Other Scientific Advances

The Scientific Revolution of the late sixteenth and seventeenth centuries produced several scientific breakthroughs that laid the foundations for modern science as it exists today. The Scientific Revolution ushered in new approaches to the natural world, including an emphasis on the experimental method, the expression of natural phenomena in mathematical terms, a mechanistic approach aimed at reducing complex phenomena to their constituent parts, and the attempt to avoid both *a priori* and teleological assumptions about the natural world. Although such natural philosophers as Copernicus and Galileo are perhaps the most famous, a significant contingent of other thinkers contributed to the larger movement.

Some of these thinkers are primarily remembered for their contributions outside the field of natural philosophy. The French-born René Descartes, for example, was instrumental for important work not only in natural philosophy and mathematics, but also in philosophy itself. Descartes’s introduction of the mind-body problem has engrossed philosophers for centuries.

Over the course of the seventeenth century, several institutions for the study of nature were established, including the Royal Society in England in 1660 and the French Academy of Sciences in 1666. These organizations typically published scientific journals that disseminated new theories and discoveries taking place throughout Europe. This pan-European network of information exchange reflects the importance of communication and print culture to the Scientific Revolution.

René Descartes

René Descartes (1596–1650) is considered one of the major figures of the seventeenth century and an important contributor to the Scientific Revolution. Descartes was a French-born philosopher and mathematician, but spent most of his adult life living in the Dutch Republic. The Dutch environment influenced the development of Descartes’s philosophical and mathematical theories. Although Descartes is primarily remembered for his writings as a philosopher—today he is often considered the father of modern philosophy—his findings in mathematics were, perhaps, equally innovative and influential.

Published in 1637, *La Géometrie*, or *The Geometry*, was Descartes’s major treatise in mathematics. In it he described the principles of coordinate geometry, a system he created for studying geometry using algebraic principles and a coordinate system. Also known as “analytic” or “Cartesian” geometry, this system allowed geometric problems to be solved more easily through the use of algebra. Descartes’s creation provided a link between algebra and geometry. Cartesian geometry presented algebraic equations in the form of geometric shapes mapped onto a coordinate system. As a result of this creation, Descartes is referred to as “the father of analytical geometry.” Descartes’s mathematical writings and findings laid the groundwork for future discoveries in mathematics, such as infinitesimal calculus.
Isaac Newton

Perhaps the most important figure of the Scientific Revolution—during his own lifetime, as well as today—was Sir Isaac Newton (1642–1727). Newton received formal training at the University of Cambridge and, beginning in 1669, taught mathematics there. Newton was a polymath, adept in many fields, including mathematics, astronomy, alchemy, and natural philosophy. He is perhaps the most important natural philosopher of all time, and his achievements stand as the hallmarks of the Scientific Revolution.

In the field of mathematics, Newton is credited with creating the fundamental principles of differential and integral calculus. Newton derived these principles around the same time as German scientist Gottfried Leibniz developed them independently.

In the fields of astronomy and what is now called “physics,” Newton built upon earlier theories by Galileo and Descartes, who posited the notion that all planets and earthly objects abide by the same laws of motion.

Newton’s most famous work, *Philosophiae Naturalis Principia Mathematica*, or *The Mathematical Principles of Natural Philosophy* (1687), provided the basic foundations for modern physics and the modern scientific worldview. This major treatise introduced the three laws of motion and the law of universal gravitation, transforming the understanding of the universe and becoming the preeminent modern account of the natural world.

Newton successfully synthesized and built upon the findings of several natural philosophers before him, such as Kepler and Galileo, successfully establishing agreement that all earthly and celestial objects acted in accordance with the same laws of motion. His work also substantiated the heliocentric model, first advanced by Copernicus in the sixteenth century.

Newton also contributed to the discovery of the speed of sound, drew up a methodical law of cooling, and formulated a theory of color based on the observation of prisms. He is also credited with creating the reflecting telescope in 1668. The reflecting telescope, unlike the refracting telescope used by Galileo, incorporated a mirror, which made it less expensive and more widely available than the refracting telescope.

In 1705, after becoming the president of England’s Royal Society two years earlier, Isaac Newton became Sir Isaac Newton, the first English natural philosopher to be knighted.

Newton also made contributions outside the realm of science. He served in Parliament from 1689 to 1690, and again from 1701 to 1702.

Like the majority of Europeans who lived during his lifetime, Newton was an adherent of Christianity. His writings included religious tracts, only one of which was published (*Observations Upon the Prophecies of Daniel and the Apocalypse of St. John*). In fact, Newton actually wrote more theological works than works in natural philosophy.
Other Prominent Scientists

Although astronomy is typically regarded as the major area of growth and development during this period, over the course of the seventeenth century and throughout the Scientific Revolution, nearly all fields of natural philosophy and mathematics witnessed new developments and striking change. English natural philosopher William Gilbert is considered to be one of the first thinkers to use the term “electricity.” Furthermore, he is considered by some to be the father of electrical engineering and magnetism. In *De Magnete, Magneticisque Corporibus, et de Magneto Magnete Tellure—or On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth* (1600)—Gilbert introduced some of the major concepts of magnetism and distinguished its force from electricity. Gilbert illustrated the magnetic field of the earth, and identified and named its two poles. He also described the use and benefits of magnets in the field of navigation.

Otto von Guericke, a German inventor and scientist, created a machine that could generate electrical sparks. Additionally, von Guericke studied the properties of, and possibilities of constructing, a perfect vacuum. In his attempts to fashion a true vacuum, he created the first air pump. Von Guerick displayed the effective results of his pump in a presentation to Emperor Ferdinand III in 1654.

John Napier, a Scottish mathematician and physicist, invented a system (known as “Napier’s bones”) by which to determine square and cube roots. Napier’s *Mirifici Logarithmorum Canonis Descriptio, or The Description of the Marvelous Canon of Logarithms* (1614), detailed his invention of natural logarithms.

William Harvey’s *De Motu Cordis, or On the Motion of the Heart and Blood* (1628), demonstrated a detailed model of the system of circulation in the human body.

Figures such as Zacharias Janssen and Anton van Leeuwenhoek (in addition to Galileo Galilei) are credited for developing the compound microscope over the course of the sixteenth and seventeenth centuries. Anton van Leeuwenhoek is responsible for popularizing the microscope and bringing it to the attention of those we now term “biologists.” This allowed natural philosophers to observe and analyze red blood cells, bacteria, and protozoa.

Robert Boyle, considered today to be the father of modern chemistry, was also one of the leading figures in developing the modern experimental scientific method. Boyle is best known for creating Boyle’s law (PV = k), which states that the absolute pressure and volume of a gas are inversely proportional. His most famous work, *The Sceptical Chymist*, was published in 1661. It is considered to be one of the foundational texts in the field of chemistry.

Robert Hooke, an English philosopher and scientist, worked on developing several scientific theories throughout his career. He studied refraction and formulated the wave theory of light. He also studied the volume of matter and the makeup of air. He postulated that matter expands when it is heated and that air, as compared to solids, is comprised of smaller particles separated by distance. Hooke constructed one of the earliest versions of the Gregorian telescope, and was particularly interested in the revolutions of Mars and Jupiter. He also dabbled in the analysis of fossils and emerged as one of the earliest proponents of the notion of biological evolution. Furthermore,
Hooke was interested in cartography and produced innovative work in surveying. Throughout his career, he held two important posts that in many ways shaped the course of his scientific work. He worked for some time as an assistant to Robert Boyle. Among other things, Hooke helped Boyle build pumps for his experiments with gas. He also served as curator of experiments for the Royal Society, England’s premier scientific organization.

Scientific Institutions and the State

Over the course of the seventeenth century, several organizations and institutions were established throughout Europe with the goal of furthering knowledge about nature. These institutions often sponsored or collaborated with scientific academies throughout Europe. Most of these organizations produced journals detailing the latest discoveries and theories advancing through Europe. Scientific journals during the seventeenth century were not nearly as specialized as contemporary science journals and enjoyed a much wider readership than they do today.

In England, the Royal Society was founded in 1660 during the reign of King Charles II, who offered his full support of the organization. Starting in 1665, The Royal Society began publication of its journal entitled Philosophical Transactions of the Royal Society. The journal, today’s oldest scientific journal to be under continuous publication, circulated the findings of new scientific experiments throughout England. The Royal Society and its journal demonstrated England’s commitment to the advancement of science, illustrating the close relationship between science and the Crown that existed in many countries—including England, the Dutch Republic, and France—during the Scientific Revolution. Furthermore, the journal illustrates the dependence of the Scientific Revolution on print culture.

In France, the Academie Royale Des Sciences, or the French Academy of Sciences, was established in 1666, during the reign of Louis XIV. The idea of creating an academy for science originated with Louis XIV’s minister of finance and confidant Jean-Baptiste Colbert. The Academy was at the forefront of the study of nature in Europe throughout the seventeenth and eighteenth centuries. Starting in 1699, the French Academy of Sciences published several journals, including Histoire and Mémoires, which disseminated new theories and research in the fields of chemistry, botany, mathematics, and other areas of natural philosophy. The journals were, in many ways, international publications that featured contributions from seventeenth-century scientists all over Europe, including the Italian astronomer Giovanni Domenico Cassini and the famous German mathematician Gottfried Wilhelm Leibniz.