Timeline

1543	Copernicus publishes *On the Revolutions of the Heavenly Bodies*
1610	Galileo publishes *The Starry Messenger*
1620	Bacon publishes *New Instrument*
1635	Académie Française founded
1637	Descartes publishes *Discourse on Method*
1660	Royal Society of London founded
1661	Palace of Versailles begun
1667	Milton publishes *Paradise Lost*
1687	Newton publishes the *Principia*
1748	Montesquieu publishes *The Spirit of the Laws*
1752–72	Diderot and d'Alembert publish the *Encyclopédie*
1759	Voltaire's *Candide* published anonymously
1762	Rousseau publishes *Emile: Or, On Education*
1786	Mozart composes *The Marriage of Figaro*
1789	Lavoisier publishes *Elementary Treatise on Chemistry*

In 1550, the Italian art historian Giorgio Vasari, who coined the word Renaissance, described the painters, sculptors, and architects of his era in a series of biographies as "rare men of genius." One hundred and seventy-five years later, another cultural commentator, the English poet Alexander Pope (1688–1744), extended this judgment to a mathematician and physicist, Isaac Newton (1642–1727), offering a brief couplet as part of the outpouring of eulogies right after Newton's death:

> Nature, and Nature's laws lay hid in night,
> God said *Let Newton be!* and all was *Light.*

Newton himself was not so sure about this, writing in a letter to fellow scientist Robert Hooke in 1675, "If I have seen further [than certain other men] it is by standing upon the shoulders of giants." In terms of intellectual development,

the period from Vasari's biographies to Pope's poem is often referred to as the "Scientific Revolution," a phrase invented in the nineteenth century to label this time of change in the way learned individuals approached, conceptualized, and studied the natural world. Like the Renaissance, the Scientific Revolution is not an event with a specific beginning and end, but a series of developments. Whether these changes were as Pope envisioned – sudden bursts of genius that altered everything – or as Newton described them – steady advances that built on earlier ones – is still a matter of debate, however.

Among recent scholars, one of the most influential voices arguing in favor of dramatic change was the philosopher and physicist Thomas Kuhn (1922–96). In *The Structure of Scientific Revolutions* (1962), Kuhn proposed that people studying the natural world (what we would now term scientists) work within a specific world view until there is too much data that contradicts that world view, but no one theory that explains all the contradictions. At that point, someone – often from outside the establishment in which scientists normally work – proposes a radically different world view, what Kuhn calls a "paradigm shift." This new paradigm does not just add to earlier knowledge, but makes people who accept it view the world in a completely new way. Kuhn uses a number of scientific developments from the sixteenth through the eighteenth centuries as examples of such paradigm shifts, the most dramatic of which was the shift from an earth-centered to a sun-centered view of the cosmos. Since then, other historians of science have argued that Kuhn overemphasized big changes. The major thinkers of the Scientific Revolution, they point out, continued to accept many ideas because they appeared in ancient sources, and built on the work of medieval scientists. Kuhn's argument has been very powerful, however, and his phrase "paradigm shift" is now so pervasive in business, government, and other realms of life that it has become a joke, particularly when coupled with "thinking outside the box."

Whether we call it a paradigm shift or not, the idea that there was a radical break in the world view of educated Europeans in the seventeenth and eighteenth centuries is a powerful one, and extends beyond the realm of science. Pope uses the word "light" to praise Newton because many of Newton's discoveries involved light and optics, and because Pope saw him as setting a pattern in which the "light of reason" is used to explore the universe. Thinkers in the eighteenth century described their enterprise as "Enlightenment," whose principles the German philosopher Immanuel Kant (1724–1804) summarized in 1784 in the phrase: "*Sapere aude*! [Dare to know!] Have the courage to use your *own* understanding!"[1]

The Enlightenment was a self-conscious intellectual movement in the same way as the Renaissance had been. Renaissance thinkers envisioned themselves as part of a rebirth of classical culture, while Enlightenment thinkers asserted that knowledge could free them *from* the ancient past. The "light of reason," they argued, could be used against the darkness of prejudice, superstition, blind belief, ignorance, tyranny, and injustice. The classical past was not uniformly rejected, as architects, writers, and even political theorists used Greek

and Roman models for their works, but it was to be emulated selectively and deliberately, and not regarded as superior. This questioning of received wisdom extended to the realm of religion, as thinkers challenged the cultural and institutional authority of the Christian churches and criticized many beliefs and practices as "superstition."

Thinkers in the Enlightenment – those in France called themselves *philosophes* – regarded the development of science as one of the most important sources of their own intellectual liberation, and also looked to the writings of several seventeenth-century thinkers who emphasized the role of reason and observation as challenges to received wisdom, including René Descartes and John Locke. They took ideas and methods from the realm of the natural sciences and applied them to the social sciences, seeking to find rules and laws that applied to human beings in the same way that the law of gravity or other of "Nature's laws" applied in the physical world. This search for order did not lead to a single ideology, for there was great diversity of opinion on a range of issues, but general consensus around a set of common values: reason, religious toleration, progress, liberty, utility, and skepticism toward traditions and dogmas.

The Scientific Revolution and the Enlightenment were not the only intellectual and cultural developments in seventeenth- and eighteenth-century Europe, which also saw new forms and themes in art, literature, and music. All of these were supported by the centralizing monarchs we discussed in chapter 9, for intelligent rulers recognized that having educated and talented writers, scientists, philosophers, musicians, and artists at their courts only enhanced their stature. In return for flattering dedications in scientific or philosophical works, defenses of their policies, effusive poems of praise, and larger-than-life individual and family portraits, rulers – and also wealthy churchmen and nobles – provided pensions in cash, positions as tutors, offices at court or ecclesiastical benefices.

Along with this traditional system of patronage, however, new social and cultural institutions developed through which ideas were exchanged, and writers, artists, and thinkers were supported. Some of the institutions were formal, including scientific and literary societies, journals and newspapers, and clubs or lodges that one paid to join. Many of them were more informal, including salons, coffeehouses, and taverns. These new institutions operated outside the traditional intellectual centers of courts, churches, and universities, and created what the German philosopher and historian Jürgen Habermas called the "public sphere," which provided both an audience for new ideas and a place where those ideas were often germinated.

Reason, knowledge, and property

Mathematics, abstract reasoning, and experimentation all provided tools for studying the natural world in the seventeenth century, and they also provided

tools for thinkers contemplating the place of humans and God in that world, and the limits of human knowledge. Descartes based all knowledge on our intuition about God's existence and understanding of ourselves as thinking beings, but other philosophers had different ideas.

Baruch Spinoza (1632–77) was born to Jewish parents in Amsterdam, but his freethinking and unorthodox views led him to be thrown out of the Jewish community. He traveled from town to town, making a living as a lens-grinder, an occupation that cut his life short because he steadily breathed in glass dust. Hostility to his earliest published works and political instability in the Netherlands led him to withhold his writings from publication, and his main work, *Ethics*, was only published after he died. In *Ethics* (1677), Spinoza argues that there is really only one substance in the universe. That substance is God. God and Nature, Creator and creation, mind and matter are all the same, a position called pantheism, which Spinoza demonstrated through logical geometrical proofs and theorems. Our sense of remoteness from one another or separation from God is an illusion, he asserted, and our immortality is certain, as the One Substance is eternal. Whatever happens is destined to happen – a position called determinism, akin to Calvin's idea of predestination – but because God and the universe are one, we can be confident that things happen for a reason. We do not have free will, but if we understand our place in nature, we can achieve freedom of mind and an intellectual love of God, a state Spinoza calls bliss. This bliss, this sense of oneness with God and other people, is vastly superior to any other emotion, which Spinoza urges us to control.

The German philosopher Gottfried Wilhelm Leibniz met Spinoza, and built his own philosophical system on Spinoza's ideas, though their lives were dramatically different. In his long life, Leibniz corresponded and visited with thinkers, rulers, and statesmen all over Europe, serving as a diplomat in Paris and the official historian and librarian for the dukes of Brunswick. He invented the calculus independently of Newton, and sought to apply Cartesian rational principles to law, theology, and politics as well as scientific issues. He was fascinated by Chinese learning, corresponding with Jesuits who had been in China and writing a knowledgeable book praising Chinese culture. Leibniz accepted Spinoza's notion that everything happens for a reason, and because all reasons are God's and God is good, everything must happen for a good reason. The world as it exists is only one of many possible worlds, but because it is what God has chosen, it is the best of all possible worlds. Suffering and evil are the result of our not understanding God's reasons.

Leibniz was ruthlessly satirized in the French author Voltaire's anonymous novel *Candide or Optimism* (1759) in which the young hero Candide, accompanied by his Leibniz-quoting tutor Pangloss, experiences a series of dreadful events, including shipwrecks, trials by the Inquisition, starvation, flogging, and the Lisbon earthquake of 1755, which was followed by a tsunami and fire. No matter what happened, Pangloss responds with "everything is for the best in this best

of all possible worlds," until finally by the end Candide decides that simple work is the only real escape. "All that is very well," he says in the last words of the book, "but let us cultivate our garden."

While Descartes, Spinoza, and Leibniz viewed abstract reason as the best tool for understanding the world, the English philosopher and political theorist John Locke (1632–1704) picked up on Francis Bacon's emphasis on experience, observation, and sense perceptions as the true basis of knowledge. In *An Essay Concerning Human Understanding* (1690) Locke argued that the mind at birth is a blank tablet (*tabula rasa*) with no innate ideas. All knowledge is derived from actual experiences, a position called empiricism or experientialism; education was thus extremely important, for only through education could the mind reach its fullest potential. Locke's empiricism was not absolute, however, for he did make room for both reason and faith in the acquisition of knowledge.

Reason, experience, and divine will were not only the sources of human understanding for Locke, but also the proper bases for government. In *Two Treatises on Government* (1690), Locke challenged both Robert Filmer (1588–1653), whose *Patriarcha* based the divine right of kings on the patriarchal power given to Adam by God, and Hobbes, who viewed the original "contract" by which monarchs had been given authority in return for order as immutable. Locke did not see the family and political society as analogous; property, not fatherhood, was the proper basis of political authority. God had given the world to humans in common, and individual property derived from applying labor and talents to that common inheritance; the state of nature was not, as it was for Hobbes, "solitary, poor, nasty, brutish and short," but rather pleasant. Individuals had not formed a contract with governments to avoid chaos, but simply to better assure protection for their property. Monarchs who did not do this, or who applied their powers in capricious or arbitrary ways, could justifiably be overthrown.

Locke uses the word "property" in several senses. Narrowly, he takes it to mean land, goods, and money. Only those who owned property, he argued, could be free enough to make political decisions without being influenced by others, an idea that fitted well with the political realities of England in the late seventeenth century, and provided justification for limiting voting rights in national elections to property-owning males until the nineteenth century. (In a few local elections in some areas of Britain and eventually in some British colonies in North America, unmarried and widowed female property owners were allowed to vote. Laws that eliminated property ownership as a requirement for voting in the nineteenth century used the word "male," thus explicitly excluding women on the basis of their gender.) More broadly, Locke uses property to mean "life, liberty, and estate," which he describes, somewhat vaguely, as "natural rights" given to humans by God. Tyrannical monarchs could thus be legitimately opposed when they failed to protect individuals' property, but also when they failed to uphold these broader natural rights.