Scientific Revolution Activity

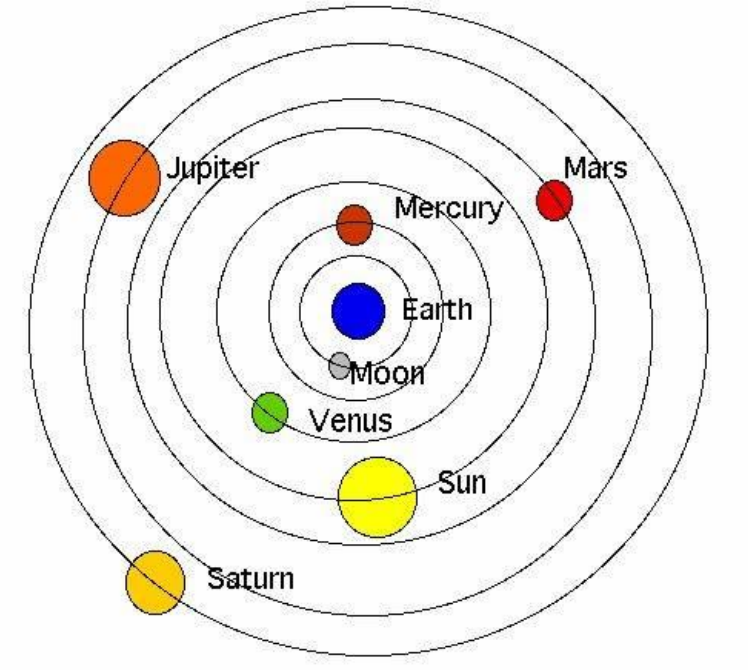
1. Background on Scientific Revolution

Before 1500, scholars generally decided what was true or false by referring to an ancient Greek or Roman author or to the Bible. Few European scholars challenged the scientific ideas of the ancient thinkers or the church.

The Medieval View:

During the Middle Ages, most scholars believed that the earth was an immovable object located at the center of the universe. According to that belief, the moon, the sun, and the planets all moved in perfectly circular paths around the earth.

This earth-centered view of the universe was called the geocentric theory. The idea came from Aristotle, the Greek philosopher of the fourth century B.C. The Greek astronomer Ptolemy (TOL•a•mee) expanded the theory in the second century A.D. In addition, Christianity taught that God had deliberately placed the earth at the center of the universe.



2. The Sparks of the Scientific Revolution

The Scientific Revolution was a new way of thinking about the natural world. That way was based upon careful observation and a willingness to question accepted beliefs.

A combination of discoveries and circumstances led to the Scientific Revolution and helped spread its impact. The invention of the printing press during this period helped spread challenging ideas—both old and new—more widely among Europe's thinkers.

The age of European exploration fueled a great deal of scientific research, especially in astronomy and mathematics. Navigators needed better instruments and geographic measurements, for example, to determine their location in the open sea. As scientists began to look more closely at the world around them, they made observations that did not match the ancient beliefs. They found they had reached the limit of the classical world's knowledge.

Changing Idea: Scientific Method

Old Science

Scholars generally relied on ancient authorities, church teachings, common sense and reasoning to explain the physical world.

New Science

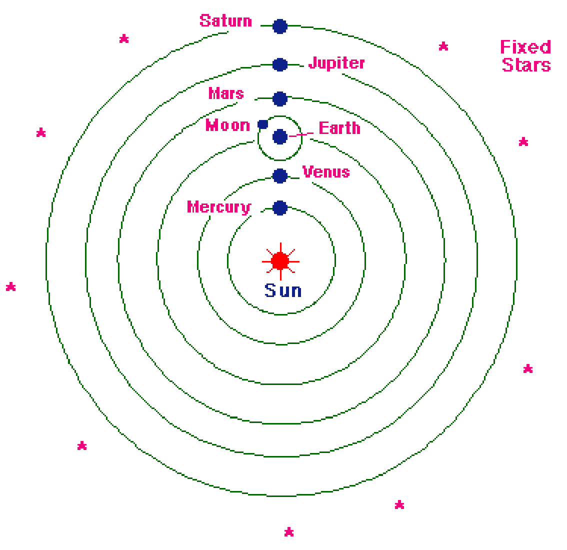
In time, scholars began to use observation, experimentation, and scientific reasoning to gather knowledge and draw conclusions about the physical world.

3. The Heliocentric Theory

Although backed by authority and common sense, the geocentric theory did not accurately explain the movements of the sun, moon, and planets. This problem troubled a Polish cleric and astronomer named Nicolaus Copernicus. In the early 1500s, Copernicus became interested in an old Greek idea that the sun stood at the center of the universe. After studying planetary movements for more than 25 years, Copernicus reasoned that indeed, the stars, the earth, and the other planets revolved around the sun.

Copernicus's heliocentric, or sun-centered, theory still did not completely explain why the planets orbited the way they did. He also knew that most scholars and clergy would reject his theory because it contradicted their religious views. Fearing ridicule or persecution, Copernicus did not publish his findings until 1543, the last year of his life. He received a copy of his book, *On the Revolutions of the Heavenly Bodies,* on his deathbed.

A brilliant mathematician named Kepler continued his work. After studying the data, Johannes Kepler concluded that certain mathematical laws govern planetary motion. One of these laws showed that the planets revolve around the sun in elliptical orbits instead of circles, as was previously thought. Kepler's laws showed that Copernicus's basic ideas were true. They demonstrated mathematically that the planets revolve around the sun.

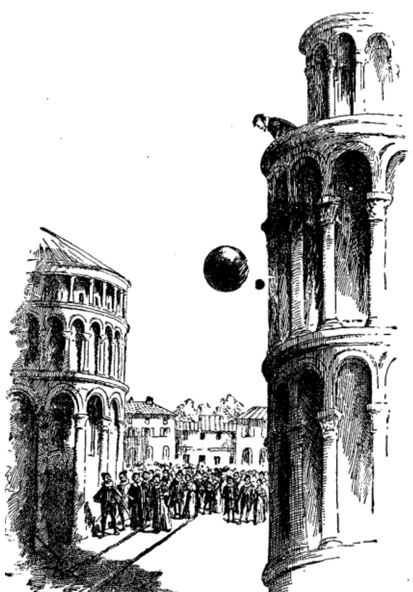


4. Galileo's Discoveries

As a young man, Galileo Galilei learned that a Dutch lens maker had built an instrument that could enlarge far-off objects. Galileo built his own telescope and used it to study the heavens in 1609.

Then, in 1610, he published a small book called *Starry Messenger,* which described his astonishing observations. Galileo announced that Jupiter had four moons and that the sun had dark spots. He also noted that the earth's moon had a rough, uneven surface. This shattered Aristotle's theory that the moon and stars were made of a pure, perfect substance. Galileo's observations, as well as his laws of motion, also clearly supported the theories of Copernicus.

Galileo dropped a cannonball and a musketball simultaneously from a tower, and observed that they hit the ground at nearly the same time. He found that the mass of an object does not affect how quickly it accelerates due to gravity. This contradicted Aristotle's long-accepted idea that heavier objects fell faster.



5. Conflict with the Church

Galileo’s findings frightened both Catholic and Protestant leaders because they went against church teaching and authority. If people believed the church could be wrong about this, they could question other church teachings as well.

In 1616, the Catholic Church warned Galileo not to defend the ideas of Copernicus. Although Galileo remained publicly silent, he continued his studies. Then, in 1632, he published *Dialogue Concerning the Two Chief World Systems.* This book presented the ideas of both Copernicus and Ptolemy, but it clearly showed that Galileo supported the Copernican theory. The pope angrily summoned Galileo to Rome to stand trial before the Inquisition.

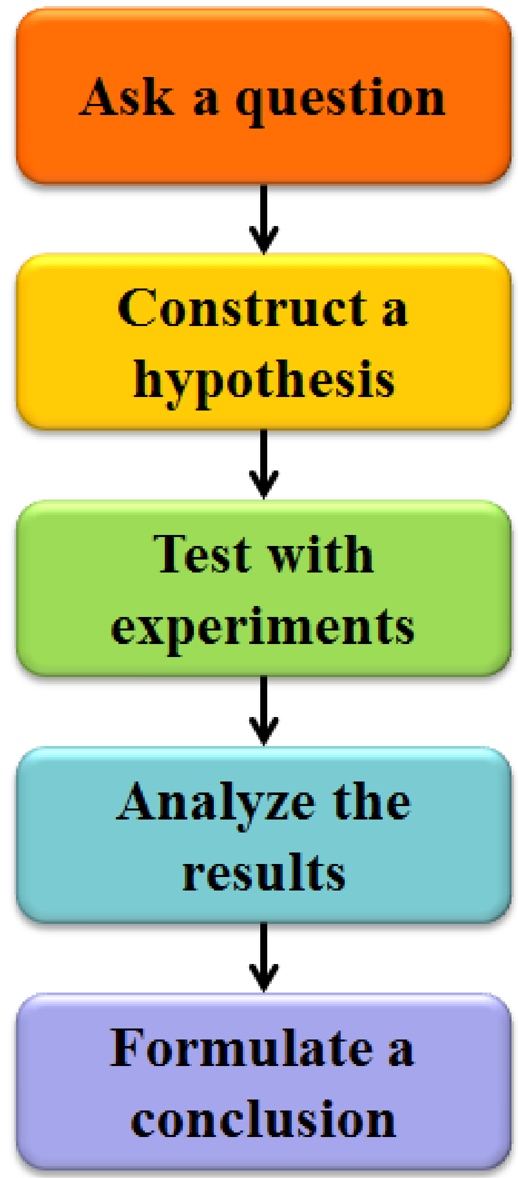
Galileo stood before the court in 1633. Under the threat of torture, he knelt before the cardinals and read aloud a signed confession. In it, he agreed that the ideas of Copernicus were false.

Galileo was never again a free man. He lived under house arrest and died in 1642 at his villa near Florence. However, his books and ideas still spread all over Europe. (In 1992, the Catholic Church officially acknowledged that Galileo had been right.)

6. The Scientific Method

The revolution in scientific thinking that Copernicus, Kepler, and Galileo began eventually developed into a new approach to science called the scientific method. The scientific method is a logical procedure for gathering and testing ideas. It begins with a problem or question arising from an observation. Scientists next form a hypothesis, or unproved assumption. The hypothesis is then tested in an experiment or on the basis of data. In the final step, scientists analyze and interpret their data to reach a new conclusion. That conclusion either confirms or disproves the hypothesis.

The scientific method did not develop overnight. The work of several key thinkers of the 1600s helped to advance the new approach. Francis Bacon, an English statesman and writer, had a passionate interest in science. He believed that by better understanding the world, scientists would generate practical knowledge that would improve people’s lives. In his writings, Bacon attacked medieval scholars for relying too heavily on the conclusions of Aristotle and other ancient thinkers. Instead of reasoning from abstract theories, he urged scientists to experiment and then draw conclusions. This approach is called empiricism, or the experimental method.

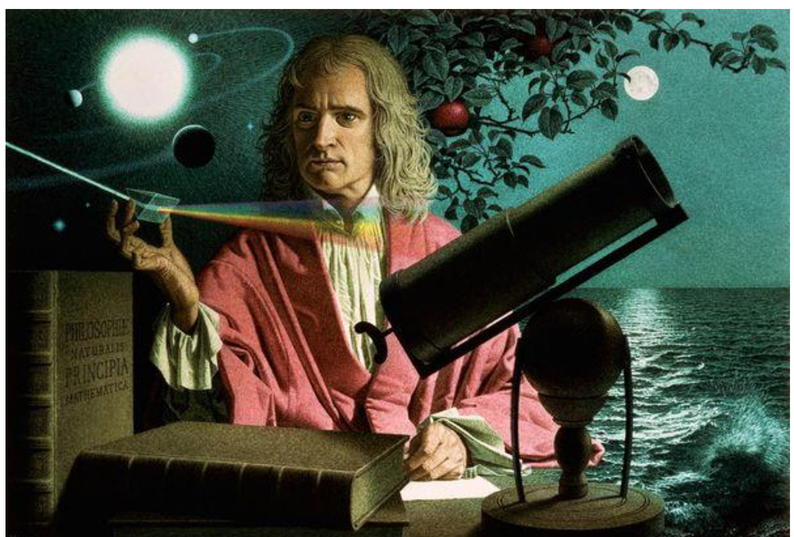


7. Newton Explains the Law of Gravity

The great English scientist Isaac Newton helped to bring together the breakthroughs of Copernicus, Kepler, and Galileo under a single theory of motion.

By the time he was 26, Newton was certain that all physical objects were affected equally by the same forces. Newton's great discovery was that the same force ruled motion of the planets and all matter on earth and in space. The key idea that linked motion in the heavens with motion on the earth was the law of universal gravitation. According to this law, every object in the universe attracts every other object. The degree of attraction depends on the mass of the objects and the distance between them.

In 1687, Newton published his ideas in a work called *The Mathematical Principles of Natural Philosophy*. It was one of the most important scientific books ever written. The universe he described was like a giant clock. Its parts all worked together perfectly in ways that could be expressed mathematically. Newton believed that God was the creator of this orderly universe, the clockmaker who had set everything in motion.



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