth century witnessed the birth of a major cultural movement known as the **Enlightenment.** At the heart of this movement lay the firm conviction—especially among intellectuals—that human reason should determine understanding of the world and the rules of social life. "[H]ave the courage to use your own intelligence," and leave your "self-caused immaturity," exhorted the German philosopher Immanuel Kant (1724–1804). "All that is required for this enlightenment is freedom, and particularly . . . the freedom for man to make public use of his reason in all matters."

Few paintings provide a better image of the Enlightenment than **Figure 14.8.** The form and content of this picture symbolize the new message. A small source of light is sufficient to enlighten humanity and reveal the laws of nature. Science is not just for specialists but something amateurs can understand and practice to obtain practical results.

The Enlightenment hit its full stride in the middle decades of the eighteenth century, when it particularly influenced literate elites of Europe and North America. Yet, its roots stretched back to the end of the seventeenth century. At that time, the thinking that would characterize the Enlightenment emerged in the writings of people who popularized science, applied a skeptical attitude toward religious standards of truth, and criticized accepted traditions and authorities.

Science Popularized

Unevenly educated and facing challenging findings, members of scientific societies often struggled to understand one another's work. For the nonscientific public, the problem of communicating new, complex ideas was even worse. Late in the seventeenth century, several talented writers, nonscientists themselves but believing that science had established a new standard of truth, began explaining in clear language the meaning of science to the literate public. For example, the French writer Bernard de Fontenelle (1657–1757) enjoyed a long, brilliant career as a popularizer of science. In *Conversations on the Plurality of Worlds* (1686), he presented the Copernican view of the universe in a series of conversations between an aristocratic woman and her lover under starry skies. The English essayist and publisher Joseph Addison (1672–1719), in the March 12, 1711, issue of his newspaper, *The Spectator,* said that he hoped to bring "philosophy out of closets and libraries, schools and colleges, to dwell in clubs and assemblies, at tea-tables and in coffee-houses." He aimed his daily paper not only at men but at women "of a more elevated life and conversation, that move in an exalted sphere of knowledge and virtue, that join all the beauties of the mind to the ornaments of dress, and inspire a kind of awe and respect, as well as love, in their male beholders." Other writers also targeted women. In 1737, for example, *Newtonianism for Women* was published in Naples and was soon translated into English. Writings such as these helped make science fashionable in elite circles.

FIGURE 14.8 Joseph Wright, Experiment with an Air Pump, 1768
The experiment takes place in the center of the picture; its apparent success is evidenced by the dead bird inside a closed glass bowl from which the air has been pumped out. The informally dressed experimenter is carefully observing his work. Around him are members of his family and some well-dressed friends.

Teaching science

In the mid-eighteenth century, this popularization of science merged with another foundation of Enlightenment thinking: the belief that every educated man and woman should be familiar with the nature and methods of science. Soon scientific ideas were being taught to children of the middle and upper classes. For example, the year 1761 saw the publication of *The Newtonian System of Philosophy, Adapted to the Capacities of Young Gentlemen and Ladies,* a book engagingly advertised as the "Philosophy of Tops and Balls." In it, a fictional boy named Tom Telescope gave lectures on science topics to children while also teaching the virtues of good manners and citizenship. The book proved immensely popular, going through many editions in Britain and in other countries.

Glorifying Newton: reason and nature

Many of these books emphasized Newton—and for understandable reasons. Enlightenment thinkers saw this brilliant Englishman as the great synthesizer of the Scientific Revolution, an astute observer who rightly described the universe as ordered, mechanical, material, and set into motion by God. From Newton, they concluded that reason and nature were compatible: Nature functioned logically and discernibly; therefore, what was natural was also reasonable. Many writers of the day agreed with the spirit of a poem written for Newton by the English author Alexander Pope upon the scientist's death in 1727:

> *Nature and Nature's Laws lay hid in Night.*
> *God said, "Let Newton be," and all was Light.*

In simple terms, Newton had become a European cultural hero, as **Figure 14.9** suggests. At the left center of this allegorical painting, a great urn "wherein is supposed to be deposited the Remains of the deceased Hero" is displayed. Above the urn shines a beam of light, broken into the colors of the spectrum by a prism—a bow to Newton's famous prism experiments. At the right are pages filled with mathematical calculations; below them, a globe and measuring instruments. Various figures in classical dress admire these objects and perhaps discuss Newton's ideas. The entire painting glorifies not only Newton but all of science.

The psychology of John Locke

Enlightenment thinkers also admired the ideas of Newton's compatriot John Locke (1632–1704), who applied scientific thinking to human psychology. This English philosopher did not hold the mind exempt from the mechanical laws of the material universe. In his *Essay Concerning Human Understanding* (1690), Locke pictured the human brain at birth as a blank sheet of paper that sensory perception and molding the individual from childhood to adulthood. These ideas, like those of Newton and the Scientific Revolution, also set the stage for the skeptical questioning of received wisdom.

Skepticism and Religion

Locke's ideas, along with those of Newton and the Scientific Revolution, set the stage for the questioning of established wisdom that came to define the Enlightenment. Among several writers, skepticism—or doubts about religious dogmas—mounted. Pierre Bayle (1647–1706), a French Huguenot forced to flee to the Dutch Republic because of Louis XIV's religious persecutions, became the leading proponent of skepticism in the late seventeenth century. In his *News from the Republic of Letters* (1684), Bayle bitterly attacked the intolerance of the French monarchy and the Catholic Church. In most of Europe, where religious principles shared by ruler and ruled underlay all political systems, nonconformity was a major challenge. Therefore, the book earned him condemnation in Paris and Rome. Eventually, however, Bayle would have the last word. In 1697 he published the *Historical and Critical Dictionary*, which contained a list of religious views and beliefs that Bayle maintained did not stand up to criticism. Bayle cited human reason and common sense as his standard of criticism: "Any particular dogma, whatever it may be, whether it is advanced on the authority of the Scriptures, or whatever else may be its origins, is to be regarded as false if it clashes with the clear and definite conclusions of the natural understanding." Bayle also argued that "morals and religion, far from being inseparable, are completely independent of each other." For Bayle, a person's moral behavior had little to do with any particular religious doctrine or creed. With these stands, Bayle pushed much harder than Galileo in challenging the Catholic Church and other religious beliefs. He became recognized as an international authority on religious toleration and skeptical criticism of the Bible.

Pierre Bayle

New information and arguments added weight to Bayle's criticism of biblical authority. For example, geological discoveries suggested that life on Earth had actually begun earlier than biblical accounts claimed. Investigators also began casting doubt on reports of miracles and prophecies. David Hume (1711–1776), a first-rate Scottish philosopher and historian, carried the skeptical argument even further. In *An Essay Concerning Human Understanding* (1748), he insisted that nothing—not even the existence of God or our own

David Hume

FIGURE 14.9 Giovanni Battista Pittori, *Allegorical Monument to Isaac Newton,* 1727–1730
This celebratory painting pays homage to Isaac Newton by glorifying the urn that stores his remains and highlighting his scientific discoveries.

reason filled as a person aged. "Our observation, employed either about external sensible objects or about the internal operations of our minds perceived and reflected on by ourselves, is that which supplies our understanding with all the materials of thinking." Locke's empirical psychology rejected the notion that human beings were born with innate ideas or that revelation was a reliable source of truth. What we become, he argued, depends solely on our experiences—on the information received through the senses. Schools and social institutions should therefore play a major role in existence—could be known for sure. Reality consisted only of human perceptions. To Hume, established religions were based on nothing but hope and fear. Reason demanded that people live with skeptical uncertainty rather than dogmatic faith.

Eastern Customs and Criticism of Authority

Travel writing had a long history, and by the eighteenth century many Enlightenment thinkers had read explanations of China's lucid Confucian traditions as well as accounts of customs and beliefs in Islamic, Buddhist, and Hindu lands. Several writers—among them the Baron de Montesquieu (1689–1755), a wealthy judge in a provincial French court, and the French author Voltaire (1694–1778)—used comparisons of place and time to criticize authority and tradition during the early decades of the eighteenth century. Journeying abroad and writing about their experiences gave such people a new perspective on their home societies. Montesquieu and Voltaire, for their part, chastised European customs in general and French institutions in particular for being contrary to reason and good ethics.

Travel writings of Montesquieu and Voltaire

Both presented the traveler as an objective observer. In his best-selling book *Persian Letters* (1721), Montesquieu bitingly satirized the customs, morals, and practices of Europeans from the point of view of two Persian travelers. Through this comparative perspective, Montesquieu painted the French as lacking in both good morals and effective government. Voltaire, in his widely read *Letters Concerning the English Nation* (1733), similarly criticized French politics and Catholic intolerance. In the island nation, "one thinks freely and nobly without being held back by any servile fear." Like many people, Voltaire idealized England because it allowed greater individual freedom, religious differences, and political reform than most other countries, especially France. England was also enviably prosperous and was the home of Newton and Locke, so admired in France. Many French intellectuals wanted for their own country what the English already seemed to have.

Other writers took a new historical perspective to criticize tradition and trumpet rapid change. For them, the tools of science and reason enabled people to surpass their historical predecessors, even the admired Greeks and Romans of antiquity. History became a story of relentless human progress, and people living in the eighteenth century stood on the brink of unprecedented historical achievements. Some people, such as the American scientist and philosopher Benjamin Franklin (1706–1790), embraced the idea of progress with an almost religious fervor: "The rapid Progress of *true* Science now occasions my regretting sometimes that I was born so soon. It is impossible to imagine the Height to which may be carried . . . the Power of Man over Matter, . . . all diseases may by sure means be prevented, . . . and our lives lengthened at pleasure."

History and progress

THE ENLIGHTENMENT IN FULL STRIDE

Building on the foundations of science, skepticism, and criticism, Western intellectuals systematically investigated the ethical, political, social, and economic implications of science after the 1730s. For them, nature—with its laws, order, simplicity, and rationality—served as a guide for human thought and society. "The source of man's unhappiness is his ignorance of Nature," claimed France's influential Baron d'Holbach (1723–1789). The Marquis de Condorcet argued, "The time will therefore come when the sun will shine only on free men who know no other master but their reason" (see Document 14.3). These optimistic intellectuals pushed for reform and change, using critical and empirical reasoning to back up their arguments. Specifically, they urged people to shrug off the shackles of tradition and custom and to participate in the accelerating progress of civilization. The spark of reason would soon dispel ignorance and enlighten all human understanding. Indeed, it was this image that lent the Enlightenment its name.

The *Philosophes*

Although Enlightenment ideas bubbled up throughout Europe and North America, France was the true heart of the movement. There Enlightenment thinkers came to be called ***philosophes,*** the French term for "philosophers." In a sense, the questions these thinkers grappled with were philosophical: How do we discover truth? How should we live our lives? Yet the *philosophes* were not traditional philosophers. Coming from both noble and middle-class origins, they were intellectuals—though often not formally trained by or associated with a university. They tended to extend, apply, or propagandize others' ideas rather than initiate new concepts themselves. They also wrote more plays, satires, histories, novels, encyclopedia entries, and short pamphlets than formal philosophical treatises. Finally, they considered themselves part of a common intellectual culture, an international "republic of letters" held together by literature, correspondence, and private gatherings. In the eyes of leading *philosophes* such as Jean Le Rond d'Alembert (1717–1783), this republic of letters should "establish the laws of philosophy and taste for the rest of the nation."

The witty, versatile François Arouet, who took the pen name Voltaire (1694–1778), best represented the *philosophes.* The

Voltaire

thinking about sources

DOCUMENTS

DOCUMENT 14.3

Condorcet Lauds the Power of Reason

No one lauded the power of reason and the Enlightenment, or had more hope for the future—thanks to the Enlightenment—than the French mathematician and philosophe the Marquis de Condorcet (1743–1794). The following is an excerpt from his Sketch of the Progress of the Human Mind, *a book tracing human "progress" over time, which he completed in 1794.*

Our hopes for the future condition of the human race can be subsumed under three important heads: the abolition of inequality between nations, the progress of equality within each nation, and the true perfection of mankind. Will all nations one day attain that state of civilization which the most enlightened, the freest and the least burdened by prejudices, such as the French and the Anglo-Americans, have attained already? Will the vast gulf that separates these peoples from the slavery of nations under the rule of monarchs, from the barbarism of African tribes, from the ignorance of savages, little by little disappear? . . .

In answering these three questions we shall find in the experience of the past, in the observation of the progress that the sciences and civilization have already made, in the analysis of the progress of the human mind and of the development of its faculties, the strongest reasons for believing that nature has set no limit to the realization of our hopes.

If we glance at the state of the world today we see first of all that in Europe the principles of the French constitution are already those of all enlightened men. We see them too widely propagated, too seriously professed, for priests and despots to prevent their gradual penetration even into the hovels of their slaves; there they will soon awaken in these slaves the remnants of their common sense and inspire them with that smoldering indignation which not even constant humiliation and fear can smother in the soul of the oppressed. . . .

The time will therefore come when the sun will shine only on free men who know no other master but their reason; when tyrants and slaves, priests and their stupid or hypocritical instruments will exist only in works of history and on the stage; and when we shall think of them only to pity their victims and their dupes; to maintain ourselves in a state of vigilance by thinking on their excesses; and to learn how to recognize and so to destroy, by force of reason, the first seeds of tyranny and superstition, should they ever dare to reappear amongst us.

FROM: Jean Antoine Nicholas Caritat, Marquis de Condorcet, *Sketch for a Historical Picture on the Progress of the Human Mind,* trans. June Barraclough (London: Weidenfeld and Nicolson [Orion Books], 1955), pp. 236–237, 244.

Analyze the Source

1. What "hopes" does Condorcet have for the future of humanity?
2. According to Condorcet, what will open the door to such great progress?

son of a Parisian lawyer, Voltaire received a fine classical education from the Jesuits and soon denounced their religious doctrine. He became the idol of French intellectuals while only in his 20s, and the enemy of many others. He soon ran afoul of state authorities, who imprisoned him in the Bastille for writing verses that criticized the crown. Released, he became embroiled in a dangerous conflict with a prominent nobleman and again landed in the Bastille. By promising to leave the country, he gained his freedom. In England, he encountered the ideas of Newton and Locke and came to admire English parliamentary government and the nation's religious tolerance. As we saw, he popularized Newton's and Locke's ideas and extolled the virtues of English society in his writings.

Slipping back into France, Voltaire hid for a time under the protection of Émilie du Châtelet (1706–1749), a wealthy woman who became his lover and match. Châtelet had already shown brilliance as a child. By the age of 12, she could speak four languages and had already translated Greek and Latin texts. Her mother worried that she would not find a mate because she "flaunts her mind, and frightens away the suitors her other excesses have not driven off." In 1733, she insisted on joining a group of male intellectuals who met regularly at a Parisian coffeehouse, donning men's clothes after the management refused to admit her because of her gender. Voltaire lived openly with Châtelet and her husband. In the great hall of their country chateau, she hung rods, pipes, and balls from the ceiling for her experiments in physics. She made her reputation by publishing a three-volume work on the German mathematician and philosopher Leibnitz and translating Newton's *Principles of Mathematics.* A *philosophe,* accomplished scientist, and leading proponent of Newtonian thought in her own right, Châtelet helped Voltaire gain a better understanding of the sciences and their significance. When she died in childbirth in 1749, the despondent Voltaire accepted an invitation from King Frederick II of Prussia to join his court. However, they soon argued, and Voltaire returned to France.

Émilie du Châtelet

Having made both a fortune in financial speculations and a rich network of friends and acquaintances, Voltaire was not without resources. He wrote poetry, drama, history, essays, letters, and scientific treatises—ninety volumes in all. The novel *Candide* (1759) became his best-known work. In this dark satire, Voltaire created the epitome of the "ivory-tower" intellectual, ridiculed the pretensions of the nobility and clergy, and skewered the naïveté of optimists who believed that "this is the best of all possible worlds and all things turn out for the best." He aimed his cynical wit especially at the Catholic Church and Christian institutions. His *Philosophical Dictionary* became the most famous, wide-ranging attack on supernatural religion and churches. Voltaire mounted several campaigns for religious toleration, coming to the defense of individuals attacked by prejudice. In his *Treatise on Tolerance* (1763), he attacked the mentality that led to the torture and murder of a Protestant merchant, Jean Calas, on the false charges of murdering his son for threatening to convert to Catholicism. "Christians ought to tolerate one another. I will go even further and say that we ought to look upon all men as our brothers. What! call a Turk, a Jew, a Siamese, my brother? Yes, of course, for are we not all children of the same father, and the creatures of the same God?" Voltaire was celebrated as a national hero and lionized internationally, and his popularity reveals the widespread acceptance of Enlightenment thought throughout the West by the late eighteenth century.

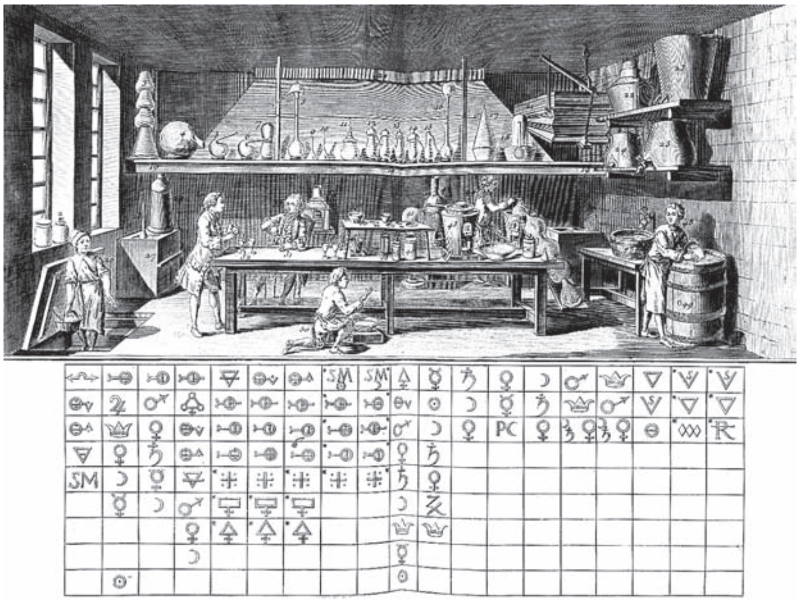


FIGURE 14.10 The *Encyclopedia,* 1751
This page from the *Encyclopedia* shows a chemical laboratory and a table with symbols for each chemical substance.

The *Encyclopedia*

No work better summarizes the philosophy of the Enlightenment than the *Encyclopedia*, a collaborative effort by many *philosophes* under the editorship of Denis Diderot (1713–1774) and Jean Le Rond d'Alembert. In the preface, the editors stated their aim: "to overturn the barriers that reason never erected" and "contribute to the certitude and progress of human knowledge." The *Encyclopedia* embodied the notion that reason alone could be used to discover, understand, or clarify almost anything. This massive work explored the complete spectrum of knowledge, offering articles on subjects ranging from music to machinery interpreted through the lens of the *philosophes'* criticism and empiricism. The authors wrote with supreme self-importance: "I can assure you," said d'Alembert in a 1752 letter, "that while writing this work I had posterity before my eyes at every line."

The first volume of the *Encyclopedia* was published in 1751. **Figure 14.10** shows one of its many illustrations. In this image of a chemical laboratory, two chemists and their assistants work. Each piece of equipment is numbered in the illustration and labeled in the text. At the bottom of the picture is a "table of affinities," a system used to organize and symbolize each chemical substance. The illustration conveys a sense of both the practicality of chemistry and its ordered progress. Although the study of chemistry and the hundreds of other topics covered in the *Encyclopedia* at first glance may appear innocent enough, they were saturated with the philosophy of the Enlightenment. Church authorities and their governmental allies therefore saw the *Encyclopedia* as a direct threat to the status quo. They censored it, halted its publication, and harassed its editors. Thanks in great part to the persistence of Diderot, who fought the authorities and managed a difficult group of contributing authors, the project was finally completed in 1772.

Battling the Church

Diderot's struggle to publish the *Encyclopedia* was part of a wider conflict between the *philosophes* and the church. Both sides spent much time and effort attacking each other. In countries such as France and Italy, where clerics were strongly entrenched in government, officials censored the writings of the *philosophes* and threatened to imprison or exile them. Governmental censorship was usually more nominal than real. However, Diderot and others trying to publish "offensive" books constantly worried about these threats: "How many times did we awake uncertain if . . . we would be torn from our families, our friends, our fellow citizens. . . ." French authors often sent their works to Holland or Switzerland for publication, and private companies then made a business of smuggling the books back into France across Swiss or Dutch borders.

Sometimes the *philosophes'* "crime" was promoting toleration of religious minorities, whether Christian or otherwise. Montesquieu and Voltaire, in France, were among several who attacked discrimination against Jews, for example. These views were particularly controversial because religious tolerance—formal and informal—was not the rule. Most governments maintained a state religion, rooted in law and viewed as the custodian of received views, that discriminated against nonmembers. For example, Denmark barred Catholic priests from entering the country, and the Catholic Inquisition remained active in Spain.

Deism

Some *philosophes,* such as the Baron d'Holbach and David Hume, verged on atheism in their attacks on organized religion. "The Christian religion not only was at first attended by miracles, but even now cannot be believed by any reasonable person without one," Hume claimed. However, few Enlightenment thinkers pushed matters that far. Most believed in some form of deism—that an impersonal, infinite Divine Being created the universe but did not interfere with the world of human affairs. The prominent author and political philosopher Thomas Paine (1737–1809) stated, "I believe in one God, and no more; and I hope for happiness beyond this life. . . . I do not believe in the creed professed by the Jewish church, by the Roman church, by the Greek church, by the Turkish church, by the Protestant church, nor by any church that I know of. My own mind is my own church." These ideas, like other ideas of the Enlightenment, gained momentum over the course of the eighteenth century. In the long run, the church probably lost more supporters among the upper and middle classes than it gained by so ardently attacking the *philosophes* and their ideas.

Reforming Society

Political thought: Montesquieu and Rousseau

The *philosophes* thought long and hard about reforming society. They wrote and argued about the relationship between the individual and society and reevaluated the functioning of traditional social institutions. Applying their critical reasoning to fields from government to education, they generated influential ideas for reform.

The most important political thinkers of the Enlightenment—Montesquieu and the Swiss-born writer Jean-Jacques Rousseau (1712–1778)—built on John Locke's work. Locke had pleaded eloquently for the "natural rights"—life, liberty, and property—of human beings. In his *Second Treatise on Civil Government* (1690), Locke had argued that to safeguard these rights, individuals agree to surrender a certain amount of their sovereignty to government. However, the powers of the government, whether it be monarchical or popular, were strictly limited. No government was allowed to violate the individual's right to life, liberty, and property. If it did, the people who set it up could and should overthrow it—something the English had done in their Glorious Revolution, according to Locke.

An admirer of Locke and the English system of government, the Baron de Montesquieu analyzed political systems from a relativistic perspective. In his widely acclaimed political masterpiece, *The Spirit of the Laws* (1748), Montesquieu argued that political institutions should conform to the climate, customs, beliefs, and economy of a particular country. For instance, limited monarchy is most appropriate for countries of moderate size, like France; and republics for small states, like Venice or ancient Athens. Each form of government had its virtues and vices.

Not only did Montesquieu approve of Locke's doctrine of limited sovereignty, but he specified how it could best be secured—by a separation of powers and a system of checks and balances. The alternative, he warned, was tyranny and an end to liberty: "There would be an end to everything, were the same man or the same body, whether of the nobles or of the people, to exercise those three powers, that of enacting laws, that of executing the public resolutions, and of trying the causes of individuals." This theory, equally applicable to monarchies and to democracies, became Montesquieu's greatest practical contribution to political thought. In North America, framers of the U.S. Constitution incorporated his ideas into their structuring of the United States government, creating separate executive, judicial, and legislative branches of government.

Rousseau offered a more radical political theory than Montesquieu's (see Biography on page 444). In his *Discourse on the Origin of Inequality* (1755), Rousseau argued that people in the "primitive" state of "noble savagery" were free, equal, and relatively happy. Only when some of them began marking off plots of ground, claiming them as their own and thereby founding civil society, did the troubles begin. Private property created inequality and the need for laws and governments to protect people from crime and wars. In *The Social Contract* (1762), Rousseau began by challenging his contemporaries: "Man is born free; and everywhere he is in chains." He then offered a solution to this conflict between individual freedom and social restrictions. In an ideal state, he argued, people entered into a compact with one another, agreeing to surrender their individual liberty, which was driven by self-interest, to the whole society. In return, the individual gained freedom by virtue of being part of the society's "general will," which was driven by the common good. "This means nothing less than that [the individual] will be forced to be free," explained Rousseau. Although Rousseau never made it clear just how the general will operated in practice, he believed that the people themselves—rather than a monarch or a parliamentary body—should make laws. His controversial ideas would powerfully influence the development of democratic theory over the next two centuries. For some, *The Social Contract* would support participatory democracy, whereas for others, Rousseau's emphasis on conforming to the general will would justify authoritarian political systems.

Although critical and combative, neither Rousseau, Montesquieu, nor the other *philosophes* were political or social revolutionaries. They did not champion the lower classes, whom they dismissed as ignorant, prone to violence, and, in Voltaire's words, "inaccessible to the progress of reason and over whom fanaticism maintains its atrocious hold." Diderot, of humble parents, admitted that he wrote "only for those with whom I should enjoy conversing . . . the philosophers; so far as I am concerned, there is no one else in the world." Most *philosophes* hoped for painless change from above rather than a revolutionary transfer of power to the still-unenlightened masses. Many shared Voltaire's belief that enlightened absolutism—rule by a well-educated, enlightened monarch—offered the best chance for the enactment of Enlightenment reforms such as religious toleration, rule subject to impartial laws, and freedom of speech (see Chapter 15).

Economic ideas: the Physiocrats and Adam Smith

If the functioning of the universe and politics could be described by understandable, rational laws, why should the same not hold true for economic activity? Several Enlightenment thinkers turned their thoughts to this question and attacked mercantilism, the system of regulated national economics that still operated throughout much of Europe. A group of French thinkers known as Physiocrats, led by François Quesnay, personal physician to Louis XV, began to teach that economics had its own set of natural laws. The Physiocrats believed that the most basic of these laws was that of supply and demand, and that these laws operated best under only minimal governmental regulation of private economic activity. This doctrine, which became known as *laissez-faire* (noninterference), favored free trade and enterprise. In France, the Physiocrats saw land and agriculture as the main source of national wealth. Other economists would build on their ideas and apply them to different settings.

In 1776, Adam Smith (1723–1790), a Scottish professor of philosophy who associated with the Physiocrats while traveling in France, published *Wealth of Nations*. The book became the bible of laissez-faire economics. By nature, Smith argued, individuals who were allowed to pursue rationally their own economic self-interest would benefit society as well as themselves. Focusing on Britain's economy, Smith emphasized commerce, manufacturing, and labor rather than agriculture as the primary sources of national wealth. Anticipating the industrial age that would first emerge in Britain, he concluded that "the greatest improvement in the productive powers of labor . . . have been the effects of the division of labor." For Smith as well as the Physiocrats, laissez-faire economics held the key to national wealth—whether a nation was built on agriculture or industry.

Criminology, penology, and slavery

What Smith and the Physiocrats did for economics, the Italian Cesare Beccaria (1738–1794) did for criminology and penology. Beccaria wrote *On Crimes and Punishments* (1764), an international best-seller, to protest "the cruelty of punishments and the irregularities of criminal procedures, . . . to demolish the accumulated errors of centuries." He argued that criminal laws and punishments, like all other aspects of life, should incorporate reason and natural law. Good laws, he explained, promoted "the greatest happiness divided among the greatest number." Criminal law should strive to deter crime and rehabilitate criminals rather than merely punish wrongdoers. In Beccaria's view, torture and capital punishment made no sense; indeed, only new penal institutions that mirrored natural law could transform convicted criminals.

Other Enlightenment thinkers used similar arguments to denounce slavery. Abbé Guillaume Raynal (1713–1796), an outspoken and widely read critic of

KEY DATES

THE ENLIGHTENMENT

1733	Voltaire, *Letters Concerning the English Nation*
1748	Montesquieu, *The Spirit of the Laws*
1751	The *Encyclopedia*
1759	Voltaire, *Candide*
1762	Rousseau, *The Social Contract*
1764	Beccaria, *On Crimes and Punishments*
1776	Smith, *Wealth of Nations*
1792	Wollstonecraft, *A Vindication of the Rights of Woman*

BIOGRAPHY

Jean-Jacques Rousseau

(1712–1778)

Jean-Jacques Rousseau described himself as a "singular soul, strange, and to say it all, a man of paradoxes." A celebrity both admired and hated in his own time, he wrote more deeply on a wide range of subjects than any of his contemporaries.

"My birth was my first misfortune," Rousseau once stated wryly. His mother died shortly after he was born in 1712 in the Republic of Geneva. His father, a watchmaker, raised him to the age of 10 and then abandoned him to a series of homes where he served unhappily as an apprentice. One day in 1728, returning late from walking in the countryside, he found the gates of Geneva closed. Anticipating punishment from his master for his tardiness, he turned around and set off on the first of a series of wanderings that would mark the rest of his life.

Singular Soul, Controversial Thinker

In 1742 the shy Rousseau arrived in Paris. He would often live there, though he harbored "a secret disgust for life in the capital," with its "dirty stinking little streets, ugly black houses, . . . poverty, [and] beggars." He first gained attention in Paris by writing about music and by joining the cultural circles. In 1745, Thérèse Levasseur, a young laundress, became his lifelong companion and ultimately his wife. The couple would have four children and abandon them all to a foundling hospital for adoption.

In 1749, Rousseau entered an essay contest that abruptly changed his life. He won the competition by arguing that progress in the arts and sciences corrupted rather than improved human conduct. Suddenly he was controversial and famous. "No longer [was I] that timid man, more ashamed than modest. . . . All Paris repeated [my] sharp and biting sarcasms. . . ." Buoyed by his newfound fame, he contributed several articles on music and political economy to the *Encyclopedia,* edited by his close friend Denis Diderot. He came to know and eventually quarrel with most of the leading figures of the Enlightenment.

Rousseau went on to publish several critical and widely circulated books, including *Discourse on the Origin of Inequality* (1755), *Julie, or The New Heloise* (1761), *Émile* (1762), and *The Social Contract* (1762). These writings inspired not only learned responses but ardent mail from ordinary readers. Yet the books also inspired scorn. Peasants once stoned Rousseau's house, for example, after a pastor attacked him from the pulpit. Authorities issued more serious threats. In 1762, Parisian officials ordered *The Social Contract* burned and Rousseau arrested. He fled to Geneva, only to discover that officials there were also seeking his arrest. Again he escaped, moving from place to place and finding shelter with friends whom he quickly lost after bitter arguments.

In the last fifteen years of his life, Rousseau felt persecuted and depressed. "I appear," he wrote, "as the enemy of the Nation." He published stunning, often exaggerated self-revelations in his *Confessions,* disclosing his affairs, lies, and quarrels.

A difficult man and a tortured soul, Rousseau was also a superb writer whose *New Heloise* became the most widely read novel of his age. He counts among the most important educational theorists in history and became an accomplished composer and musical theorist. Author of one of the most striking autobiographical works ever written, he also proved an extremely influential philosopher and political theorist. "I am different," he wrote, "alone on earth. . . . Whether nature did well or ill to break the mould in which she formed me, this is something one can only judge after reading me." Sixteen years after Rousseau's death in 1778, France's revolutionary government moved his body to a place of honor near Voltaire's burial site in Paris.

Connecting People & Society

1. What do authorities' and ordinary people's harsh reactions to Rousseau's socially critical works reveal about eighteenth-century society?
2. How did Rousseau's work and life reflect the ideas and efforts of other Enlightenment thinkers?

slavery, argued that this institution and many other practices of European and American colonists were irrational and inhumane. In the name of natural rights, he called for a slave rebellion. An article in the authoritative *Encyclopedia* asserted similar views, declaring that all enslaved individuals "have the right to be declared free. . . ." These arguments, like the ideas of Beccaria and, in politics, of Montesquieu and Rousseau, would resound again and again through eighteenth-century Western society.

Education

Becoming enlightened required education. Diderot claimed that the *Encyclopedia* was written so "that our children, by becoming more educated, may at the same time become more virtuous and happier. . . ." Many Enlightenment thinkers based their ideas on the psychological ideas of John Locke, which emphasized the power of education to mold the child into the adult. These thinkers often attacked organized religion in particular for controlling education.

Rousseau became the outstanding critic of traditional education. In *Émile,* he argued that teachers should appeal to children's natural interests and goodness rather than impose discipline and punishment. "Hold childhood in reverence," he counseled. "Give nature time to work." He also pushed for less "artificial" schools, maintaining that nature and experience were better guides to independent thinking and practical knowledge—at least for males. "I hate books," he pointed out. "They only teach us to talk about things we know nothing about." By emphasizing practical education, learning by doing, and motivating rather than requiring the child to learn, Rousseau's *Émile* became one of the most influential works on modern education. His ideas on the education of females, however, were not so modern. Like most men of his time (enlightened or not), he believed that girls should be educated to fulfill their traditional domestic roles as wives and mothers.

In theory at least, the Enlightenment emphasis on individualism opened the door to the idea of equality between men and women. Several intellectuals explored this controversial issue. Early in the period, some challenging books on the "woman question" were published by female authors. In one of the best known of these, *A Serious Proposal to the Ladies* (1694), the English writer Mary Astell (1666–1731) argued that women should be educated according to the ideas of the new science—reason and debate—rather than tradition. Later, she explained that men seem to know more than women because "boys have much time and pains, care and cost bestowed on their education, girls have little or none. The former are early initiated in the sciences" and "have all imaginable encouragement" while "the latter are restrained, frowned upon, and beaten." In other writings, she questioned the inequality of men's and women's roles: "If all Men are born Free, how is it that all Women are born Slaves?" Later in the eighteenth century, the British author Mary Wollstonecraft (1759–1797) published *A Vindication of the Rights of Woman* (1792), in which she analyzed the condition of women and argued forcefully for equal rights for all human beings. Like Astell, Wollstonecraft stressed the need to educate women: "If she be not prepared by education to become the companion of man, she will stop the progress of knowledge and virtue; for truth must be common to all, or it will be inefficacious with respect to its influence on general practice."

The "woman question"

Few male writers went that far. Although some men supported better education for women, most held the traditional view that women were weaker than men and best suited for domestic rather than public affairs. According to Immanuel Kant, who spoke so optimistically and eloquently about education and enlightenment, "laborious learning or painful pondering, even if a woman should greatly succeed in it, destroy the merits that are proper to her sex." The editors of the *Encyclopedia* also ignored contributions from women, instead praising those who remained at home. Some of Rousseau's writings were particularly influential among women, primarily because they glorified child rearing, maternalism, and emotional life. Rousseau never suggested that women were independent beings equal to men. For him, "Woman is made to please and to be subjugated to man."

The Culture and Spread of the Enlightenment

The Enlightenment glittered especially in Paris, and salon meetings became the chief social setting for this intellectual culture. These meetings were hosted by wealthy Parisian patrons, usually women of the aristocracy or upper-middle class. In an environment lush with art, music, and wealth, the *philosophes,* powerful nobles, diplomats, statesmen, artists, and well-educated conversationalists gathered regularly to read, listen to, and debate the ideas of the Enlightenment. They also discussed—and sometimes influenced—economic policies, wars, and the king's choice of ministers. The German critic Friedrich Grimm (1723–1807), who published a private newsletter on Parisian life, described the salons of Julie de Lespinasse, who lived openly with the *philosophe* d'Alembert: "Her circle met daily from five o'clock until nine in the evening. There we were sure to find choice men of all orders in the State, the Church, the Court—military men, foreigners, and the most distinguished men of letters. Politics, religion, philosophy, anecdotes, news, nothing was excluded from the conversation." These salon meetings became self-conscious forums for arbitrating and molding public opinion through the open use of reason.

Salon meetings

As leaders, patrons, and intellectual contributors to these gatherings, women played a particularly important role in the Enlightenment. Independent, witty, powerful women governed the potentially unruly meetings and discussions by enforcing rules of polite conversation. One of the most famous of these patrons was Madame Marie-Thérèse Geoffrin (1699–1777), a rich middle-class widow who served as a model and mentor for other women leaders of salons. **Figure 14.11,** a painting by Anicet Charles Lemonnier, shows a salon meeting at her home

FIGURE 14.11 Anicet Charles Lemonnier, *An Evening at Madame Geoffrin's in 1755,* 1812
Philosophes, nobles, statesmen, and well-educated conversationalists often gathered in Enlightenment-age salons led by women such as Madame Geoffrin, shown here sitting on the right in a blue dress.

in 1755. Madame Geoffrin, wearing a blue dress and looking at the viewer, sits at the left next to Bernard de Fontenelle, 98-year-old popularizer of science. Above is a bust of Voltaire, the Enlightenment hero living in exile at the time. Women with the right intellectual and social qualifications attended this and other salons, but the star invitees were usually men.

Smaller meetings in other French and foreign cities, from Berlin to Philadelphia, paralleled the Parisian salon meetings. Moreover, all these meetings went hand in hand with an extensive international correspondence carried out by participants. For some, letter writing, like good conversation in the salons, was an art. People also read and discussed Enlightenment ideas in local academies, Freemason lodges, societies, libraries, and coffeehouses. In addition, most municipalities had clubs where the social and intellectual elites could mingle.

Even bookstores, where people could purchase books or pay small fees to read recent works, became hotbeds of Enlightenment ideas. **Figure 14.12** shows an eighteenth-century bookstore. In the doorway stand two women, reading books. Just outside are packages of books being delivered from or to Spain, Portugal, Rome, and Naples. In a growing number of bookstores such as this, all sorts of works became increasingly available, from religious tracts and chivalric tales to new novels and Enlightenment literature.

Bookstores

These gatherings and interchanges spread the ideas of the Enlightenment throughout society and enhanced the social respectability of intellectuals. They also helped create a common intellectual culture that crossed class lines and political borders and that contributed to an informed body of public opinion. People who participated in these interchanges came to sense that they could freely express ideas as well as debate political and social issues. By the last quarter of the eighteenth century, Enlightenment ideas could be heard even in the camps of the *philosophes'* traditional opponents—the clergy, governmental officials, and monarchs. As we will see, these ideas pushed some monarchs to enact "enlightened" reforms and encouraged many other people to demand revolutionary change.

thinking about sources VISUALS

FIGURE 14.12

Léonard Defrance, *At the Shield of Minerva,* 1781

In this painting, French artist Léonard Defrance depicts a street scene in front of a bookstore in France. Notice the reference in the store's name to Minerva, the Roman goddess of poetry and wisdom. Also note the mix of people and the prominence of the clergyman (in white robes) among them.

Analyze the Source

1. In what ways does this painting imply that people of all classes were being touched by books—and perhaps by Enlightenment ideas?
2. Why do you think the artist included a member of the clergy in such a central place in this painting?

LOOKING BACK & MOVING FORWARD

Summary The great intellectual revolution of the seventeenth and eighteenth centuries was fueled by advances in science. Brimming with new scientific ideas and discoveries, Western civilization relinquished its medieval assumptions and embarked on an innovative journey unique among the cultures of the world. Although some Western scientific ideas began penetrating Asian cultures during the seventeenth century, this change in direction became one of the main forces behind the power and dynamism that came to characterize the West. Through science, Westerners hoped to gain greater control over the material world and nature.

Enlightenment thinkers carried these daring aspirations further, self-consciously leading a mission of reform and freedom from the shackles of tradition. By striking the match of reason, they believed, people could at last dispel the darkness of the past and liberate themselves as never before. Thus enlightened, humanity as a whole could move from childhood to adulthood. As the *philosophe* Baron d'Holbach proclaimed, "The *enlightened man,* is man in his maturity, in his perfection; who is capable of pursuing his own happiness; because he has learned to examine, to think for himself, and not to take that for truth upon the authority of others."

Many participants in Enlightenment circles have since been criticized as self-concerned dilettantes reluctant to take on the risks of real reform. Most historians, however, see the *philosophes* as thoughtful, sincere, and sometimes brilliant thinkers. The *philosophes* clearly left a mark on Western culture. Their ideas, like those of the seventeenth-century scientists, threatened the traditional order, especially the church. As their primary legacy, they widened the gap between religiously influenced doctrines and accepted scholarly thought. Equally significant, they set the intellectual stage for a series of revolutions that would soon sweep America and Europe. Above all, their way of thinking—stressing reason, individualism, and progress—would form the intellectual foundation of modern Western society and further distinguish this civilization from its non-Western counterparts.

KEY TERMS

Neoplatonism *p.427*
Hermetic doctrine *p.427*
Copernican revolution *p.428*
heliocentric model *p.428*
empirical method *p.433*
deductive reasoning *p.433*
Cartesian dualism *p.434*
Scientific Revolution *p.434*
Enlightenment *p.436*
philosophes *p.439*

REVIEW, ANALYZE, & CONNECT TO TODAY

REVIEW THE PREVIOUS CHAPTERS

Chapter 12—"Faith, Fortune, and Fame"—told how several European powers expanded overseas during the fifteenth, sixteenth, and seventeenth centuries and grew rich from the commerce. Chapter 13—"The Struggle for Survival and Sovereignty"—focused on how kings and nobles battled for power, the resolutions of those struggles, and their impact on the millions of people outside the elite.

1. Analyze how the expansion of Europe might have stimulated scientific research.
2. In what ways did the effort of monarchs to increase their power and create stability relate to the promotion of science and the desire for greater intellectual certainty?

ANALYZE THIS CHAPTER

Chapter 14—"A New World of Reason and Reform"—examines the changing intellectual foundations of the West.

1. List and analyze the differences between the new scientific views of the world and traditional medieval views. How did standards for ascertaining the "truth" differ between these two perspectives?
2. Analyze the beliefs and motives of three central figures in the Scientific Revolution. What barriers did they have to overcome to present their views?
3. Do you think the Enlightenment merely popularized the Scientific Revolution, or did it accomplish something more?
4. In what ways did the Enlightenment threaten traditional views and authorities?

CONNECT TO TODAY

Think about the meaning of the Scientific Revolution and the values underlying the Enlightenment.

1. In what ways are our present-day assumptions about the physical universe and the workings of nature based on the ideas and discoveries of the Scientific Revolution?
2. What aspects of world politics today reflect Enlightenment values? What aspects of present-day global politics seem to be opposed to those values?