The Scientific Revolution

The Dawn of Modern Science

Old View – One example of how scholars relied on traditional authorities was in their beliefs about the structure of the universe. People believed that the earth was the center of the universe and that the sun, moon and planets revolved around the earth. This viewpoint was called the geocentric theory.

The Greek philosopher Aristotle proposed the geocentric theory in the 300s BC. The Greek astronomer Ptolemy expanded upon Aristotle’s ideas in the 200s AD. These ideas were upheld by the church, which taught that God put the earth at the center of the universe. For centuries, scholars and the church were the accepted authorities for European intellectuals.

New Viewpoints – In the Middle Ages, scholars in Europe learned about scientific advances in the Arab world. By the mid-1500s, they began to challenge traditional authorities. They posed theories about the natural world and developed procedures to test those ideas. Historians have called this new way of thinking the Scientific Revolution.

Why were Europeans open to new ideas at this time? One reason was exploration. When explorers journeyed to Africa, Asia, and the Americas, they found people and animals they had never seen before. The ancient scholars could provide no information about these new lands. Perhaps there were other things to be discovered that the ancients had not known.

The Age of Exploration also led scientists to study the natural world more closely. Navigators, for example, needed more accurate instruments and geographic knowledge to help find their way across vast oceans. The more that they examined the natural world, however, the more they found that it did not match ancient beliefs.

The Scientific Method – Scientists eventually developed a new approach to investigation and discovery called the scientific method. The scientific method consists of five basic steps. First, scientists identify a problem. Next, they try to form a hypothesis that can be tested. They then perform experiments to test the hypothesis. They record the results of the experiments. Finally, they analyze the results to form a conclusion that supports or denies the hypothesis.

Two of the most important scholars that developed the scientific method were Francis Bacon and Rene Descartes. In England, Bacon wrote in 1620 that the only true way to gain scientific knowledge was through experimentation — observation, measuring, explaining, and verifying. In France, Descartes placed more emphasis on reason. He believed that everything should be doubted until it could be proven by reason. Descartes relied on mathematics and logic to prove basic truths. Both of these men still influence scientists today.

Discoveries in Astronomy, Physics, and Math

Copernicus – In the early 1500s, Polish astronomer Nicolaus Copernicus recognized that the geocentric theory did not explain the movements of the sun, moon and planets accurately. After years of careful observation, he came to the conclusion that the sun, not the earth, was near the center of the solar system. This theory that states the earth rotates around the sun is called the heliocentric theory. This theory was not new, but Copernicus developed a detailed mathematical explanation of how the process worked. He was also the first scientist to create a complete model of the solar system that combined physics, astronomy, and mathematics. Because he knew the church would oppose his teachings, he waited until the end of his life to publish his book, On the Revolutions of the Heavenly Spheres.

Galileo – Copernican theory was supported by Galileo Galilei, an Italian scientist. After learning about the a sailor’s spyglass that allowed one to see distant objects, Galileo built the first telescope used for astronomy in 1609, which was used to scan the heavens. Galileo was the first scientist to observe Saturn, the craters on the moon, sunspots, and the moons of Jupiter. He detailed the Milky Way galaxy in his book Starry Messenger.

Sir Isaac Newton – The English Scientist Isaac Newton changed the world of science by bringing together astronomy, physics and mathematics. He wondered if gravity affected the universe the way that it affected objects on earth. His book, The Mathematical Principles of Natural Philosophy, explained his law of universal gravitation. This law states that gravity affects objects in the universe as well as on earth. Just as gravity causes an apple to fall from a tree, gravity keeps the planets in their orbits. From these findings, he developed calculus.
Discoveries in Biology and Chemistry

Biology – In the Middle Ages, Europeans relied on the works of the ancient Greek physician Galen, but his works were inaccurate. He had assumed that human anatomy was similar to that of animals, because he had never dissected a human body. Andreas Vesalius, a Flemish doctor, became known for his work in anatomy at the University of Padua in Italy. In 1539, a judge learned of his work and made the bodies of executed criminals available to Vesalius for dissection, who in turn hired artists to produce accurate drawings of the bodies. They appeared in his book, *On the Workings of the Human Body*, in 1543.

Robert Hooke, and English physicist and inventor, would use an early microscope to look at microorganisms. He is credited with creating the term cell.

Chemistry – Robert Boyle is often called the father of modern chemistry. Boyle was the first chemist to define an element. His 1661 work, *The Skeptical Chemist*, described matter as a cluster of tiny particles (now called atoms). Boyle stated that these changes in matter happened when these clusters were rearranged. His most significant contribution to chemistry was Boyle’s Law, which describes how temperature, volume, and pressure affect gases.

Science & Society

Science and Church – As the most powerful institution in Europe during the Middle Ages, the church had also been the primary resource for knowledge and learning. The church had established cathedral schools, many of which became universities, to train people to run the church. How did scientists and their innovative ways fit into the church’s established structure?

Galileo’s theories, however, brought him into direct conflict with the church. Church leaders pressured Galileo not to support the ideas of Copernicus. Still, Galileo continued his studies. In 1632, he published *Dialogue Concerning Two Chief World Systems*. Although this book included the views of both Ptolemy and Copernicus, it clearly showed Galileo’s support of Copernican theory. Pope Urban VIII angrily ordered Galileo to Rome to stand trial before the Inquisition.

In April 1633 Galileo stood trial before the Inquisition. He reluctantly stated that he would not use Copernican theory in his work so that he would receive a lenient sentence. The pope ordered Galileo placed under house arrest in his villa near Florence, where he spent the remainder of his life.

Science & Art – During the Renaissance, the study of art and architecture were not separate from the study of science. Artists learned human anatomy so they could paint the body. Artists experimented with the chemistry of paints and the nature of light. Painters used mathematics to create compositions of perfect balance. The use of mathematics and physics were crucial to the great architecture and engineering achievements of the time.

Science and religion thus combined to produce the great artistic achievements of the Renaissance. Much of the great art and architecture of the Renaissance was dedicated to the glory of God and would have been impossible without reason and science. But the artists and architects had not challenged a basic belief of the church. Rather, astronomers such as Galileo did.

Science & Community – The Scientific Revolution had firmly established a new way of thinking about the physical world. Great advances had been made in the disciplines of astronomy, physics, biology, and chemistry. In turn, those advances had influenced developments in the arts and architecture. As the Scientific Revolution spread, its impact would reach far beyond laboratories and observatories.

Soon, philosophers and scholars would seek new understandings about society. They would reexamine old ideas on government, religion, education and economics. They would also wonder if reason could solve the age-old problems of poverty, war, and ignorance. The new ways of thinking that emerged from the Scientific Revolution would lead to even more dramatic changes.