Life During the Scientific Revolution
This 1768 painting by Joseph Wright captures the popularization of science and experimentation during the Enlightenment. Here, a scientist demonstrates the creation of a vacuum by withdrawing air from a flask, with the suffocating cockatoo serving as shocking proof of the experiment. *(An Experiment on a Bird in the Air Pump*, 1768/National Gallery, London/Bridgeman Images)

CHAPTER PREVIEW

- What revolutionary discoveries were made in the sixteenth and seventeenth centuries?
- What intellectual and social changes occurred as a result of the Scientific Revolution?
- How did the Enlightenment emerge, and what were major currents of Enlightenment thought?
- How did the Enlightenment change social ideas and practices?
- What impact did new ways of thinking have on politics?

What revolutionary discoveries were made in the sixteenth and seventeenth centuries?

Until the middle of the sixteenth century, Europeans relied on an understanding of motion and matter drawn from the ancient Greek philosopher Aristotle and adapted to Christian theology. The rise of the university, along with the intellectual vitality of the Renaissance and technological advancements, inspired European scholars to seek better explanations. From the work of Nicolaus Copernicus to the work of Isaac Newton, a revolutionary new understanding of the universe had emerged by the end of the seventeenth century. Collectively known as the "Scientific Revolution," the work of these scientists constituted significant milestones in the creation of modern science.

The major figures of the Scientific Revolution (ca. 1540–1700) were for the most part devout Christians who saw their work as heralding the glory of creation and who combined older traditions of magic, astrology, and alchemy with their pathbreaking experimentation. Their discoveries took place in a broader context of international trade, imperial expansion, and cultural exchange. Alongside developments in modern science and natural philosophy, the growth of natural history in this period is now recognized by historians as a major achievement of the Scientific Revolution.

Contributions from the Muslim World

In 1500 scientific activity flourished in many parts of the world. Between 750 and 950 Muslim, Christian, and Jewish scholars in the expanding Muslim world began translating the legacy of ancient Greek science and natural philosophy into Arabic, especially the works of Aristotle. The interaction of peoples and cultures across the vast Muslim world, facilitated by religious tolerance and the common scholarly language of Arabic, was highly favorable to advances in learning.

In a great period of cultural and intellectual flourishing from 1000 to 1500, Muslim scholars thrived in cultural centers such as Baghdad and Córdoba, the capital of Islamic Spain. They established the world's first institutions of higher learning, called *madrasas*, in Constantinople, Fez (Morocco), and Cairo, which were devoted to Islamic theology and law. In this fertile atmosphere, scholars surpassed the texts they had inherited in areas such as mathematics, physics, astronomy, and medicine. Arab and Persian mathematicians, for example, invented algebra, the concept of the algorithm, and decimal point notation. Arab astronomers built observatories to collect celestial observations, and an Egyptian scholar, Ibn al-Haytham (d. 1042), revolutionized optics by demonstrating mathematically that light travels in straight lines.

Given the scientific and philosophical knowledge possessed by Arab and Muslim scholars in the tenth and eleventh centuries, one might have expected that modern science would have emerged in the Muslim world first. However, the madrasas excluded study of the natural sciences, and Muslim scholars did not benefit from institutions dedicated to the creation and dissemination of scientific knowledge. This pattern of education was unlike that of the Europeans, who created independent institutions of higher education (universities) and then placed study of the Greek natural sciences at the center of the curriculum.

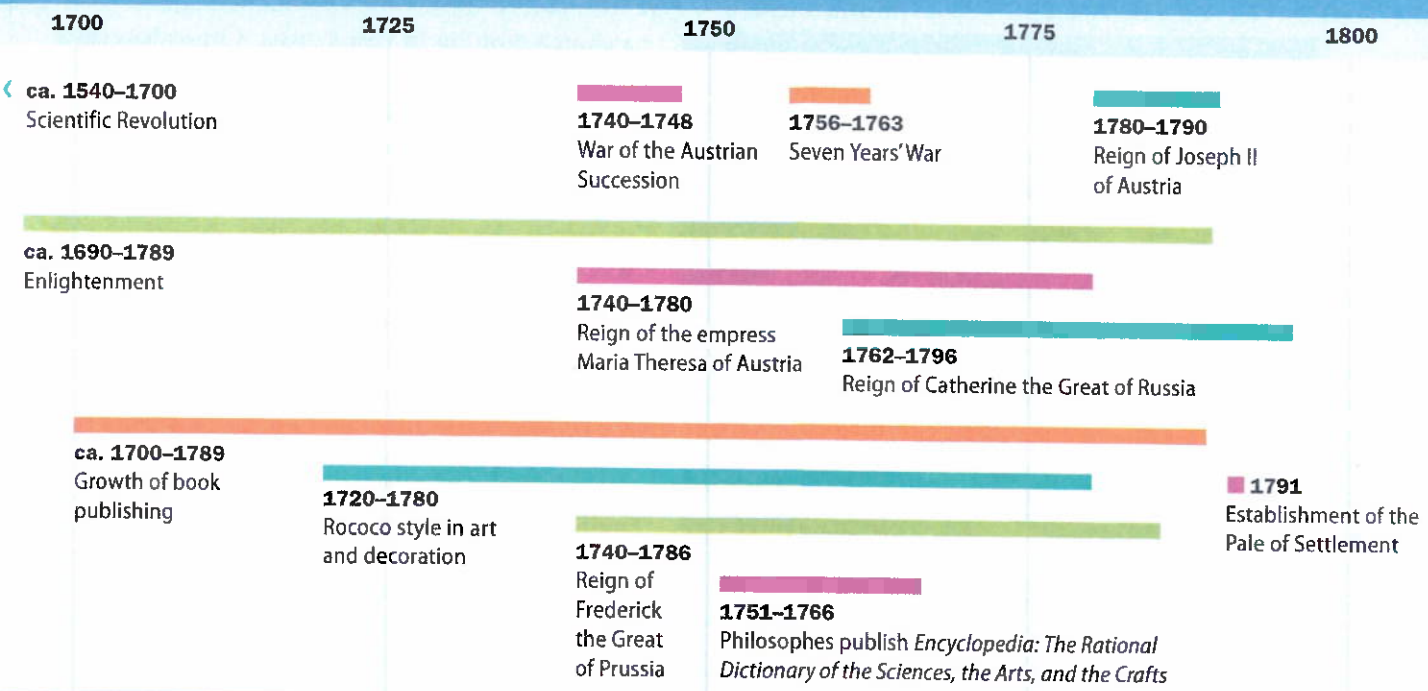
The growth of trade and the re-establishment of stronger monarchies in the High Middle Ages encouraged the circulation of ideas and the patronage of educational institutions in western Europe. As European scholars became aware of advances in knowledge made in Muslim territories, they traveled to Islamic territories in Iberia, Sicily, and the eastern Mediterranean to gain access to this knowledge. In the twelfth century, these scholars translated many Greek texts—including works of Aristotle, Ptolemy, Galen, and Euclid previously lost to the West—into Latin, along with the commentaries of Arab scholars. With the patronage of kings and religious institutions, groups of scholars created universities in which these translated works, especially those of the ancient Greek philosopher Aristotle, dominated the curriculum.

The intellectual and cultural movement known as the Renaissance provided a crucial foundation for the Scientific Revolution. The quest to restore the glories of the ancient past led to a new period of rediscovery of classical texts, including Ptolemy's *Geography*, which was translated into Latin around 1410. An encyclopedic treatise on botany by Theophrastus was rediscovered in the 1450s moldering on the shelves of the Vatican library. The fall of Constantinople to the Ottomans in 1453 resulted in a great influx of little-known Greek works, as Christian scholars fled to Italy with their precious texts.

In this period, western European universities established new professorships of mathematics, astronomy, and natural philosophy. The prestige of the new fields was low, especially of mathematics, which was reserved for practical problems such as accounting, surveying, and computing planetary tables, but not used to understand the functioning of the physical world itself. Nevertheless, these professorships eventually

■ **natural philosophy** An early modern term for the study of the nature of the universe, its purpose, and how it functioned; it encompassed what we would call "science" today.

TIMELINE



enabled the union of mathematics with natural philosophy that was to be a hallmark of the Scientific Revolution.

Scientific Thought to 1500

The term *science* as we use it today came into use only in the nineteenth century. For medieval scholars, philosophy was the path to true knowledge about the world, and its proofs consisted of the authority of ancients (as interpreted by Muslim and Christian theologians) and their techniques of logical argumentation. Questions about the physical nature of the universe and how it functioned belonged to a minor branch of philosophy, called **natural philosophy**. Drawing on scholarship in the Muslim world, natural philosophy was based primarily on the ideas of Aristotle, the great Greek philosopher of the fourth century B.C.E. Medieval theologians such as Thomas Aquinas brought Aristotelian philosophy into harmony with Christian doctrines. According to the Christianized view of Aristotle, a motionless earth stood at the center of the universe and was encompassed by ten separate concentric crystal spheres in which were embedded the moon, the sun, planets, and stars. Beyond the spheres was Heaven, with the throne of God and the souls of the saved. Angels kept the spheres moving in perfect circles.

Aristotle's views also dominated thinking about physics and motion on earth. Aristotle had distinguished between the world of the celestial spheres and that of the earth—the sublunar world. The spheres consisted of a perfect, incorruptible "quintessence," or fifth essence. The sublunar world, however, was made up of four imperfect, changeable elements: air, fire, water, and earth. Aristotle and his followers also believed that a uniform force moved an object at a constant speed and that the object would stop as soon as that force was removed.

Aristotle's cosmology made intellectual sense, but it could not account for the observed motions of the stars and planets and, in particular, provided no explanation for the apparent backward motion of the planets (which we now know occurs as the earth passes the slower-moving outer planets or is passed by the faster-moving inner ones). More than four centuries later the Greek scholar Ptolemy offered a theory for this phenomenon. According to Ptolemy, the planets moved in small circles, called epicycles, each of which moved in turn along a larger circle, or deferent. Ptolemaic astronomy was less elegant than Aristotle's neat nested circles and required complex calculations, but it provided a surprisingly accurate model for predicting planetary motion.

The work of Ptolemy also provided the basic foundation of knowledge about the earth. Rediscovered and translated from Arabic into Latin around 1410, his *Geography* presented crucial advances on medieval cartography by representing a round earth divided into 360 degrees with the major latitude marks. However, Ptolemy's map reflected the limits of ancient knowledge, showing only the continents of Europe, Africa, and Asia, with land covering three-quarters of the world.

Model of the Ptolemaic System This seventeenth-century brass model was used to demonstrate the Ptolemaic astronomical system, with the earth at the center and the movement of the sun, stars, and planets around it. (Armillary sphere made by Adam Heroldt [fl. 1648]/Science Museum, London, UK/Bridgeman Images)

These two frameworks reveal the strengths and limitations of European knowledge on the eve of the Scientific Revolution. Overcoming the authority of the ancients to develop a new understanding of the natural world, derived from precise techniques of observation and experimentation, was the Scientific Revolution's monumental achievement. Europeans were not the first to use experimental methods—of which there was a long tradition in the Muslim world and elsewhere—but they were the first to separate scientific knowledge decisively from philosophical and religious beliefs and to accord mathematics a fundamental role in understanding the natural world.

The Copernican Hypothesis

The first great departure from the medieval system was the work of the Polish cleric Nicolaus Copernicus (1473–1543). Copernicus studied astronomy, medicine, and church law at the famed universities of Bologna, Padua, and Ferrara before taking up a church position in East Prussia. Copernicus came to believe that Ptolemy's cumbersome rules detracted from the majesty of a perfect creator. He preferred an idea espoused by some ancient Greek scholars: that the sun, rather than the earth, was at the center of the universe. Without questioning the Aristotelian belief in crystal spheres or the idea that circular motion was divine, Copernicus theorized that the stars and planets, including the earth, revolved around a fixed sun. He laid out his hypothesis in an unpublished manuscript between 1510 and 1514, but, fearing the ridicule of other scholars, he did not publish *On the Revolutions of the Heavenly Spheres* until 1543, the year of his death.

The **Copernican hypothesis** had enormous scientific and religious implications, many of which the conservative Copernicus did not anticipate. First, it put the stars at rest, their apparent nightly movement simply a result of the earth's rotation. Thus it destroyed the main reason for believing in crystal spheres capable of moving the stars around the earth. Second, Copernicus's theory suggested a universe of staggering size. If in the course of a year the earth moved around the sun and yet the stars appeared to remain in the same place, then the universe was unthinkably large. Third, by using mathematics, instead of philosophy, to justify his theories, Copernicus challenged the traditional hierarchy of the disciplines. Finally, by characterizing the earth as just another planet, Copernicus destroyed the basic idea of Aristotelian physics—that the earthly sphere was quite different from the heavenly one. Where then were Heaven and the throne of God?

Religious leaders varied in their response to Copernicus's theories. A few Protestant scholars became avid Copernicans, while others accepted some elements of his criticism of Ptolemy but firmly rejected the notion that the earth moved, a doctrine that contradicted the literal reading of some passages of the Bible. Among Catholics, Copernicus's ideas drew little attention prior to 1600. Because the Catholic Church had never insisted on literal interpretations of the Bible, it did not officially declare the Copernican hypothesis false until provoked by the publications of Galileo Galilei in 1616 (see "Science and Religion" later in this chapter).

Other events were almost as influential in creating doubts about traditional astronomy. In 1572 a new star appeared and shone very brightly for almost two years. Actually a distant exploding star, it made an enormous impression on people and seemed to contradict the idea that the heavenly spheres were unchanging and therefore perfect. In 1577 a new comet suddenly moved through the sky, cutting a straight path across the supposedly impenetrable crystal spheres. It was time, as a sixteenth-century scientific writer put it, for "the radical renovation of astronomy."[1]

Brahe, Kepler, and Galileo: Proving Copernicus Right

One astronomer who partially agreed with the Copernican hypothesis was the Danish astronomer Tycho Brahe (TEE-koh BRAH-hee) (1546–1601). Brahe established himself as Europe's leading astronomer with his detailed observations of the new star that appeared in 1572. Impressed by his work, the king of Denmark provided funds for Brahe to build the most sophisticated observatory of his day. Upon the king's death, Brahe acquired a new patron in the Holy Roman emperor Rudolph II and built a new observatory in Prague.

For twenty years Brahe had observed the stars and planets with the aim of creating new and improved tables of planetary motions. He produced the most exact observations ever carried out with the naked eye, but his limited understanding of mathematics and his sudden death in 1601 prevented him from making much sense out of his mass of data. Part Ptolemaic, part Copernican, he believed that all the planets except the earth revolved around the sun and that the entire group of sun and planets revolved in turn around the earth-moon system.

It was Brahe's assistant, Johannes Kepler (1571–1630), who discovered what his observations revealed about planetary movements. Kepler carefully re-examined his predecessor's notations and came to believe that they could not be explained by Ptolemy's astronomy. Abandoning the notion of the circular paths of epicycles and deferents developed by Ptolemy to explain the retrograde motion of the planets—which even Copernicus had retained in part—Kepler developed three revolutionary laws of planetary motion. First, largely through observations of the planet Mars, he demonstrated that the orbits of the planets around the sun are elliptical rather than circular. Second, he demonstrated that the planets do not move at a uniform speed in their orbits. When a planet is close to the sun it moves more rapidly, and it slows as it moves farther away from the sun. Finally, Kepler's third law stated that the time a planet takes to make its complete orbit is precisely related to its distance from the sun.

Kepler's contribution was monumental. Whereas Copernicus had used mathematics to describe planetary movement, Kepler proved mathematically the precise relations of a sun-centered (solar) system. He thus united for the first time the theoretical cosmology of natural philosophy with mathematics. His work demolished the old system of Aristotle and Ptolemy, and with his third law he came close to formulating the idea of universal gravitation (see the next section). In 1627 he also published the *Rudolphine Tables*, named in honor of Emperor Rudolph and based on his observations and those of Tycho Brahe. The work consisted of a catalogue of more than one thousand stars as well as tables of the positions of the sun, moon, and planets. They were used by astronomers for many years.

While Kepler was unraveling planetary motion, a Florentine named Galileo Galilei (1564–1642) was challenging Aristotelian ideas about motion on earth. Galileo's fascination with mathematics led to a professorship during which he examined motion and mechanics in a new way. Galileo focused on deficiencies in Aristotle's theories of motion. He measured the movement of a rolling ball across a surface, repeating the action again and again to verify his results. In his famous acceleration experiment, he showed that a uniform force—in this case, gravity—produced a uniform acceleration. He also achieved new insight into the principle of inertia by hypothesizing that an object would continue in motion forever unless stopped by some external force. The **law of inertia** was formulated explicitly after Galileo's death by René Descartes (see "The Methods of Science: Bacon and Descartes" later in this chapter) and Pierre Gassendi. Galileo's work on mechanics proved Aristotelian physics wrong.

On hearing details about the invention of the telescope in Holland, Galileo made one for himself and trained it on the heavens. He quickly discovered that, far from being a perfect crystal sphere, the moon is cratered with mountains and valleys, just like the earth. He then discovered the first four moons of Jupiter, which clearly suggested that Jupiter could not possibly be embedded in an impenetrable crystal sphere as Aristotle and Ptolemy maintained. This discovery provided new evidence for the Copernican theory, in which Galileo already believed. He wrote in 1610 in *The Sidereal Messenger*: "By the aid of a telescope anyone may behold [the Milky Way] in a manner which so distinctly appeals to the senses that all the disputes which have tormented philosophers through so many ages are exploded by the irrefutable evidence of our eyes, and we are freed from wordy disputes upon the subject."[2] (See "Evaluating Written Evidence: Galileo Galilei, *The Sidereal Messenger*, page 466.)

A crucial corner in Western civilization had been turned. No longer should one rely on established authority. A new method of learning and investigating was being developed, one that proved useful in any field of inquiry. A historian investigating documents of the past, for example, is not so different from a Galileo studying stars and rolling balls.

■ **Copernican hypothesis** The idea that the sun, not the earth, is the center of the universe.

■ **law of inertia** A law hypothesized by Galileo that states that motion, not rest, is the natural state of an object, and that an object continues in motion forever unless stopped by some external force.

Galileo Galilei, *The Sidereal Messenger*

In this passage from *The Sidereal Messenger* (1610), Galileo Galilei recounts his experiments to build a telescope and his observations of the moon. By discovering the irregularity of the moon's surface, Galileo disproved a central tenet of medieval cosmography: that the heavens were composed of perfect, unblemished spheres essentially different from the base matter of earth.

About ten months ago a report reached my ears that a Dutchman had constructed a telescope, by the aid of which visible objects, although at a great distance from the eye of the observer, were seen distinctly as if near. . . . A few days after, I received confirmation of the report in a letter written from Paris . . . , which finally determined me to give myself up first to inquire into the principle of the telescope, and then to consider the means by which I might compass [achieve] the invention of a similar instrument, which a little while after I succeeded in doing, through deep study of the theory of refraction; and I prepared a tube, at first of lead, in the ends of which I fitted two glass lenses, both plane on one side, but on the other side one spherically convex, and the other concave. . . . At length, by sparing neither labour nor expense, I succeeded in constructing for myself an instrument so superior that objects seen through it appear magnified nearly a thousand times, and more than thirty times nearer than if viewed by the natural powers of sight alone. . . .

Let me speak first of the surface of the moon, which is turned towards us. For the sake of being understood more easily, I distinguish two parts in it, which I call respectively the brighter and the darker. The brighter part seems to surround and pervade the whole hemisphere, but the darker part, like a sort of cloud, discolours the moon's surface and makes it appear covered with spots. Now these spots . . . are plain to every one, and every age has seen them, wherefore I shall call them *great* or *ancient* spots, to distinguish them from other spots, smaller in size, but so thickly scattered that they sprinkle the whole surface of the moon, but especially the brighter portion of it. These spots have never been observed by any one before me, and from my observations of them, often repeated, I have been led to that opinion which I have expressed, namely, that I feel sure that the surface of the moon is not perfectly smooth, free from inequalities and exactly spherical, as a large school of philosophers considers with regard to the moon and the other heavenly bodies, but that, on the contrary, it is full of inequalities, uneven, full of hollows and protuberances, just like the surface of the earth itself, which is varied everywhere by lofty mountains and deep valleys.

EVALUATE THE EVIDENCE

1. What did the telescope permit Galileo to see on the moon that was not visible to the naked eye, and how did he interpret his observations?
2. Why were Galileo's observations so important to the destruction of the Ptolemaic universe?

Source: Galileo Galilei, *The Sidereal Messenger* (London: Rivingtons, 1880), pp. 10–11, 14–15.

Newton's Synthesis

By about 1640 the work of Brahe, Kepler, and Galileo had been largely accepted by the scientific community despite opposition from religious leaders. The old Aristotelian astronomy and physics were in ruins, and several fundamental breakthroughs had been made. But the new findings failed to explain what forces controlled the movement of the planets and objects on earth. That challenge was taken up by English scientist Isaac Newton (1642–1727), a genius who spectacularly united the experimental and theoretical-mathematical sides of modern science.

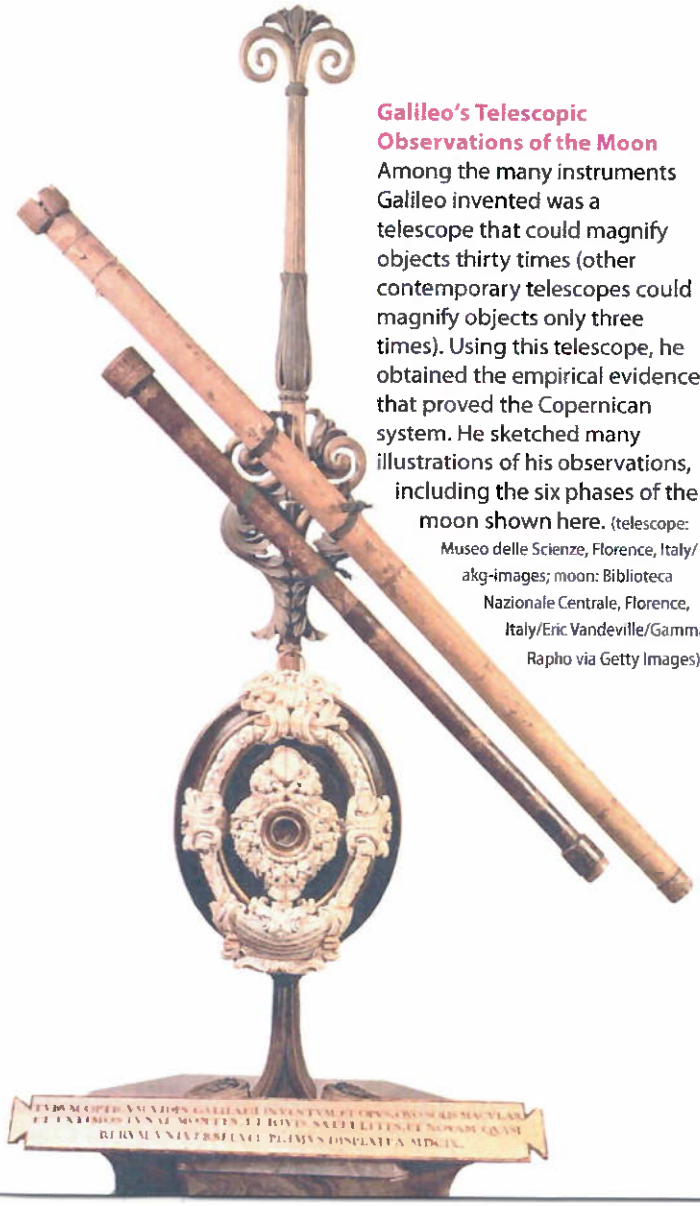
Newton was born into the lower English gentry, and he enrolled at Cambridge University in 1661. He arrived at some of his most basic ideas about physics in 1666 at age twenty-four but was unable to prove them mathematically. In 1684, after years of studying optics, Newton returned to mechanics for eighteen intensive months. The result was his towering accomplishment, a single explanatory system that could integrate the astronomy of Copernicus, as corrected by Kepler's laws, with the physics of Galileo and his predecessors. Newton did this through a set of mathematical laws that explain motion and mechanics. These laws were published in 1687 in Newton's *Mathematical Principles of Natural Philosophy* (also known as the *Principia Mathematica*). Because of their complexity, it took scientists and engineers two hundred years to work out all their implications.

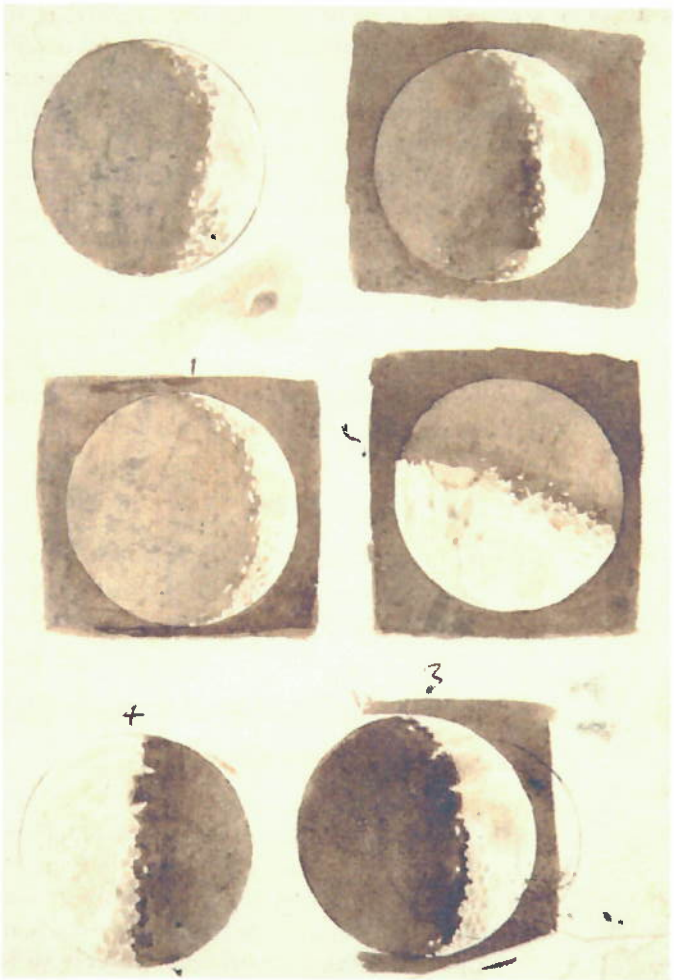
■ **law of universal gravitation** Newton's law that all objects are attracted to one another and that the force of attraction is proportional to the objects' quantity of matter and inversely proportional to the square of the distance between them.

The key feature of the Newtonian synthesis was the **law of universal gravitation**. According to this law, every body in the universe attracts every other body in the universe in a precise mathematical relationship, whereby the force of attraction is proportional to the quantity of matter of the objects and inversely proportional to the square of the distance between them. The whole universe—from Kepler's elliptical orbits to Galileo's rolling balls—was unified in one majestic system. Newton's synthesis of mathematics with physics and astronomy established him as one of the most important figures in the history of science; it prevailed until Albert Einstein's formulation of the general theory of relativity in 1915. Yet, near the end of his life, he declared: "I do not know what I may appear to the world; but to myself I seem to have been only like a boy, playing on the seashore, and diverting myself, in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."[3]

Natural History and Empire

At the same time that they made advances in astronomy and physics, Europeans embarked on the pursuit of knowledge about unknown geographical regions and the useful and valuable resources they contained. Because they were the first to acquire a large overseas empire, the Spanish pioneered these efforts. Following the conquest of the Aztec and Inca Empires (see "Conquest of the Aztec Empire" and "The Fall of the Incas" in Chapter 14), they sought to learn about and profit from their New World holdings. The Spanish crown sponsored many scientific expeditions to gather information and specimens, out of which emerged new discoveries that reshaped the fields of botany, zoology, cartography, and metallurgy, among others. These accomplishments have attracted less attention from historians in part because the strict policy of secrecy imposed on scientific discoveries by the Spanish crown limited the documents circulating about them.





Galileo's Telescopic Observations of the Moon Among the many instruments Galileo invented was a telescope that could magnify objects thirty times (other contemporary telescopes could magnify objects only three times). Using this telescope, he obtained the empirical evidence that proved the Copernican system. He sketched many illustrations of his observations, including the six phases of the moon shown here. (telescope: Museo delle Scienze, Florence, Italy/akg-images; moon: Biblioteca Nazionale Centrale, Florence, Italy/Eric Vandeville/Gamma Rapho via Getty Images)

Plants were a particular source of interest because they offered potential for tremendous profits in the form of spices, medicines, dyes, and cash crops. King Philip II of Spain sent his personal physician, Francisco Hernández, to New Spain for seven years in the 1560s. Hernández filled fifteen volumes with illustrations of three thousand plants previously unknown in Europe. He extensively interviewed local healers about the plants' medicinal properties, thereby benefiting from centuries of Mesoamerican botanical knowledge. In the seventeenth century, for example, the Spanish obtained a monopoly on the world's supply of cinchona bark, which comes from a tree native to the high altitudes of the Andes and was the first effective treatment for malaria.

Other countries followed the Spanish example as their global empires expanded, relying on both official expeditions and the private initiative of merchants, missionaries, and settlers. Royal botanical gardens served as living laboratories for cultivating valuable foreign plants. Over time, the stream of new information about plant and animal species overwhelmed existing intellectual frameworks. Carl Linnaeus (1707–1778) of Sweden sent his students on exploratory voyages around the world and, based on their observations and the specimens they collected, devised a formal system of naming and classifying living organisms still used today (with substantial revisions).

New encyclopedias of natural history popularized this knowledge with realistic drawings and descriptions emphasizing the usefulness of animals and plants. Audiences at home eagerly read the accounts of naturalists, who braved the heat, insects, and diseases of tropical jungles to bring home exotic animal, vegetable, and mineral specimens (along with captive indigenous human subjects). Audiences heard much less about the many local guides, translators, and practitioners of medicine and science who made these expeditions possible and who contributed a great deal of knowledge about the natural world.

Magic and Alchemy

Recent historical research on the Scientific Revolution has focused on the contribution of ideas and practices we no longer recognize as science, such as astrology and alchemy. For most of human history, interest in astronomy was inspired by the belief that the movement of heavenly bodies influenced events on earth. Many of the most celebrated astronomers also worked as astrologers. Used as a diagnostic tool in medicine, astrology formed a regular part of the curriculum of medical schools.

Centuries-old practices of magic and alchemy also remained important traditions for natural philosophers. Early modern practitioners of magic strove to understand and control hidden connections they perceived among different elements of the natural world, such as that between a magnet and iron. The idea that objects possessed hidden or "occult" qualities that allowed them to affect objects at a distance was a particularly important legacy of the magical tradition. Belief in occult qualities—or numerology or cosmic harmony—was not antithetical to belief in God. On the contrary, adherents believed that only a divine creator could infuse the universe with such meaningful mystery.

Johannes Kepler exemplifies the interaction among these different strands of interest. His duties as court mathematician included casting horoscopes for the royal family, and he guided his own life by astrological principles. He also wrote at length on cosmic harmonies and explained elliptical motion through ideas about the beautiful music created by the combined motion of the planets. Kepler's fictional account of travel to the moon, written partly to illustrate the idea of a non-earth-centered universe, caused controversy and may have contributed to the arrest and trial of his mother as a witch in 1620. Kepler also suffered because of his unorthodox brand of Lutheranism, which led to his condemnation by both Lutherans and Catholics.

Another example of the interweaving of ideas and beliefs is Sir Isaac Newton, who was both intensely religious and fascinated by alchemy, whose practitioners believed (among other things) that base metals could be turned into gold. Critics complained that his idea of universal gravitation was merely a restatement of old magical ideas about the innate sympathies between bodies; Newton himself believed that the attraction of gravity resulted from God's actions in the universe.

What intellectual and social changes occurred as a result of the Scientific Revolution?

The Scientific Revolution was not accomplished by a handful of brilliant individuals working alone. Advancements occurred in many fields—medicine, chemistry, and botany, among others—as scholars developed new methods to seek answers to long-standing problems. They did so in collaboration with skilled craftsmen who invented new instruments and helped conduct experiments. These results circulated in an intellectual community from which women were usually excluded.

The Methods of Science: Bacon and Descartes

One of the keys to the achievement of a new worldview in the seventeenth century was the development of better ways of obtaining knowledge. Two important thinkers, Francis Bacon (1561–1626) and René Descartes (day-KAHRT) (1596–1650), were influential in describing and advocating for improved scientific methods based, respectively, on empirical observation and on mathematical reasoning.

The English politician and writer Francis Bacon was the greatest early propagandist for the experimental method. Rejecting the Aristotelian and medieval method of using speculative reasoning to build general theories, Bacon called for a new approach to scientific inquiry based on direct observation, free from the preconceptions and prejudices of the past. The researcher who wants to learn more about leaves or rocks, for example, should not speculate about the subject but rather collect a multitude of specimens and then compare and analyze them to derive general principles. This technique of producing knowledge is known as inductive reasoning, which works from specific observations up to broader generalizations and theories. Bacon's work, and his prestige as lord chancellor under James I, led to the widespread adoption of what was called "experimental philosophy" in Britain after his death. In 1660 followers of Bacon created the Royal Society (still in existence), which met weekly to conduct experiments and discuss the latest findings of scholars across Europe.

On the continent, more speculative methods gained support. In 1619, as a twenty-three-year-old soldier serving in the Thirty Years' War, the French philosopher René Descartes experienced a life-changing intellectual vision. Descartes saw that there was a perfect correspondence between geometry and algebra and that geometrical spatial figures could be expressed as algebraic equations and vice versa. A major step forward in the history of mathematics, Descartes's discovery of analytic geometry provided scientists with an important new tool.

Descartes used mathematics to elaborate a new vision of the workings of the cosmos. Accepting Galileo's claim that all elements of the universe are composed of the same matter, Descartes began to investigate the basic nature of matter. Drawing on ancient Greek atomist philosophies, he developed the idea that matter was made up of "corpuscles" (tiny particles) that collided together in an endless series of motions, akin to the workings of a machine. All occurrences in nature could be analyzed as matter in motion, and the total "quantity of motion" in the universe was constant. Descartes's mechanistic view of the universe depended on the idea that space was identical to matter and that empty space—a vacuum—was therefore impossible.

Although Descartes's hypothesis about the vacuum was proved wrong, his notion of a mechanistic universe intelligible through the physics of motion proved inspirational. Decades later, Newton rejected Descartes's idea of a full universe and several of his other ideas, but retained the notion of a mechanistic universe as a key element of his own system.

Descartes's greatest achievement was to develop his initial vision into a whole philosophy of knowledge and science. The Aristotelian cosmos was appealing in part because it corresponded with the evidence of the human senses. When experiments proved that sensory impressions could be wrong, Descartes decided it was necessary to doubt them and everything that could reasonably be doubted, and to then, as in geometry, use deductive reasoning from self-evident truths, which he called "first principles," to ascertain scientific laws.

Descartes's reasoning ultimately reduced all substances to "matter" and "mind"—that is, to the physical and the mental. The devout Descartes believed that God had endowed man with reason for a purpose and that rational speculation could provide a path to the truths of creation. His view of the world as consisting of these two fundamental entities is known as **Cartesian dualism**. Descartes's thought was highly influential in France and the Netherlands, but less so in England, where experimental philosophy won the day.

Both Bacon's inductive experimentalism and Descartes's deductive mathematical reasoning had flaws. Bacon's inability to appreciate the importance of mathematics and his obsession with practical results clearly showed the limitations of antitheoretical empiricism. Likewise, some of Descartes's positions demonstrated the inadequacy of rigid, dogmatic rationalism. For example, he believed that it was possible to deduce the whole science of medicine from first principles. Although insufficient on their own, Bacon's and Descartes's extreme approaches are combined in the modern scientific method, which began to crystallize in the late seventeenth century.

Medicine, the Body, and Chemistry

The Scientific Revolution, which began with the study of the cosmos, soon transformed the understanding of the microcosm of the human body. For many centuries the ancient Greek physician Galen's explanation of the body carried the same authority as Aristotle's account of the universe. According to Galen, the body contained four humors: blood, phlegm, black bile, and yellow bile. Illness was believed to result from an

■ **Cartesian dualism** Descartes's view that all of reality could ultimately be reduced to mind and matter.

MAJOR CONTRIBUTORS TO THE SCIENTIFIC REVOLUTION

Nicolaus Copernicus (1473–1543)	Wrote *On the Revolutions of the Heavenly Spheres* (1543); theorized that the sun, rather than the earth, was the center of the universe
Paracelsus (1493–1541)	Swiss physician and alchemist who pioneered the use of chemicals to address illness
Andreas Vesalius (1514–1564)	Wrote *On the Structure of the Human Body* (1543)
Tycho Brahe (1546–1601)	Built observatory and recorded data on planetary motions
Francis Bacon (1561–1626)	Advocated experimental method, formalizing theory of inductive reasoning known as empiricism
Galileo Galilei (1564–1642)	Used telescopic observation to provide evidence for Copernican hypothesis
Johannes Kepler (1571–1630)	Used Brahe's data to provide mathematical support for the Copernican hypothesis; his new laws of planetary motion united for the first time natural philosophy and mathematics; completed the *Rudolphine Tables* in 1627
William Harvey (1578–1657)	Discovered the circulation of the blood (1628)
René Descartes (1596–1650)	Used deductive reasoning to formulate the theory of Cartesian dualism
Robert Boyle (1627–1691)	Formulated Boyle's law (1662) governing the pressure of gases
Isaac Newton (1642–1727)	Published *Principia Mathematica* (1687); set forth the law of universal gravitation, synthesizing previous theories of motion and matter

imbalance of humors, which is why doctors frequently prescribed bloodletting to expel excess blood.

Swiss physician and alchemist Paracelsus (1493–1541) was an early proponent of the experimental method in medicine and pioneered the use of chemicals to address what he saw as chemical, rather than humoral, imbalances. Another experimentalist, Flemish physician Andreas Vesalius (1514–1564), studied anatomy by dissecting human bodies, often those of executed criminals. In 1543, the same year Copernicus published *On the Revolutions*, Vesalius issued his masterpiece, *On the Structure of the Human Body*. Its two hundred precise drawings revolutionized the understanding of human anatomy, disproving Galen, just as Copernicus and his successors had disproved Aristotle and Ptolemy. (See "Evaluating Visual Evidence: Frontispiece to *On the Structure of the Human Body*," page 471.) The experimental approach also led English royal physician William Harvey (1578–1657) to discover the circulation of blood through the veins and arteries in 1628. Harvey was the first to explain that the heart worked like a pump and to explain the function of its muscles and valves.

Robert Boyle (1627–1691), a key figure in the victory of experimental methods in England, helped create the Royal Society in 1660. Among the first scientists to perform controlled experiments and publish details of them, he helped improve a number of scientific instruments. For example, he built and experimented with an air pump, which he used to investigate the properties of air and create a vacuum, thus disproving Descartes's belief that a vacuum could not exist in nature. Based on these experiments, he formulated a new law in 1662, now known as Boyle's law, that states that the pressure of a gas varies inversely with volume. Boyle also hypothesized that chemical substances were composed of tiny mechanical particles, out of which all other matter was formed.

Science and Religion

It is sometimes assumed that the relationship between science and religion is fundamentally hostile and that the pursuit of knowledge based on reason and proof is incompatible with faith. Yet during the Scientific Revolution most practitioners were devoutly religious and saw their work as contributing to the celebration of God's glory rather than undermining it. However, the concept of heliocentrism, which displaced the earth from the center of the universe, threatened the understanding of the place of mankind in creation as stated in Genesis. All religions derived from the Old Testament—Catholic, Protestant, Jewish, and Muslim—thus faced difficulties accepting the Copernican system. The leaders of the Catholic Church were initially less hostile than Protestant and Jewish religious leaders, but in the first decades of the sixteenth century the Catholic attitude changed. In 1616, alarmed by research findings by Galileo Galilei and other astronomers that undermined traditional astronomy, the Holy Office placed the works of Copernicus and his supporters on a list of books Catholics were forbidden to read. It also warned Galileo not to espouse heliocentrism or face the consequences.

Out of caution, Galileo silenced his views for several years, until 1623 saw the ascension of Pope Urban VIII,

Frontispiece to *On the Structure of the Human Body*

During the sixteenth century, anatomists began to perform public dissections on human corpses, often those of executed criminals, with the aim of unveiling the mystery and the complexity of the human body. This was a revolutionary new hands-on approach for physicians, who usually worked from a theoretical, rather than a practical, understanding of the body. To establish their authors' scientific authority and foster readers' interest, books on anatomy in this period began to feature images of their authors engaged in the act of dissection.

One of the pioneers of this new approach was Andreas Vesalius, who occupied the chair of anatomy at the University of Padua in Italy. The frontispiece to his book *On the Structure of the Human Body*, published in 1543, is shown here. The image depicts Vesalius gazing at the viewer while gesturing at the abdomen of a female cadaver he has cut open to reveal the womb. An unruly crowd of onlookers presses around the table to observe the procedure. A plaque hanging above the scene identifies Vesalius as "Andreae Vesalii" of Brussels and provides information about the book. Two barber-surgeons, the craftsmen previously responsible for dissections, sit underneath the table, fighting over surgical instruments. A skeleton is perched on the railing of the seats that overlook the dissection table.

(Universal History Archive/Shutterstock)

EVALUATE THE EVIDENCE

1. Do you think this is a realistic image of a medical dissection? Why or why not?
2. Why would Vesalius choose to open his book with an image of himself dissecting a corpse? What impression of the author and of the science of anatomy does the frontispiece give?
3. What is the significance of the depiction of a female cadaver with her womb exposed? Overall, what impression of the gendering of scientific knowledge does the image convey?

a man sympathetic to the new science. However, Galileo's 1632 *Dialogue on the Two Chief Systems of the World* went too far. Published in Italian and widely read, it openly lampooned the Aristotelian view and defended Copernicus. In 1633 the papal Inquisition placed Galileo on trial for heresy. Imprisoned and threatened with torture, the aging Galileo recanted, "renouncing and cursing" his Copernican errors.

Thereafter, the Catholic Church became more hostile to science, a change that helped account for the decline of science in Italy (but not in Catholic France, where there was no Inquisition and the papacy held less sway). At the same time, some Protestant countries, including the Netherlands, Denmark, and England, became quite "pro-science." This was especially true in countries without a strong religious authority capable of imposing religious orthodoxy on scientific questions.

Science and Society

The rise of modern science had many consequences. First, it created a new social group—the international scientific community. Members of this community were linked together by common interests and values

Metamorphoses of the Caterpillar and Moth Maria Sibylla Merian (1647–1717), the stepdaughter of a Dutch painter, became a celebrated scientific illustrator in her own right. Her finely observed pictures of insects in the South American colony of Suriname introduced many new species. For Merian, science was intimately tied with art: she not only painted but also bred caterpillars and performed experiments on them. Her two-year stay in Suriname, accompanied by a teenage daughter, was a daring feat for a seventeenth-century woman. (From *Metamorphosis Insectorum Surinamensium*, 1705/akg-images)

as well as by scholarly journals and associations. The personal success of scientists and scholars depended on making new discoveries, and science became competitive. Second, as governments intervened to support and sometimes direct research, the new scientific community became closely tied to the state and its agendas. National academies of science were created under state sponsorship in London in 1660, Paris in 1666, Berlin in 1700, and later across Europe.

It was long believed that the Scientific Revolution had little relationship to practical concerns and the life of the masses until the late-eighteenth-century Industrial Revolution (see Chapter 20). More recently, historians have emphasized the importance of skilled craftsmen in the rise of science, particularly in the development of the experimental method. Many artisans developed a strong interest in emerging scientific ideas, and, in turn, the practice of science in the seventeenth century often relied on artisans' expertise in making instruments and conducting precise experiments.

Some things did not change in the Scientific Revolution. For example, scholars willing to challenge received ideas about the natural universe did not question the seemingly natural inequalities between the sexes. Instead, the emergence of professional science may have worsened them in some ways. When Renaissance courts served as centers of learning, talented noblewomen could find niches in study and research. But the rise of a scientific community raised new barriers for women because the universities and academies that furnished professional credentials refused them entry.

There were, however, a number of noteworthy exceptions. In Italy, universities and academies did offer posts to women. Across Europe, women worked as makers of wax anatomical models and as botanical and zoological illustrators, like Maria Sibylla Merian. They were also very much involved in informal scientific communities, attending salons (see "Women and the Enlightenment" later in this chapter), participating in scientific experiments, and writing learned treatises. Some female intellectuals became full-fledged members of the philosophical dialogue. In England, Margaret Cavendish, Anne Conway, and Mary Astell all contributed to debates about Descartes's mind-body dualism, among other issues. Descartes himself conducted an intellectual correspondence with the princess Elizabeth of Bohemia, of whom he stated: "I attach more weight to her judgment than to those messieurs the Doctors, who take for a rule of truth the opinions of Aristotle rather than the evidence of reason."[4]

How did the Enlightenment emerge, and what were major currents of Enlightenment thought?

The political, intellectual, and religious developments of the early modern period that gave rise to the Scientific Revolution further contributed to a series of debates about key issues in late-seventeenth- and eighteenth-century Europe and the wider world that came to be known as the **Enlightenment**. By shattering the unity of Western Christendom, the conflicts of the Reformation brought old religious certainties into question; the strong states that emerged to quell the disorder soon inspired questions about

political sovereignty and its limits. Increased movement of peoples, goods, and ideas within and among the continents of Asia, Africa, Europe, and America offered examples of surprisingly different ways of life and patterns of thought. Finally, the tremendous achievements of the Scientific Revolution inspired intellectuals to believe that answers to all the questions being asked could be found through observation and critical thinking. Nothing was to be accepted on faith; everything was to be submitted to **rationalism**, a secular, critical way of thinking. It was believed that through such thinking progress could be made in human society as well as science.

The Early Enlightenment

Loosely united by certain key ideas, the European Enlightenment (ca. 1690–1789) was a broad intellectual and cultural movement that gained strength gradually and did not reach its maturity until about 1750. Its origins in the late seventeenth century lie in a combination of developments, including political opposition to absolutist rule; religious conflicts between Protestants and Catholics and within Protestantism; European contacts with other cultures; and the attempt to apply principles and practices from the Scientific Revolution to increase knowledge and improve living conditions in human society.

A key crucible for Enlightenment thought was the Dutch Republic, with its traditions of religious tolerance and republican rule. When Louis XIV demanded that all Protestants convert to Catholicism, around two hundred thousand French Protestants, or Huguenots, fled France, many destined for the Dutch Republic. From this haven of tolerance, Huguenots and their supporters began to publish tracts denouncing religious intolerance and suggesting that only a despotic monarch, not a legitimate ruler, would deny religious freedom. Their challenge to authority thus combined religious and political issues.

These dual concerns drove the career of one important early Enlightenment writer, Pierre Bayle (1647–1706), a Huguenot who took refuge in the Dutch Republic. Bayle critically examined the religious beliefs and persecutions of the past in his *Historical and Critical Dictionary* (1697). Demonstrating that human beliefs had been extremely varied and very often mistaken, he concluded that nothing can ever be known beyond all doubt, a view known as skepticism. His influential *Dictionary* was found in more private libraries of eighteenth-century France than any other book.

The Dutch Jewish philosopher Baruch Spinoza (1632–1677) was another key figure in the transition from the Scientific Revolution to the Enlightenment. Deeply inspired by advances in science—in particular by debates about Descartes's thought—Spinoza sought to apply natural philosophy to thinking about human society. He borrowed Descartes's emphasis on rationalism and his methods of deductive reasoning, but he rejected the French thinker's mind-body dualism. Instead, Spinoza came to espouse monism, the idea that mind and body were united in one substance and that God and nature were merely two names for the same thing. He envisioned a deterministic universe in which good and evil were merely relative values and human actions were shaped by outside circumstances, not free will. Spinoza was excommunicated by the Jewish community of Amsterdam for his controversial religious ideas, but he was heralded by his Enlightenment successors as a model of personal virtue and courageous intellectual autonomy.

The German philosopher and mathematician Gottfried Wilhelm von Leibniz (1646–1716), who had developed calculus independently of Isaac Newton, refuted both Cartesian dualism and Spinoza's monism. Instead, he adopted the idea of an infinite number of substances, or "monads," from which all matter is composed. His *Theodicy* (1710) declared that ours must be "the best of all possible worlds" because it was created by an omnipotent and benevolent God. Leibniz's optimism was later ridiculed by the French philosopher Voltaire in *Candide or Optimism* (1759).

Out of this period of intellectual turmoil came John Locke's *Essay Concerning Human Understanding* (1690), perhaps the most important text of the early Enlightenment. In this work Locke (1632–1704), a physician and member of the Royal Society, set forth a new theory about how human beings learn and form their ideas. Whereas Descartes based his deductive logic on the conviction that certain first principles, or innate ideas, are imbued in humans by God, Locke insisted that all ideas are derived from experience. The human mind at birth is like a blank tablet, or tabula rasa, on which understanding and beliefs are inscribed by experience. Human development is therefore determined by external forces, like education and social institutions, not innate characteristics. Locke's essay contributed to the theory of **sensationalism**, the idea that all human ideas and thoughts are produced as a result of sensory impressions.

Along with Newton's *Principia*, the *Essay Concerning Human Understanding* was one of the great

■ **Enlightenment** The influential intellectual and cultural movement of the late seventeenth and eighteenth centuries that introduced a new worldview based on the use of reason, the scientific method, and progress.

■ **rationalism** A secular, critical way of thinking in which nothing was to be accepted on faith and everything was to be submitted to reason.

■ **sensationalism** The idea that all human ideas and thoughts are produced as a result of sensory impressions.

Philosophes' Dinner Party This engraving depicts one of the famous dinners hosted by Voltaire at Ferney, the estate on the French-Swiss border where he spent the last twenty years of his life. A visit to the great philosophe (pictured in the center with arm raised) became a cherished pilgrimage for Enlightenment writers. (Engraving by Jean Huber [1721–1786]/Album/Art Resource, NY)

intellectual inspirations of the Enlightenment. Locke's equally important contribution to political theory, *Two Treatises of Government* (1690), insisted on the sovereignty of the Parliament against the authority of the Crown (see "Constitutional Monarchy" in Chapter 15).

The Influence of the Philosophes

Divergences among the early thinkers of the Enlightenment show that, while they shared many of the same premises and questions, the answers they found differed widely. The spread of this spirit of inquiry owed a great deal to the work of the **philosophes** (fee-luh-ZAWFZ) (French for "philosopher"), a group of French intellectuals who proudly proclaimed that they were bringing the light of reason to their ignorant fellow humans.

In the mid-eighteenth century France became a hub of Enlightenment thought, for at least three reasons. First, French was the international language of the educated classes, and France was the wealthiest and most populous country in Europe. Second, the rising unpopularity of the French monarchy generated growing discontent and calls for reform among the educated elite. Third, the French philosophes made it their goal to reach a larger audience of elites, many of whom were joined together in a concept inherited from the Renaissance known as the Republic of Letters—an imagined transnational realm in which critical thinkers and writers participated.

To appeal to the public and get around the censors, the philosophes wrote novels and plays, histories and philosophies, and dictionaries and encyclopedias, all filled with satire and double meanings to spread their message. One of the greatest philosophes, the baron de Montesquieu (mahn-tuhs-KYOO) (1689–1755), pioneered this approach in *The Persian Letters*, published in 1721. This work consists of letters written by two fictional Persian travelers, who as outsiders see European customs in unique ways and thereby allow Montesquieu a vantage point for criticizing existing practices and beliefs.

Disturbed by the growth in absolutism under Louis XIV and inspired by the example of the physical sciences, Montesquieu set out to apply the critical method to the problem of government in *The Spirit of Laws* (1748). Arguing that forms of government were shaped by history and geography, Montesquieu identified three main types: monarchies, republics, and despotisms. A great admirer of the English parliamentary system, he argued for a separation of powers, with political power divided among different classes and legal estates holding unequal rights and privileges. Montesquieu was no democrat; he was apprehensive about the uneducated poor and did not question the sovereignty of the French monarchy. But he was concerned that absolutism in France was drifting into tyranny and believed that strengthening the influence of intermediary powers was the best way to prevent it. Decades later, his theory of separation of powers had a great impact on the constitutions of the young United States in 1789 and of France in 1791.

The most famous philosophe was François Marie Arouet, known by the pen name Voltaire (vohl-TAIR) (1694–1778). In his long career, Voltaire wrote more than seventy witty volumes, hobnobbed with royalty, and died a millionaire through shrewd

speculations. His early career, however, was turbulent, and he was twice arrested for insulting noblemen. To avoid a prison term, Voltaire moved to England for three years, and there he came to share Montesquieu's enthusiasm for English liberties and institutions.

Returning to France, Voltaire met Gabrielle-Emilie Le Tonnelier de Breteuil, marquise du Châtelet (SHAH-tuh-lay) (1706–1749), a gifted noblewoman. Madame du Châtelet invited Voltaire to live in her country house at Cirey in Lorraine and became his long-time companion, under the eyes of her tolerant husband. Passionate about science, she studied physics and mathematics and published scientific articles and translations, including the first translation of Newton's *Principia* into French, still in use today. Excluded from the Royal Academy of Sciences because she was a woman, Madame du Châtelet had no doubt that women's limited role in science was due to their unequal education. Discussing what she would do if she were a ruler, she wrote, "I would reform an abuse which cuts off, so to speak, half the human race. I would make women participate in all the rights of humankind, and above all in those of the intellect."[5]

While living at Cirey, Voltaire wrote works praising England and popularizing English science. Yet, like almost all of the philosophes, Voltaire was a reformer, not a revolutionary, in politics. He pessimistically concluded that the best one could hope for in the way of government was a good monarch, since human beings "are very rarely worthy to govern themselves." Nor did Voltaire believe in social and economic equality. The only realizable equality, Voltaire thought, was that "by which the citizen only depends on the laws which protect the freedom of the feeble against the ambitions of the strong."[6]

Voltaire's philosophical and religious positions were much more radical. He believed in God, but he rejected Catholicism in favor of **deism**, belief in a distant noninterventionist deity. Drawing on mechanistic philosophy, he envisioned a universe in which God acted like a great clockmaker who built an orderly system and then stepped aside to let it run. Above all, Voltaire and most of the philosophes hated all forms of religious intolerance, which they believed led to fanaticism and cruelty. (See "Thinking Like a Historian: The Enlightenment Debate on Religious Tolerance," page 476.)

The strength of the philosophes lay in their dedication and organization. Their greatest achievement was a group effort—the seventeen-volume *Encyclopedia: The Rational Dictionary of the Sciences, the Arts, and the Crafts*, edited by Denis Diderot (DEE-duh-roh) (1713–1784) and Jean le Rond d'Alembert (dah-luhm-BEHR) (1717–1783). Completed in 1766 despite opposition from the French state and the Catholic Church, the *Encyclopedia* contained seventy-two thousand articles by leading scientists, writers, skilled workers, and progressive priests. Science and the industrial arts were exalted, religion and immortality questioned. Intolerance, legal injustice, and out-of-date social institutions were openly criticized. The *Encyclopedia* also included many articles describing non-European cultures and societies, and it acknowledged Muslim scholars' contribution to Western science. Summing up the new worldview of the Enlightenment, the *Encyclopedia* was widely read, especially in less expensive reprint editions, and it was extremely influential.

After about 1770 a number of thinkers and writers began to attack the philosophes' faith in reason and progress. The most famous of these was Jean-Jacques Rousseau (1712–1778). The son of a poor Swiss watchmaker, Rousseau made his way into the Parisian Enlightenment through his brilliant intellect. Like other Enlightenment thinkers, he was passionately committed to individual freedom. Unlike them, however, he attacked rationalism and civilization as destroying, rather than liberating, the individual. Warm, spontaneous feeling, Rousseau believed, had to complement and correct cold intellect. Moreover, he asserted, the basic goodness of the individual and the unspoiled child had to be protected from the cruel refinements of civilization. Rousseau's ideals greatly influenced the early Romantic movement, which rebelled against the culture of the Enlightenment in the late eighteenth century.

Rousseau's contribution to political theory in *The Social Contract* (1762) was based on two fundamental concepts: the general will and popular sovereignty. According to Rousseau, the general will is sacred and absolute, reflecting the common interests of all the people, who have displaced the monarch as the holder of sovereign power (and thus exercise popular sovereignty). The general will is not necessarily the will of the majority, however. At times the general will may be the authentic, long-term needs of the people as correctly interpreted by a farsighted minority. Little noticed before the French Revolution, Rousseau's concept of the general will appealed greatly to democrats and nationalists after 1789.

Enlightenment Movements Across Europe

The Enlightenment was a movement of international dimensions, with thinkers traversing borders in a constant exchange of visits, letters, and printed materials.

■ **philosophes** A group of French intellectuals who proclaimed that they were bringing the light of knowledge to their fellow humans in the Age of Enlightenment.

■ **deism** Belief in a distant, noninterventionist deity; common among Enlightenment thinkers.

The Enlightenment Debate on Religious Tolerance

Enlightenment philosophers questioned many aspects of European society, including political authority, social inequality, and imperialism. A major focus of their criticism was the dominance of the established church and the persecution of minority faiths. While many philosophers defended religious tolerance, they differed widely in their approaches to the issue.

1 Moses Mendelssohn, "Reply to Lavater," 1769.

In 1769 Johann Caspar Lavater, a Swiss clergyman, called on Moses Mendelssohn to either refute proofs of Christianity publicly or submit to baptism. Mendelssohn's reply is both a call for toleration and an affirmation of his religious faith.

It is, of course, the natural obligation of every mortal to diffuse knowledge and virtue among his fellow men, and to do his best to extirpate their prejudices and errors. One might think, in this regard, that it was the duty of every man publicly to oppose the religious opinions that he considers mistaken. But not all prejudices are equally harmful, and hence the prejudices we may think we perceive among our fellow men must not all be treated in the same way. Some are directly contrary to the happiness of the human race. . . . These must be attacked outright by every friend of humanity. . . . Of this kind are all people's errors and prejudices that disturb their own or their fellows' peace and contentment and kill every seed of the true and the good in man before it can germinate. On the one hand, fanaticism, misanthropy, and the spirit of persecution, and on the other, frivolity, luxury, and libertinism.

Sometimes, however, the opinions of my fellow men, which in my belief are errors, belong to the higher theoretical principles which are too remote from practical life to do any direct harm; but, precisely because of their generality, they form the basis on which the nation that upholds them has built its moral and social system, and thus happen to be of great importance to this part of the human race. To oppose such doctrines in public, because we consider them prejudices, is to dig up the ground to see whether it is solid and secure, without providing any other support for the building that stands on it. Anyone who cares more for the good of humanity than for his own fame will be slow to voice his opinion about such prejudices, and will take care not to attack them outright without extreme caution.

2 Voltaire, *Treatise on Toleration*, 1763.

Voltaire, the prominent French philosophe, began his *Treatise on Toleration* by recounting the infamous trial of Jean Calas. Although all the evidence pointed toward suicide, the judges concluded that Calas had killed his son to prevent him from converting to Catholicism, and Calas was brutally executed in 1762. For Voltaire, the Calas affair was a battle between fanaticism and reason, extremism and moderation.

Some fanatic in the crowd cried out that Jean Calas had hanged his son Marc Antoine. The cry was soon repeated on all sides; some adding that the deceased was to have abjured Protestantism on the following day, and that the family and young Lavaisse had strangled him out of hatred of the Catholic religion. In a moment all doubt had disappeared. The whole town was persuaded that it is a point of religion with the Protestants for a father and mother to kill their children when they wish to change their faith.

. . . There was not, and could not be, any evidence against the family; but a deluded religion took the place of proof. . . . [The judges] were confounded when the old man, expiring on the wheel, prayed God to witness his innocence, and begged him to pardon his judges.

The daughters were taken from the mother and put in a convent. The mother, almost sprinkled with the blood of her husband, her eldest son dead, the younger banished, deprived of her daughters and all her property, was alone in the world, without bread, without hope, dying of the intolerable misery. Certain persons, having carefully examined the circumstances of this horrible adventure, were so impressed that they urged the widow, who had retired into solitude, to go and demand justice at the feet of the throne. . . . She reached Paris almost at the point of death. She was astonished at her reception, at the help and the tears that were given to her.

At Paris reason dominates fanaticism, however powerful it be; in the provinces fanaticism almost always overcomes reason.

ANALYZING THE EVIDENCE

1. Based on these sources, what attitudes did eighteenth-century Europeans manifest toward religions other than their own? Were such attitudes always negative?
2. What justifications did Enlightenment philosophers use to argue in favor of religious tolerance? Were these arguments necessarily antireligious?
3. Why did Judaism figure so prominently in debates about religious tolerance in eighteenth-century Europe? In what ways do you think Mendelssohn's experience as a Jew (Source 1) shaped his views on religious tolerance?

3 **Bernard Picart, "Jewish Meal During the Feast of the Tabernacles," from *Ceremonies and Customs of All the Peoples of the World*, 1724.** Eighteenth-century travel literature provided eager audiences with images and descriptions of religious practices from around the world. This image emphasizes the prosperity and warm family relations of a Jewish family enjoying a holiday meal, echoing the tolerant mind-set of the author.

(Jewish Chronicle/Heritage Images/Getty Images)

4 **Gotthold Ephraim Lessing, *Nathan the Wise*, 1779.** In this excerpt from *Nathan the Wise*, a play by German writer Gotthold Ephraim Lessing, the sultan Saladin asks a Jewish merchant named Nathan to tell him which is the true religion: Islam, Christianity, or Judaism. Nathan responds with a parable about a man who promised to leave the same opal ring, a guarantor of divine favor, to each of his three beloved sons. He then had two exact replicas of the ring made so that each son would believe he had inherited the precious relic.

NATHAN: Scarce was the father dead,
When each one with his ring appears
Claiming each the headship of the house.
Inspections, quarrelling, and complaints ensue;
But all in vain, the veritable ring
Was not distinguishable —
(After a pause, during which he expects the Sultan's answer)
Almost as indistinguishable as to us,
Is now — the true religion.

SALADIN: What? Is that meant as answer to my question?

NATHAN: 'Tis meant but to excuse myself, because
I lack the boldness to discriminate between the rings,
Which the father by express intent had made
So that they might not be distinguished.

SALADIN: The rings! Don't play with me.
I thought the faiths which I have named
Were easily distinguishable,
Even to their raiment, even to meat and drink.

NATHAN: But yet not as regards their proofs:
For do not all rest upon history, written or traditional?
And history can also be accepted
Only on faith and trust. Is it not so?
Now, whose faith and confidence do we least misdoubt?
That of our relatives? Of those whose flesh and blood we are,
Of those who from our childhood
Have lavished on us proofs of love,
Who ne'er deceived us, unless 'twere wholesome for us so?
How can I place less faith in my forefathers
Than you in yours? or the reverse?
Can I desire of you to load your ancestors with lies,
So that you contradict not mine? Or the reverse?
And to the Christian the same applies.
Is that not so?

PUTTING IT ALL TOGETHER

Using the sources above, along with what you have learned in class and in this chapter, compare and contrast the views on religious toleration presented in the sources. On what would the authors of these works have agreed? How did their arguments in favor of toleration differ? What explanation can you offer for the differences you note?

Sources: (1) Ritchie Robertson, ed., *The German-Jewish Dialogue: An Anthology of Literary Texts, 1749–1993* (New York: Oxford University Press, 1999), pp. 41–42; (2) Voltaire, *A Treatise on Toleration and Other Essays*, trans. Joseph McCabe (Amherst, N.Y.: Prometheus Books, 1994), pp. 147–149, 152–153; (4) Crane Brinton, ed., *The Portable Age of Reason Reader* (New York: Viking Press, 1956), pp. 383–389.

MAJOR FIGURES OF THE ENLIGHTENMENT

Baruch Spinoza (1632–1677)	Early Enlightenment thinker excommunicated from the Jewish religion for his concept of a deterministic universe
John Locke (1632–1704)	*Essay Concerning Human Understanding* (1690)
Gottfried Wilhelm von Leibniz (1646–1716)	German philosopher and mathematician known for his optimistic view of the universe
Pierre Bayle (1647–1706)	*Historical and Critical Dictionary* (1697)
Montesquieu (1689–1755)	*The Persian Letters* (1721); *The Spirit of Laws* (1748)
Voltaire (1694–1778)	Renowned French philosophe and author of more than seventy works
David Hume (1711–1776)	Central figure of the Scottish Enlightenment; *Of Natural Characters* (1748)
Jean-Jacques Rousseau (1712–1778)	*The Social Contract* (1762)
Denis Diderot (1713–1784) and Jean le Rond d'Alembert (1717–1783)	Editors of *Encyclopedia: The Rational Dictionary of the Sciences, the Arts, and the Crafts* (1751–1766)
Adam Smith (1723–1790)	*An Inquiry into the Nature and Causes of the Wealth of Nations* (1776)
Immanuel Kant (1724–1804)	*What Is Enlightenment?* (1784); *On the Different Races of Man* (1775)
Moses Mendelssohn (1729–1786)	Major philosopher of the Haskalah, or Jewish Enlightenment
Cesare Beccaria (1738–1794)	*On Crimes and Punishments* (1764)

Voltaire alone wrote almost eighteen thousand letters to correspondents in France and across Europe. The Republic of Letters, as this international group of scholars and writers was called, was a truly cosmopolitan set of networks stretching from western Europe to its colonies in the Americas, to Russia and eastern Europe, and along the routes of trade and empire to Africa and Asia.

Within this broad international conversation, scholars have identified numerous regional and national particularities. Outside of France, many strains of Enlightenment—Protestant, Catholic, and Jewish—sought to reconcile reason with faith, rather than emphasizing the errors of religious fanaticism and intolerance. Some scholars point to a distinctive "Catholic Enlightenment" that aimed to renew and reform the church from within, looking to divine grace rather than human will as the source of progress.

The Scottish Enlightenment, which was centered in Edinburgh, was marked by an emphasis on common sense and scientific reasoning. After the Act of Union with England in 1707, Scotland was freed from political crisis to experience a vigorous period of intellectual growth. Advances in philosophy were also stimulated by the creation of the first public educational system in Europe.

A central figure in Edinburgh was David Hume (1711–1776), whose emphasis on civic morality and religious skepticism had a powerful impact at home and abroad. Hume strove to apply Newton's experimental methods to what he called the "science of man." Building on Locke's writings on learning, Hume argued that the human mind is really nothing but a bundle of impressions that originate only in sensory experiences and our habits of mentally joining these experiences together. Therefore, reason cannot tell us anything about questions that cannot be verified by sensory experience (in the form of controlled experiments or mathematics), such as the origin of the universe or the existence of God. Hume further argued, in opposition to Descartes, that reason alone could not supply moral principles and that they derived instead from emotions and desires, such as feelings of approval or shame. Hume's rationalistic inquiry thus ended up undermining the Enlightenment's faith in the power of reason by emphasizing the superiority of the senses and the passions over reason in driving human thought and behavior.

Hume's emphasis on human experience, rather than abstract principle, had a formative influence on another major figure of the Scottish Enlightenment, Adam Smith (1723–1790). Smith argued that social interaction produced feelings of mutual sympathy that led people to behave in ethical ways, despite inherent tendencies toward self-interest. By observing others and witnessing their feelings, individuals imaginatively experienced such feelings and learned to act in ways that would elicit positive sentiments and avoid negative ones. Smith believed that the thriving commercial life of the eighteenth century was likely to produce civic virtue through the values of competition, fair play, and individual autonomy. In *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), Smith attacked the laws and regulations created by mercantilist governments that, he argued, prevented commerce from reaching its full capacity (see "Adam Smith and Economic Liberalism" in Chapter 17).

Inspired by philosophers of moral sentiments like Hume and Smith, as well as by physiological studies of the role of the nervous system in human perception, the celebration of sensibility became an important element of eighteenth-century culture. *Sensibility* referred to an acute sensitivity of the nerves and brains to outside stimuli, which produced strong emotional and physical reactions. Novels, plays, and other literary genres depicted moral and aesthetic sensibility as a particular characteristic of women and the upper classes. The proper relationship between reason and the emotions (or between *Sense and Sensibility*, as Jane Austen put it in the title of her 1811 novel) became a key question.

After 1760 Enlightenment ideas were hotly debated in the German-speaking states, often in dialogue with Christian theology. Immanuel Kant (1724–1804), a professor in East Prussia, was the greatest German philosopher of his day. Kant posed the question of the age when he published a pamphlet in 1784 titled *What Is Enlightenment?* He answered, "*Sapere Aude* [dare to know]! 'Have the courage to use your own understanding' is therefore the motto of enlightenment." He argued that if intellectuals were granted the freedom to exercise their reason publicly in print, enlightenment would almost surely follow. Kant was no revolutionary; he also insisted that in their private lives individuals must obey all laws, no matter how unreasonable, and should be punished for "impertinent" criticism. Like other Enlightenment figures in central and east-central Europe, Kant thus tried to reconcile absolute monarchical authority and religious faith with a critical public sphere.

Northern Europeans often regarded the Italian states as culturally backward, yet important developments in Enlightenment thought took place in the Italian peninsula. After achieving independence from Habsburg rule (1734), the kingdom of Naples entered a period of intellectual flourishing as reformers struggled to lift the heavy weight of church and noble power. In northern Italy a central figure was Cesare Beccaria (1738–1794), a nobleman educated at Jesuit schools and the University of Pavia. His *On Crimes and Punishments* (1764) was a passionate plea for reform of the penal system that decried the use of torture, arbitrary imprisonment, and capital punishment, and advocated the prevention of crime over the reliance on punishment. The text was quickly translated into French and English and made an impact throughout Europe and its colonies.

Beccaria's *On Crimes and Punishments* An Italian nobleman, the marquis de Beccaria brought the Enlightenment spirit of rationalism and tolerance to bear on the justice system. In his 1764 work *On Crimes and Punishments*, from which this illustration is taken, he argued for the abolition of torture and capital punishment as being ineffectual deterrents to crime and unethical actions on the part of the state. (Bibliothèque Nationale, Paris, France/Bridgeman Images)

How did the Enlightenment change social ideas and practices?

Europeans' increased interactions with non-European peoples and cultures also helped produce the Enlightenment spirit. Enlightenment thinkers struggled to assess differences between Western and non-Western cultures, often adopting Eurocentric views, but sometimes expressing admiration for other cultures. These same thinkers focused a great deal of attention on other forms of cultural and social difference, developing new ideas about race, gender, and political power. Although new "scientific" ways of thinking often served to justify inequality, the Enlightenment did see a rise in religious tolerance, a particularly crucial issue for Europe's persecuted Jewish population. As literacy rates rose and print

Portrait of Lady Mary Wortley Montagu Lady Mary Wortley Montagu accompanied her husband to the Ottoman Empire after he was named British ambassador to the empire. Her lively letters home, published after her death, question the supposedly inferior social status of Ottoman women compared to that of European women and other European assumptions about Ottoman society and culture. After her return home she publicized Ottoman practices of smallpox inoculation (as yet unknown in the West) and commissioned portraits of herself in Ottoman dress.
(By George Knapton [1698–1778]/Private Collection/photo © Christie's Images/Bridgeman Images)

culture flourished, Enlightenment ideas spread in a new "public sphere" composed of coffeeshops, literary salons, lending libraries, and other social institutions.

Global Contacts

In the wake of the great discoveries of the fifteenth and sixteenth centuries, the rapidly growing travel literature taught Europeans that the peoples of China, India, Africa, and the Americas had very different beliefs and customs. Educated Europeans began to look at truth and morality in relative, rather than absolute, terms. If anything was possible, who could say what was right or wrong?

The powerful and advanced nations of Asia were obvious sources of comparison with the West. Seventeenth-century Jesuit missionaries brought knowledge to the West about Chinese history and culture. Leibniz corresponded with Jesuits stationed in China, coming to believe that Chinese ethics and political philosophy were superior but that Europeans had equaled China in science and technology; some scholars believe his concept of monads was influenced by Confucian teaching on the harmony between the cosmic order and human society.[7]

During the Enlightenment, European opinion on China was divided. Voltaire and some other philosophes revered China—without ever visiting or seriously studying it—as an ancient culture replete with wisdom and learning, ruled by benevolent absolutist monarchs. They enthusiastically embraced Confucianism as a natural religion in which universal moral truths were uncovered by reason. By contrast, Montesquieu and Diderot criticized China as a despotic land ruled by fear.

Attitudes toward Islam and the Muslim world were similarly mixed. As the Ottoman military threat receded at the end of the seventeenth century, some Enlightenment thinkers assessed Islam favorably. Some deists praised Islam as superior to Christianity and valued Judaism for its rationality, compassion, and tolerance. Others, including Spinoza, saw Islamic culture as superstitious and favorable to despotism. In most cases, writing about Islam and Muslim cultures served primarily as a means to reflect on Western values and practices. Thus Montesquieu's *Persian Letters* used the Persian harem as a symbol of despotic rule that he feared his own country was adopting. Voltaire's play about the life of the Prophet portrayed Muhammad as the epitome of the religious fanaticism the philosophes opposed.

One writer with considerable personal experience in a Muslim country was Lady Mary Wortley Montagu, wife of the English ambassador to the Ottoman Empire. Her letters challenged prevailing ideas by depicting Turkish people as sympathetic and civilized. Montagu also disputed the notion that women were oppressed in Ottoman society.

Apart from debates about Asian and Muslim lands, the "discovery" of the New World and subsequent explorations in the Pacific Ocean also challenged existing norms and values in Europe. One popular idea, among Rousseau and others, was that indigenous peoples of the Americas were living examples of "natural man," who embodied the essential goodness of humanity uncorrupted by decadent society. Others depicted as utopian natural men were the Pacific Island societies explored by Captain James Cook and others from the 1770s on.

Enlightenment Debates About Race

As scientists developed taxonomies of plant and animal species in response to discoveries in the Americas,

they also began to classify humans into hierarchically ordered "races" and to speculate on the origins of such races. In *The System of Nature* (1735), Swedish botanist Carl Linnaeus argued that nature was organized into a God-given hierarchy. The comte de Buffon (komt duh buh-FOHN) argued that humans originated with one species that then developed into distinct races due largely to climatic conditions. Although the notion of a single origin of human beings opened the door to arguments for equality, Buffon and others who espoused this idea maintained that white Europeans represented the human norm, while other groups had degenerated from this norm over time.

Enlightenment thinkers such as David Hume and Immanuel Kant helped popularize ideas about racial difference and inequality. In *Of Natural Characters* (1748), Hume wrote:

> I am apt to suspect the negroes and in general all other species of men (for there are four or five different kinds) to be naturally inferior to the whites. There never was a civilized nation of any other complexion than white, nor even any individual eminent amongst them, no arts, no sciences. . . . Such a uniform and constant difference could not happen, in so many countries and ages if nature had not made an original distinction between these breeds of men.[8]

Kant taught and wrote as much about anthropology and geography as he did about standard philosophical themes such as logic, metaphysics, and moral philosophy. He elaborated his views about race in *On the Different Races of Man* (1775), claiming that there were four human races, each of which had derived from an original race. The closest descendants of the original race, and the most superior, were the white inhabitants of northern Germany. (Scientists now know the human race originated in Africa.)

Using the word *race* to designate biologically distinct groups of humans, akin to distinct animal species, was new. Previously, Europeans had grouped other peoples into "nations" based on their historical, political, and cultural affiliations, rather than on supposedly innate physical differences. Unsurprisingly, when European thinkers drew up a hierarchical classification of human species, their own "race" was placed at the top. Europeans had long believed they were culturally superior to supposedly "barbaric" peoples in Africa and, since 1492, the New World. Now emerging ideas about racial difference taught them they were biologically superior as well. In turn, scientific racism helped legitimate and justify the tremendous growth of slavery that occurred during the eighteenth century. If one "race" of humans was fundamentally different and inferior, its members could be seen as particularly fit for enslavement and liable to benefit from tutelage by the superior race.

Racist ideas did not go unchallenged. The abbé Raynal's *History of the Two Indies* (1770) fiercely attacked slavery and the abuses of European colonization. *Encyclopedia* editor Denis Diderot adopted Montesquieu's technique of criticizing European attitudes through the voice of outsiders in "Supplement to Bougainville's Voyage," which contains an imaginary dialogue between Tahitian villagers and their European visitors. Scottish philosopher James Beattie (1735–1803) responded directly to claims of white superiority by pointing out that Europeans had started out as savage as nonwhites supposedly were and that many non-European peoples in the Americas, Asia, and Africa had achieved high levels of civilization. Former slaves, like Olaudah Equiano and Ottobah Cugoana, published eloquent memoirs testifying to the horrors of slavery and the innate equality of all humans. These challenges to racism, however, were in the minority. Many other Enlightenment voices supporting racial inequality—Thomas Jefferson among them—may be found.

Women and the Enlightenment

Dating back to the Renaissance *querelle des dames*, the debate over women's proper role in society and the nature of gender differences continued to fascinate Enlightenment thinkers. Some philosophes championed greater rights and expanded education for women, claiming that the position and treatment of women were the best indicators of a society's level of civilization and decency.[9] In *Persian Letters*, Montesquieu used the oppression of women in the harem, described in letters from the wives of Usbek, one of the Persian voyagers, as a potent symbol of the political tyranny he identified with the Persian Empire. At the end of the book, the rebellion of the harem against the cruel eunuchs Usbek left in charge serves to make Montesquieu's point that despotism must ultimately fail.

In the 1780s the marquis de Condorcet, a celebrated mathematician and contributor to the *Encyclopedia*, went so far as to urge that women should share equal rights with men. This was an extremely rare position. Most philosophes accepted that women were inferior to men intellectually as well as physically. They sought moderate reform at best, particularly in the arena of female education, and had no desire to upend men's traditional dominance over women.

From the first years of the Enlightenment, women writers made crucial contributions both to debates about women's rights and to the broader

Enlightenment conversations. In 1694 Mary Astell published *A Serious Proposal to the Ladies*, which encouraged women to aspire to the life of the mind and proposed the creation of a college for women. Astell also harshly criticized the institution of marriage. Echoing arguments made against the absolute authority of kings during the Glorious Revolution (see "Constitutional Monarchy" in Chapter 15), she argued that husbands should not exercise absolute control over their wives in marriage. Yet Astell, like most female authors of the period, was careful to acknowledge women's God-given duties to be good wives and mothers.

The explosion of printed literature during the eighteenth century (see the next section) brought significant numbers of women writers into print, but they remained a small proportion of published authors. In the second half of the eighteenth century, women produced some 15 percent of published novels, the genre in which they enjoyed the greatest success. They constituted a much tinier proportion of nonfiction authors.[10]

If they remained marginal in the world of publishing, women played a much more active role in the informal dimensions of the Enlightenment: conversation, letter writing, travel, and patronage. A key element of their informal participation was as salon hostesses, or *salonnières* (sah-lahn-ee-EHRZ). **Salons** were weekly meetings held in wealthy households that brought together writers, aristocrats, financiers, and noteworthy foreigners for meals and witty discussions of the latest trends in literature, science, and philosophy. One prominent salonnière was Madame du Deffand, whose weekly Parisian salon included such guests as Montesquieu, d'Alembert, and Benjamin Franklin, then serving as the first U.S. ambassador to France. Invitations to salons were highly coveted; introductions to the rich and powerful could make the career of an ambitious writer, and, in turn, the social elite found amusement and cultural prestige in their ties to up-and-coming artists and men of letters.

Elite women also exercised great influence on artistic taste. Soft pastels, ornate interiors, sentimental portraits, and paintings featuring starry-eyed lovers protected by hovering cupids were all hallmarks of the style they favored. This style, known as **rococo** (ruh-KOH-koh), was popular throughout Europe

Madame Geoffrin's Salon This painting depicts a meeting of the salon of celebrated Parisian hostess Madame Geoffrin, at which an actor reads aloud a new play by the French philosophe Voltaire. The painter, Gabriel Lemonnier, was a regular guest at the salon, and virtually all of the individuals he has depicted here are recognizable members of Parisian salon society, including Enlightenment writers Diderot, d'Alembert, and Rousseau as well as high-ranking nobles, government ministers, and fellow *salonnières*. (Musée National du Chateau de Malmaison, Rueil-Malmaison, France/Bridgeman Images)

Madame de Pompadour, Mistress to French King Louis XV Madame de Pompadour used the wealth at her command to patronize many highly skilled artists and craftsmen. She helped popularize the ornate, lightly colored, and highly decorative rococo style, epitomized by the sumptuous trimmings of her dress. (By François Boucher [1703–1770], [oil on canvas]/© Scottish National Gallery, Edinburgh/Bridgeman Images)

from 1720 to 1780. It was particularly associated with the mistress of Louis XV, Madame de Pompadour, who used her position to commission paintings, furniture, and other luxury objects in the rococo style.

Women's prominent role as society hostesses and patrons of the arts and letters outraged some Enlightenment thinkers. According to Jean-Jacques Rousseau, women and men were radically different by nature and should play diametrically opposed roles in life. Destined by nature to assume the active role in sexual relations, men were naturally suited for the rough-and-tumble of politics and public life. Women's role was to attract male sexual desire in order to marry and create families and then to care for their homes and children in private. For Rousseau, wealthy Parisian women's love for attending social gatherings and pulling the strings of power was unnatural and had a corrupting effect on both politics and society. Some women eagerly accepted Rousseau's idealized view of their domestic role, but others—such as the English writer Mary Wollstonecraft—vigorously rejected his notion of women's limitations. (See "Viewpoints: Rousseau and Wollstonecraft Debate Women's Equality," page 484.)

Rousseau's emphasis on the natural laws governing women echoed a wider shift in ideas about gender during this period, as doctors, scientists, and philosophers increasingly agreed that women's essential characteristics were determined by their sexual organs and reproductive functions. This turn to nature, rather than tradition or biblical scripture, as a means to understand human society had parallels in contemporary views on racial difference. Just as writers like Rousseau used women's allegedly "natural" passivity to argue for their subordinate role in society, so Kant and others used ideas about non-Europeans' "natural" inferiority to defend slavery and colonial domination. The new powers of science and reason were thus marshaled to imbue traditional stereotypes with the force of natural law. Scholars continue to debate the apparent paradox between Enlightenment thinkers' ideals of universalism, progress, and reason and their support for racial and gender inequality.

■ **salon** Regular social gathering held by talented and rich Parisians in their homes, where philosophes and their followers met to discuss literature, science, and philosophy.

■ **rococo** A popular style in Europe in the eighteenth century, known for its soft pastels, ornate interiors, sentimental portraits, and starry-eyed lovers protected by hovering cupids.

VIEWPOINTS

Rousseau and Wollstonecraft Debate Women's Equality

Enlightenment philosophers fervently debated the essential characteristics of the female sex and the appropriate education and social roles for women. Two of the most vociferous participants in this debate were Jean-Jacques Rousseau and Mary Wollstonecraft. Looking to nature as a guiding principle, Rousseau reasoned that women's role in the process of reproduction meant they were intended to be subordinate to men and to devote themselves to motherhood and home life. Wollstonecraft responded that virtue was a universal human attribute created by God that could not be differentiated by gender. While acknowledging that women were weaker in some ways than men, she insisted that they should strive to honor their God-given human dignity through education and duty, just like men.

Jean-Jacques Rousseau, *Emile, or on Education*

In the union of the sexes, both pursue one common object, but not in the same manner. From their diversity in this particular, arises the first determinate difference between the moral relations of each. The one should be active and strong, the other passive and weak: it is necessary the one should have both the power and the will, and that the other should make little resistance. . . .

Woman and man are made for each other; but their mutual dependence is not the same. The men depend on the women only on account of their desires; the women on the men both on account of their desires and their necessities: we could subsist better without them than they without us. Their very subsistence and rank in life depend on us, and the estimation in which we hold them, their charms and their merit. By the law of nature itself, both women and children lie at the mercy of the men. . . .

To please, to be useful to us, to make us love and esteem them, to educate us when young, and take care of us when grown up, to advise, to console us, to render our lives easy and agreeable; these are the duties of women at all times, and what they should be taught in their infancy.

Mary Wollstonecraft, *A Vindication of the Rights of Woman*

Rousseau declares that a woman should never, for a moment, feel herself independent, that she should be governed by fear to exercise her *natural* cunning, and made a coquettish slave in order to render her a more alluring object of desire, a *sweeter* companion to man, whenever he chooses to relax himself. . . .

What nonsense! When will a great man arise with sufficient strength of mind to puff away the fumes which pride and sensuality have thus spread over the subject! If women are by nature inferior to men, their virtues must be the same in quality, if not in degree, or virtue is a relative idea; consequently, their conduct should be founded on the same principles, and have the same aim. . . .

. . . [C]ultivate their minds, give them the salutary, sublime curb of principle, and let them attain conscious dignity by feeling themselves only dependent on God. Teach them, in common with man, to submit to necessity instead of giving, to render them more pleasing, a sex to morals. . . . Further, should experience prove that they cannot attain the same degree of strength of mind, perseverance, and fortitude, let their virtues be the same in kind, though they may vainly struggle for the same degree.

QUESTIONS FOR ANALYSIS

1. How does Rousseau derive his ideas about women's proper relationship to men from his view of "nature"?
2. What does Wollstonecraft mean when she criticizes writers like Rousseau for giving "a sex to morals"? What arguments does she use to oppose such views?
3. Rousseau and Wollstonecraft differed greatly in their ideas on the essential characteristics of men and women, but do you see any areas where they agree?

Sources: Jean-Jacques Rousseau, *Emilius and Sophia: or, a new system of education*, trans. William Kenrick (London: T. Becket and P.A. de Hondt, 1763), vol. 4, pp. 3–4, 18–20; Mary Wollstonecraft, *A Vindication of the Rights of Woman* (London: Johnson, 1792), pp. 47–48, 71.

Urban Culture and Life in the Public Sphere

Enlightenment ideas did not float on thin air. A series of new institutions and practices encouraged the spread of enlightened ideas. From about 1700 to 1789, the production and consumption of books grew significantly and the types of books people read changed dramatically. For example, the proportion of religious and devotional books published in Paris declined after 1750; history and law held constant; the arts and sciences surged.

Reading more books on many more subjects, the educated public approached reading in a new way. The old style of reading in Europe had been centered on a core of sacred texts read aloud by the father to his assembled family. Now reading involved a broader field of books that constantly changed. Reading

became individual and silent, and texts could be questioned.

For those who could not afford to purchase books, lending libraries offered access to the new ideas of the Enlightenment. Coffeehouses, which first appeared in the late seventeenth century, became meccas of philosophical discussion. In addition to these institutions, book clubs, debating societies, Masonic lodges (groups of Freemasons, a secret society based on egalitarian principles that accepted craftsmen and shopkeepers as well as middle-class men and nobles), salons, and newspapers all played roles in the creation of a new **public sphere** that celebrated open debate informed by critical reason. The public sphere was an idealized space where members of society came together as individuals to discuss issues relevant to the society, economics, and politics of the day.

What of the common people? Did they participate in the Enlightenment? Enlightenment philosophes did not direct their message to peasants or urban laborers. They believed that the masses had no time or talent for philosophical speculation and that elevating them would be a long and potentially dangerous process. Deluded by superstitions and driven by violent passions, the people, they thought, were like children in need of firm parental guidance. D'Alembert characteristically made a sharp distinction between "the truly enlightened public" and "the blind and noisy multitude."[11]

Despite these prejudices, the ideas of the philosophes did find an audience among some members of the common people. At a time of rising literacy, book prices were dropping, and many philosophical ideas were popularized in cheap pamphlets and through public reading. Although they were barred from salons and academies, ordinary people were not immune to the new ideas in circulation. Some of them made vital contributions to the debate, like Englishman Thomas Paine, born and apprenticed to a corset-maker, and author of *Common Sense*, a foundational text of the American Revolution.

What impact did new ways of thinking have on politics?

Enlightenment thinkers' insistence on questioning long-standing traditions and norms inevitably led to issues of power and politics. Most Enlightenment thinkers outside of Britain and the Netherlands, especially in central and eastern Europe, believed that political change could best come from above—from the ruler—rather than from below. Royal absolutism was a fact of life, and the monarchs of Europe's leading states clearly had no intention of giving up their great power. Therefore, the philosophes and their sympathizers realistically concluded that a benevolent absolutism offered the best opportunities for improving society.

Many government officials were interested in philosophical ideas. They were among the best-educated members of society, and their daily involvement in complex affairs of state made them naturally attracted to ideas for improving human society. Encouraged and instructed by these officials, some absolutist rulers tried to reform their governments in accordance with Enlightenment ideals—what historians have called the **enlightened absolutism** of the later eighteenth century. In both Catholic and Protestant lands, rulers typically fused Enlightenment principles with religion, drawing support for their innovations from reform-minded religious thinkers. The most influential of the new-style monarchs were in Prussia, Russia, and Austria, and their example illustrates both the achievements and the great limitations of enlightened absolutism. France experienced its own brand of enlightened absolutism in the contentious decades prior to the French Revolution.

Frederick the Great of Prussia

Frederick II (r. 1740–1786) of Prussia, commonly known as Frederick the Great, built masterfully on the work of his father, Frederick William I (see "The Consolidation of Prussian Absolutism" in Chapter 15). Although in his youth he embraced culture and literature rather than the militarism championed by his father, by the time he came to the throne Frederick was determined to use the splendid army he had inherited.

Therefore, when Maria Theresa inherited the Habsburg dominions upon the death of her father, Holy Roman emperor Charles VI, Frederick pounced. He invaded the rich province of Silesia (sigh-LEE-zhuh), which bordered the Prussian territory of Brandenburg, thereby defying solemn Prussian promises to respect the Pragmatic Sanction, a diplomatic

■ **public sphere** An idealized intellectual space that emerged in Europe during the Enlightenment, where the public came together to discuss important issues relating to society, economics, and politics.

■ **enlightened absolutism** Term coined by historians to describe the rule of eighteenth-century monarchs who, without renouncing their own absolute authority, adopted Enlightenment ideals of rationalism, progress, and tolerance.

agreement that had guaranteed Maria Theresa's succession. In 1742, as other powers vied for Habsburg lands in the European War of the Austrian Succession (1740–1748), Maria Theresa was forced to cede almost all of Silesia to Prussia. In one stroke Prussia had doubled its population to 6 million people and now stood as a major European power.

Though successful in 1742, Frederick had to fight against great odds to save Prussia from destruction after competition between Britain and France for colonial empire brought another great conflict in 1756. Maria Theresa, seeking to regain Silesia, formed an alliance with the leaders of France and Russia. The aim of the alliance during the resulting Seven Years' War (1756–1763) was to conquer Prussia and divide up its territory. Despite invasions from all sides, Frederick fought on. In the end he was unexpectedly saved when Peter III came to the Russian throne in 1762 and called off the attack against Frederick, whom he greatly admired.

The War of the Austrian Succession, 1740–1748

The terrible struggle of the Seven Years' War tempered Frederick's interest in territorial expansion and brought him to consider how more humane policies for his subjects might also strengthen the state. He tolerantly allowed his subjects to believe as they wished in religious and philosophical matters. He promoted the advancement of knowledge, improving his country's schools and permitting scholars to publish their findings. Moreover, Frederick tried to improve the lives of his subjects more directly. As he wrote to his friend Voltaire in 1770, "[I have to] enlighten mind, cultivate morality, and make the people as happy as it suits human nature, and as the means at my disposal permit."[12]

The legal system and the bureaucracy were Frederick's primary tools. Prussia's laws were simplified, torture was abolished, and judges decided cases quickly and impartially. After the Seven Years' War ended in 1763, Frederick's government energetically promoted the reconstruction of agriculture and industry. Frederick himself set a good example. He worked hard and lived modestly, claiming that he was "only the first servant of the state." Thus Frederick justified monarchy in terms of practical results and said nothing of the divine right of kings.

Frederick's dedication to high-minded government went only so far, however. While he condemned serfdom in the abstract, he accepted it in practice and did not free the serfs on his own estates. He accepted and extended the privileges of the nobility, who remained the backbone of the army and the entire Prussian state.

In reforming Prussia's bureaucracy, Frederick drew on the principles of **cameralism**, the German science of public administration that emerged in the decades following the Thirty Years' War and came to occupy a central place in the university curriculum of the German lands. Cameralism held that monarchy was the best of all forms of government, that all elements of society should be placed at the service of the state, and that, in turn, the state should make use of its resources and authority to improve society. Predating the Enlightenment, cameralist interest in the public good was usually inspired by the needs of war. Cameralism shared with the Enlightenment an emphasis on rationality, progress, and utilitarianism.

Catherine the Great of Russia

Catherine the Great of Russia (r. 1762–1796) was one of the most remarkable rulers of her age, and the French philosophes adored her. Catherine was a German princess from Anhalt-Zerbst, a small principality sandwiched between Prussia and Saxony. Her father commanded a regiment of the Prussian army, but her mother was related to the Romanovs of Russia, and that proved to be Catherine's opening to power.

Catherine's Romanov connection made her a suitable bride at the age of fifteen for the heir to the Russian throne. It was a mismatch from the beginning, but her *Memoirs* made her ambitions clear: "I did not care about Peter, but I did care about the crown." When her husband, Peter III, came to power during the Seven Years' War, his decision to withdraw Russian troops from the coalition against Prussia alienated the army. Catherine profited from his unpopularity to form a conspiracy to depose her husband. In 1762 Catherine's lover Gregory Orlov and his three brothers, all army officers, murdered Peter, and the German princess became empress of Russia.

Catherine had drunk deeply at the Enlightenment well. Never questioning that absolute monarchy was

cameralism View that monarchy was the best form of government, that all elements of society should serve the monarch, and that, in turn, the state should use its resources and authority to increase the public good.

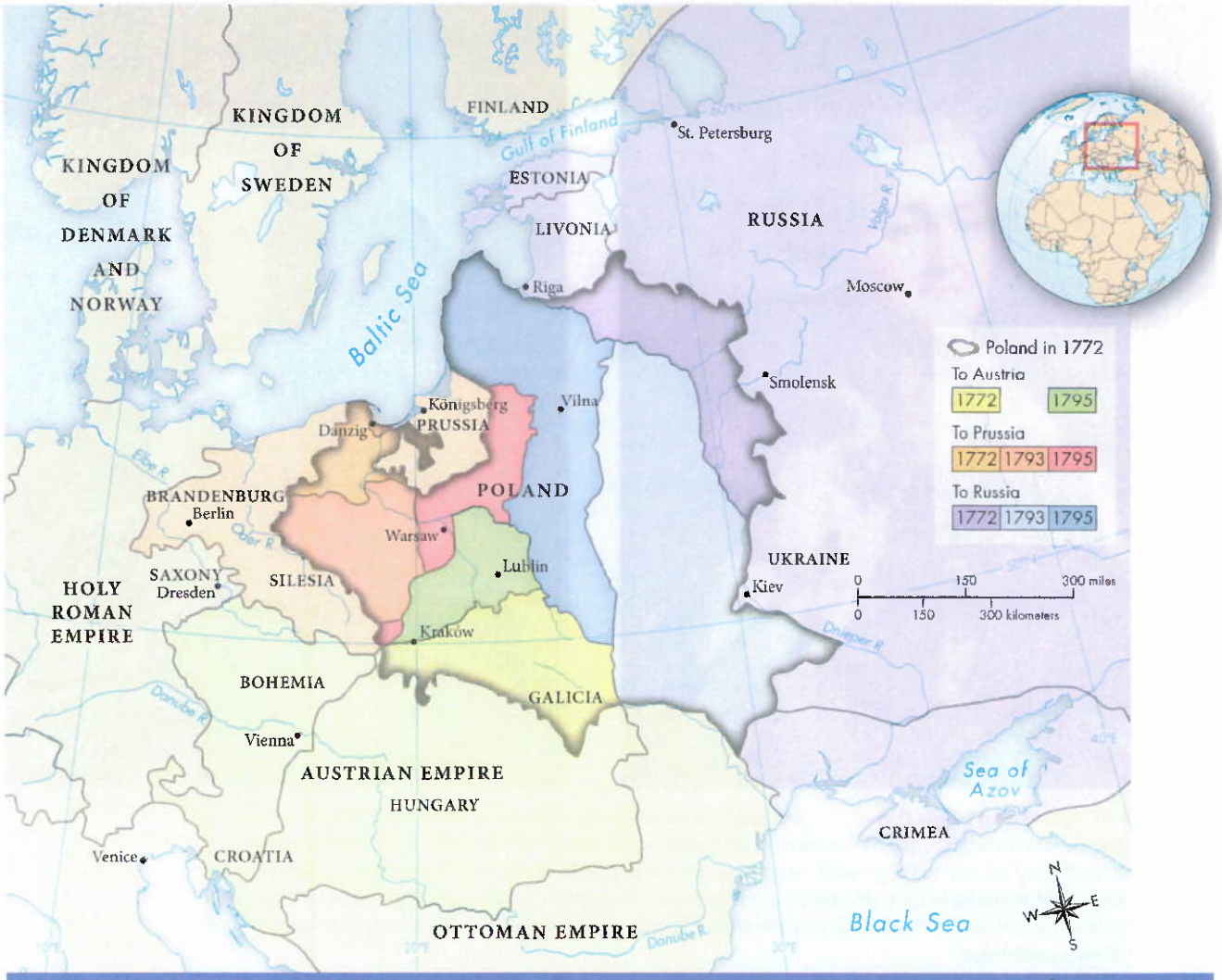
Catherine the Great and Denis Diderot Self-proclaimed adherent of Enlightenment ideals, Russian empress Catherine the Great enthusiastically corresponded with philosophes like Voltaire and Denis Diderot. When Diderot put his library on sale to raise much-needed funds, Catherine sent him the money but allowed him to keep his books. Historians have long debated the "enlightened despotism" represented by Catherine and other absolutist rulers. (Catherine: Based on a work by Alexander Roslin [1718–1793], [oil on canvas]/Museum of Art, Serpukhov, Russia/Bridgeman Images; Diderot: Heritage Images/Getty Images)

the best form of government, she set out to rule in an enlightened manner. She had three main goals. First, she worked hard to continue Peter the Great's effort to bring the culture of western Europe to Russia (see "The Reforms of Peter the Great" in Chapter 15). To do so, she imported Western architects, musicians, and intellectuals. She bought masterpieces of Western art and patronized the philosophes. An enthusiastic letter writer, she corresponded extensively with Voltaire and praised him as the "champion of the human race." When the French government banned the *Encyclopedia*, she offered to publish it in St. Petersburg, and she sent money to Diderot when he needed it. With these actions, Catherine won good press in the West for herself and for her country. Moreover, this intellectual ruler, who wrote plays and loved good talk, set the tone for the entire Russian nobility. Peter the Great westernized Russian armies, but it was Catherine who westernized the imagination of the Russian nobility.

Catherine's second goal was domestic reform, and she began her reign with sincere and ambitious projects. In 1767 she appointed a legislative commission to prepare a new law code. This project was never completed, but Catherine did restrict the practice of torture and allowed limited religious toleration. She also tried to improve education and strengthen local government. The philosophes applauded these measures and hoped more would follow.

Such was not the case. In 1773 a Cossack soldier named Emelian Pugachev sparked a gigantic uprising of serfs, very much as Stenka Razin had done a century earlier (see "Building the Russian Empire" in Chapter 15). Proclaiming himself the true tsar, Pugachev issued orders abolishing serfdom, taxes, and army service. Thousands joined his cause, slaughtering landlords and officials over a vast area of southwestern Russia. Pugachev's untrained forces eventually proved no match for Catherine's professional army. Betrayed by his own company, Pugachev was captured and brutally executed.

Pugachev's rebellion put an end to any intentions Catherine had about reforming the system and improving the lot of the peasantry. After 1775 Catherine gave the nobles absolute control of their serfs, and



MAPPING THE PAST

MAP 16.1 The Partition of Poland, 1772–1795

In 1772 war between Russia and Austria threatened over Russian gains from the Ottoman Empire. To satisfy desires for expansion without fighting, Prussia's Frederick the Great proposed that parts of Poland be divided among Austria, Prussia, and Russia. In 1793 and 1795 the three powers partitioned the remainder, and the republic of Poland ceased to exist.

ANALYZING THE MAP Of the three powers that divided the kingdom of Poland, which gained the most territory? How did the partition affect the geographical boundaries of each state, and what was the significance? What border with the former Poland remained unchanged? Why do you think this was the case?

CONNECTIONS What does it say about European politics at the time that a country could simply cease to exist on the map? Could that happen today?

she extended serfdom into new areas, such as Ukraine. In 1785 she freed nobles from taxes and state service. Under Catherine the Russian nobility attained its most exalted position, and serfdom entered its most oppressive phase.

Catherine's third goal was territorial expansion, and in this respect she was extremely successful. Her armies subjugated the last descendants of the Mongols and the Crimean Tartars and began the conquest of the Caucasus (KAW-kuh-suhs), the region between the Black Sea and the Caspian Sea. Her greatest coup by far was the partition of Poland (Map 16.1). When, between 1768 and 1772, Catherine's armies scored unprecedented victories against the Ottomans and

thereby threatened to disturb the balance of power between Russia and Austria in eastern Europe, Frederick of Prussia obligingly came forward with a deal. He proposed that the Ottomans be let off easily and that Prussia, Austria, and Russia each compensate itself by taking a gigantic slice of the weakly ruled Polish territory. Catherine jumped at the chance. The first partition of Poland took place in 1772. Subsequent partitions in 1793 and 1795 gave away the rest of Polish territory, and the ancient republic of Poland vanished from the map.

The Austrian Habsburgs

Another female monarch, Maria Theresa (r. 1740–1780) of Austria, set out to reform her nation, although traditional dynastic power politics was a more important motivation for her than were Enlightenment teachings. A devoutly Catholic mother and wife who inherited power from her father, Charles VI, Maria Theresa was a remarkable but old-fashioned absolutist. Her more radical son, Joseph II (r. 1780–1790), drew on Enlightenment ideals, earning the title of "revolutionary emperor."

Emerging from the long War of the Austrian Succession in 1748 with the serious loss of Silesia, Maria Theresa was determined to introduce reforms that would make the state stronger and more efficient. First, she initiated church reform, with measures aimed at limiting the papacy's influence, eliminating many religious holidays, and reducing the number of monasteries. Second, a whole series of administrative renovations strengthened the central bureaucracy, smoothed out some provincial differences, and revamped the tax system, taxing even the lands of nobles, previously exempt from taxation. Third, the government sought to improve the conditions of the agricultural population, cautiously reducing the power of lords over their hereditary serfs and their partially free peasant tenants.

Joseph II, coregent with his mother from 1765 onward and a strong supporter of change from above, implemented reform rapidly when he came to the throne in 1780. Most notably, Joseph abolished serfdom in 1781, and in 1789 he decreed that peasants could pay landlords in cash rather than through labor on their land. This measure was violently rejected not only by the nobility but also by the peasants it was intended to help, because they lacked the necessary cash. When a disillusioned Joseph died prematurely at forty-nine, the entire Habsburg empire was in turmoil. His brother Leopold II (r. 1790–1792) canceled Joseph's radical edicts in order to re-establish order. Peasants once again were required to do forced labor for their lords.

Despite differences in their policies, Joseph II and the other absolutists of the later eighteenth century combined old-fashioned state-building with the culture and critical thinking of the Enlightenment. In doing so, they succeeded in expanding the role of the state in the life of society. They perfected bureaucratic machines that were to prove surprisingly adaptive and enduring. Their failure to implement policies we would recognize as humane and enlightened—such as abolishing serfdom—probably reveal inherent limitations in Enlightenment thinking about equality and social justice, rather than deficiencies in their execution of Enlightenment programs. The fact that leading philosophes supported rather than criticized absolutist rulers' policies thus exposes the blind spots of the era.

Jewish Life and the Limits of Enlightened Absolutism

Perhaps the best example of the limitations of enlightened absolutism is the debates surrounding the emancipation of the Jews. Europe's small Jewish populations lived under highly discriminatory laws. For the most part, Jews were confined to tiny, overcrowded ghettos, were excluded by law from most professions, and could be ordered out of a kingdom at a moment's notice. Still, a very few did manage to succeed and to obtain the right of permanent settlement, usually by performing some special service for the state. Many rulers relied on Jewish bankers for loans to raise armies and run their kingdoms. Jewish merchants prospered in international trade because they could rely on contacts with colleagues in Jewish communities scattered across Europe.

In the eighteenth century an Enlightenment movement known as the **Haskalah** emerged from within the European Jewish community, led by the Prussian philosopher Moses Mendelssohn (1729–1786). (See "Individuals in Society: Moses Mendelssohn and the Jewish Enlightenment," page 490.) Christian and Jewish Enlightenment philosophers, including Mendelssohn, began to advocate for freedom and civil rights for European Jews. In an era of reason and progress, they argued, restrictions on religious grounds could not stand. The Haskalah accompanied a period of controversial social change within Jewish communities in which rabbinic controls loosened and interaction with Christians increased.

Arguments for tolerance won some ground. The British Parliament passed a law allowing naturalization of Jews in 1753, but it later repealed the law due to public opposition. The most progressive reforms took place under Austrian emperor Joseph II. Among his liberal edicts of the 1780s were measures intended to integrate Jews more fully into society, including eligibility for military service, admission to higher education and artisanal trades, and removal of requirements for special clothing or emblems. Welcomed by many Jews, these

Haskalah The Jewish Enlightenment of the second half of the eighteenth century, led by the Prussian philosopher Moses Mendelssohn.

INDIVIDUALS IN SOCIETY

Moses Mendelssohn and the Jewish Enlightenment

In 1743 a small, humpbacked Jewish boy with a stammer left his poor parents in Dessau in central Germany and walked eighty miles to Berlin, the capital of Frederick the Great's Prussia. According to one story, when the boy reached the Rosenthaler (ROH-zuhn-taw-lehr) Gate, the only one through which Jews could pass, he told the inquiring watchman that his name was Moses and that he had come to Berlin "to learn." The watchman laughed and waved him through. "Go Moses, the sea has opened before you."*

In Berlin the young Mendelssohn studied Jewish law and eked out a living copying Hebrew manuscripts in a beautiful hand. But he was soon fascinated by an intellectual world that had been closed to him in the Dessau ghetto. There, like most Jews throughout central Europe, he had spoken Yiddish — a mixture of German, Polish, and Hebrew. Now, working mainly on his own, he mastered German; learned Latin, Greek, French, and English; and studied mathematics and Enlightenment philosophy. Word of his exceptional abilities spread in Berlin's Jewish community (the dwelling of 1,500 of the city's 100,000 inhabitants). He began tutoring the children of a wealthy Jewish silk merchant, and he soon became the merchant's clerk and later his partner. But his great passion remained the life of the mind and the spirit, which he avidly pursued in his off-hours.

Gentle and unassuming in his personal life, Mendelssohn was a bold thinker. Reading eagerly in Western philosophy since antiquity, he was, as a pious Jew, soon convinced that Enlightenment teachings need not be opposed to Jewish thought and religion. He concluded that reason could complement and strengthen religion, although each would retain its integrity as a separate sphere.† Developing his idea in his first great work, *On the Immortality of the Soul* (1767), Mendelssohn used the neutral setting of a philosophical dialogue between Socrates and his followers in ancient Greece to argue that the human soul lived forever. In refusing to bring religion and critical thinking into conflict, he was strongly influenced by contemporary German philosophers who argued similarly on behalf of Christianity. He reflected the way the German Enlightenment generally supported established religion, in contrast to the French Enlightenment, which attacked it.

Mendelssohn's treatise on the human soul captivated the educated German public, which marveled that a Jew could have written a philosophical masterpiece. In the excitement, a Christian zealot named Johann Casper Lavater challenged Mendelssohn in a pamphlet to demonstrate how the Christian faith was not "reasonable" or to accept Christianity. Replying politely but passionately, the Jewish philosopher affirmed that his studies had only strengthened him in his faith, although he did not seek to convert anyone not born into Judaism. Rather, he urged toleration in religious matters and spoke up courageously against Jewish oppression.

Lavater (right) attempts to convert Mendelssohn, in a painting by Moritz Oppenheim of an imaginary encounter. (The Magnes Collection of Jewish Art and Life, Berkeley, California/akg-images)

Orthodox Jew and German philosophe, Moses Mendelssohn serenely combined two very different worlds. He built a bridge from the ghetto to the dominant culture over which many Jews would pass, including his novelist daughter Dorothea and his famous grandson, the composer Felix Mendelssohn.

QUESTIONS FOR ANALYSIS

1. How did Mendelssohn seek to influence Jewish religious thought in his time?
2. How do Mendelssohn's ideas compare with those of the French Enlightenment?

*H. Kupferberg, *The Mendelssohns: Three Generations of Genius* (New York: Charles Scribner's Sons, 1972), p. 3.

†David Sorkin, *Moses Mendelssohn and the Religious Enlightenment* (Berkeley: University of California Press, 1996), pp. 8ff.

The Pale of Settlement, 1791

reforms raised fears among traditionalists about the possibility of assimilation into the general population.

Many monarchs rejected all ideas of emancipation. Although he permitted freedom of religion to his Christian subjects, Frederick the Great of Prussia firmly opposed any general emancipation for the Jews, as he did for the serfs. Catherine the Great, who acquired most of Poland's large Jewish population when she annexed part of that country in the late eighteenth century, similarly refused. In 1791 she established the Pale of Settlement, a territory including parts of modern-day Poland, Latvia, Lithuania, Ukraine, and Belarus, in which most Jews were required to live. Jewish habitation was restricted to the Pale until the Russian Revolution in 1917.

The first European state to remove all restrictions on the Jews was France during the French Revolution. Over the next hundred years, Jews gradually won full legal and civil rights throughout the rest of western Europe. Emancipation in eastern Europe took even longer and aroused more conflict and violence.

NOTES

1. Quoted in H. Butterfield, *The Origins of Modern Science* (New York: Macmillan, 1951), p. 47.
2. Quoted in Butterfield, *The Origins of Modern Science*, p. 120.
3. Quoted in John Freely, *Aladdin's Lamp: How Greek Science Came to Europe Through the Islamic World* (New York: Knopf, 2009), p. 225.
4. Quoted in Jacqueline Broad, *Women Philosophers of the Seventeenth Century* (Cambridge: Cambridge University Press, 2003), p. 17.
5. Quoted in L. Schiebinger, *The Mind Has No Sex? Women in the Origins of Modern Science* (Cambridge, Mass.: Harvard University Press, 1989), p. 64.
6. Quoted in G. L. Mosse et al., eds., *Europe in Review* (Chicago: Rand McNally, 1964), p. 156.
7. D. E. Mungello, *The Great Encounter of China and the West, 1500–1800*, 2d ed. (Lanham, Md.: Rowman & Littlefield, 2005), p. 98.
8. Quoted in Emmanuel Chukwudi Eze, ed., *Race and the Enlightenment: A Reader* (Oxford: Blackwell, 1997), p. 33.
9. See E. Fox-Genovese, "Women in the Enlightenment," in *Becoming Visible: Women in European History*, 2d ed., ed. R. Bridenthal, C. Koonz, and S. Stuard (Boston: Houghton Mifflin, 1987), esp. pp. 252–259, 263–265.
10. Aurora Wolfgang, *Gender and Voice in the French Novel, 1730–1782* (Aldershot, U.K.: Ashgate, 2004), p. 8.
11. Jean Le Rond d'Alembert, *Eloges lus dans les séances publiques de l'Académie française* (Paris, 1779), p. ix, quoted in Mona Ozouf, "'Public Opinion' at the End of the Old Regime," *The Journal of Modern History* 60, *Supplement: Rethinking French Politics in 1788* (September 1988): S9.
12. Cited in Giles McDonough, *Frederick the Great: A Life in Deed and Letters* (New York: St. Martin's Griffin, 2001), 341.

LOOKING BACK LOOKING AHEAD

Hailed as the origin of modern thought, the Scientific Revolution must also be seen as a product of its past and of the interaction between Europeans and non-Europeans. Medieval translations of ancient Greek texts from Arabic into Latin spurred the advance of scholarship in western Europe, giving rise to universities that produced and disseminated knowledge of the natural world. Natural philosophers following Copernicus pioneered new methods of observing and explaining nature while drawing on centuries-old traditions of Christian faith as well as astrology, alchemy, and magic. In expanding their knowledge about the natural world, Europeans drew on traditions of observation and practice among indigenous peoples of the New World.

The Enlightenment ideas of the eighteenth century were a similar blend of past and present, European and non-European; they could serve as much to bolster absolutist monarchical regimes as to inspire revolutionaries to fight for individual rights and liberties. Although the Enlightenment fostered critical thinking about everything from science to religion, the majority of Europeans, including many prominent thinkers, remained devout Christians. Enlightenment ideas were inspired by contact and exchange with non-Europeans in Asia, Africa, and the Americas.

The achievements of the Scientific Revolution and the Enlightenment are undeniable. Key Western values of rationalism, human rights, and open-mindedness were born from these

movements. With their new notions of progress and social improvement, Europeans would embark on important revolutions in industry and politics in the centuries that followed. Nonetheless, others have seen a darker side. For these critics, the mastery over nature permitted by the Scientific Revolution now threatens to overwhelm the earth's fragile equilibrium, and the Enlightenment belief in the universal application of reason can lead to arrogance and intolerance of other people's spiritual, cultural, and political values. Such vivid debates about the legacy of these intellectual and scientific developments testify to their continuing importance in today's world.

Make Connections

Think about the larger developments and continuities within and across chapters.

1. How did the era of European exploration and discovery (Chapter 14) affect the ideas of the scientists and philosophers discussed in this chapter? In what ways did contact with new peoples and places stimulate new forms of thought among Europeans?
2. What was the relationship between the Scientific Revolution and the Enlightenment? How did new ways of understanding the natural world influence thinking about human society?
3. Compare the policies and actions of seventeenth-century absolutist rulers (Chapter 15) with their "enlightened" descendants described in this chapter. How accurate is the term *enlightened absolutism*?

16 REVIEW & EXPLORE

Identify Key Terms

Identify and explain the significance of each item below.

natural philosophy (p. 463)
Copernican hypothesis (p. 464)
law of inertia (p. 465)
law of universal gravitation (p. 467)
Cartesian dualism (p. 469)
Enlightenment (p. 472)
rationalism (p. 473)
sensationalism (p. 473)
philosophes (p. 474)
deism (p. 475)
salon (p. 482)
rococo (p. 482)
public sphere (p. 485)
enlightened absolutism (p. 485)
cameralism (p. 486)
Haskalah (p. 489)

Review the Main Ideas

Answer the section heading questions from the chapter.

1. What revolutionary discoveries were made in the sixteenth and seventeenth centuries? (p. 462)
2. What intellectual and social changes occurred as a result of the Scientific Revolution? (p. 468)
3. How did the Enlightenment emerge, and what were major currents of Enlightenment thought? (p. 472)
4. How did the Enlightenment change social ideas and practices? (p. 479)
5. What impact did new ways of thinking have on politics? (p. 485)