

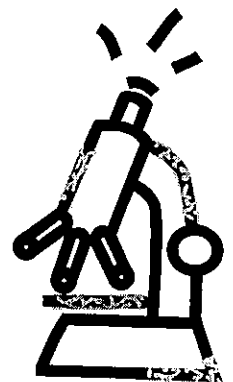
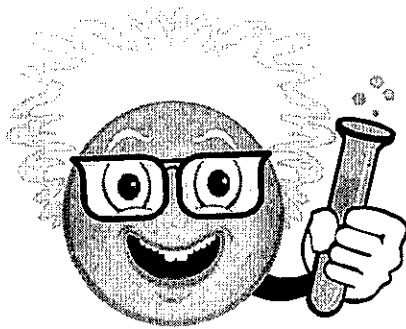
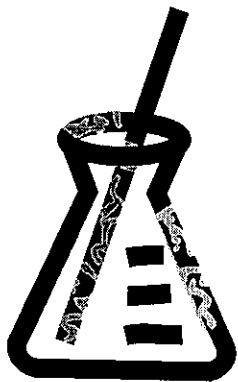
Causes of the Scientific Revolution

The state of science prior to the scientific revolution was a mixture of three influences: the scholarly writings of the natural philosophers of ancient Greece the technological advances made by the trades people of the Middle Ages, and the doctrines (teachings) of the Roman Catholic Church. Few European scholars challenged the scientific ideas of ancient thinkers or the church for themselves.

Beginning in the 1500s, several scholars published works that challenged the ideas of the ancient thinkers and the Church. As these scholars replaced old assumptions with new theories, they launched a change in European thought that historians call 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 the Scientific Revolution in Europe, such as:

1. European scholars uncovered many classical manuscripts during the Crusades and through trade
2. Europeans began to question the Church during the Reformation resulting in people questioning Church teachings on science
3. Europeans began questioning traditional teachings during the Renaissance rather than just accepting information as fact



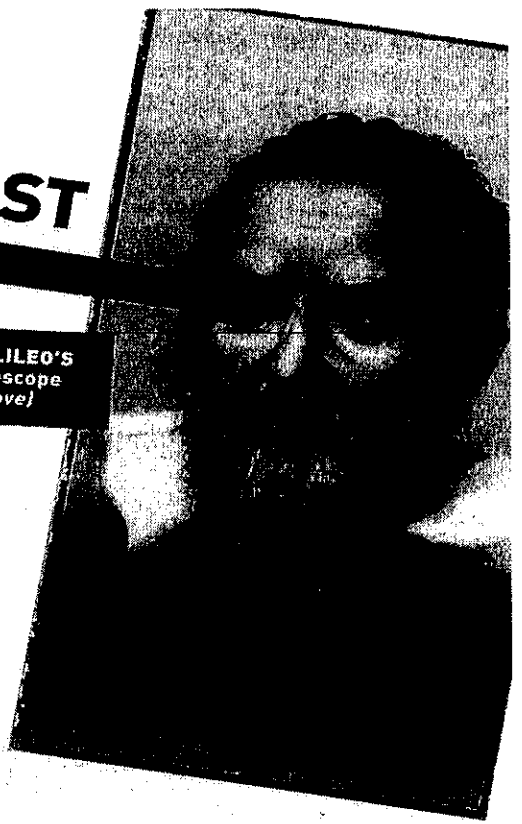
A TELESCOPE TO THE PAST

Four hundred years ago, Galileo Galilei built his first telescope—and began to change the way people viewed the universe. In honor of the anniversary, one of Galileo's telescopes (shown above) is on display at the Franklin Institute in Philadelphia through the summer. (It's one of two that still exist; until now, neither had been seen outside Italy since Galileo's lifetime.) An

astronomer and physicist, Galileo made his first telescope in 1609 after hearing that a Dutch eyeglass maker had built a spyglass. Galileo's telescopes allowed him to become the first to see mountains on the moon and satellites orbiting Jupiter. These discoveries challenged the Earth-centered view of the universe that had prevailed for a

thousand years. In 1633, Galileo was put on trial by the Roman Catholic Church for promoting the Copernican theory that the Earth and other planets orbited the sun. He was convicted of holding views "contrary to Scripture" and declared "vehemently suspect of heresy." Galileo recanted and spent the rest of his life under house arrest. ●

GALILEO'S telescope (above)



Pope Absolves Galileo

Says church erred in condemnation

THE ASSOCIATED PRESS

Vatican City, Italy — Pope John Paul II formally proclaimed yesterday that the Roman Catholic Church had erred in the 17th Century by condemning the astronomer Galileo for holding that the Earth was not the center of the universe.

Galileo's condemnation resulted from a "fragile mutual incomprehension" and became a symbol for the church's "supposed rejection of scientific progress," the Pope told the Pontifical Academy of Sciences.

His speech was the Vatican's final word on the matter nearly four centuries after the astronomer was found guilty of violating church doctrine by contending the Earth revolved around the sun, and not vice versa. Vatican experts appointed by John Paul had studied the case for 13 years.

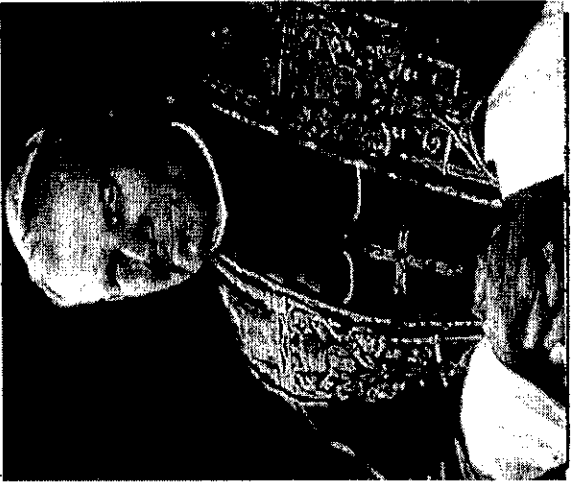
Galileo was forced to recant his beliefs and ordered imprisoned. He died under house arrest in 1642, blind but working on his theories to the end.

John Paul has admitted several times since his election that the Catholic Church wronged Galileo.

"Galileo, who practically invented the experimental method, understood why the sun could function as the center of the world, as it was then known, that is to say, as a planetary system," the Pope

told church officials and scholars gathered in the Apostolic Palace.

The theologians of the time, in maintaining the "centrality of the Earth," erred by thinking that the "literal sense of sacred Scripture" explained the physical world. The president of the Academy of the Lincei in Rome, of which Galileo had been a member, said the Pope's



AP P

The Pope yesterday in Vatican City

speech was a long time coming. "This is not only about a rehabilitation, but about a recognition of errors and of guilt," said physicist Giorgio Salvini.

John Paul said it was important to understand the matter in case of future conflicts between religion and science. Galileo Galilei left from 1564 to 1642. He built the first compound astronomical telescope and used it to gather evidence supporting Copernicus' theory that Earth revolves around the sun.

The theory had been denounced in 1616 as dangerous to the faith, and Galileo was warned to stop teaching it. He defied the warning by publishing his "Dialogues Concerning the Two Chief World Systems," in 1632 and was tried a year later as a heretic.

Galileo defended himself by saying study of the natural world would promote religious understanding. Church authorities branded him suspected heretic and forced him to say he "repented, cursed and detested" his beliefs. He was sentenced to life imprisonment, a penalty he changed to house arrest, where he spent the last eight years of his life.

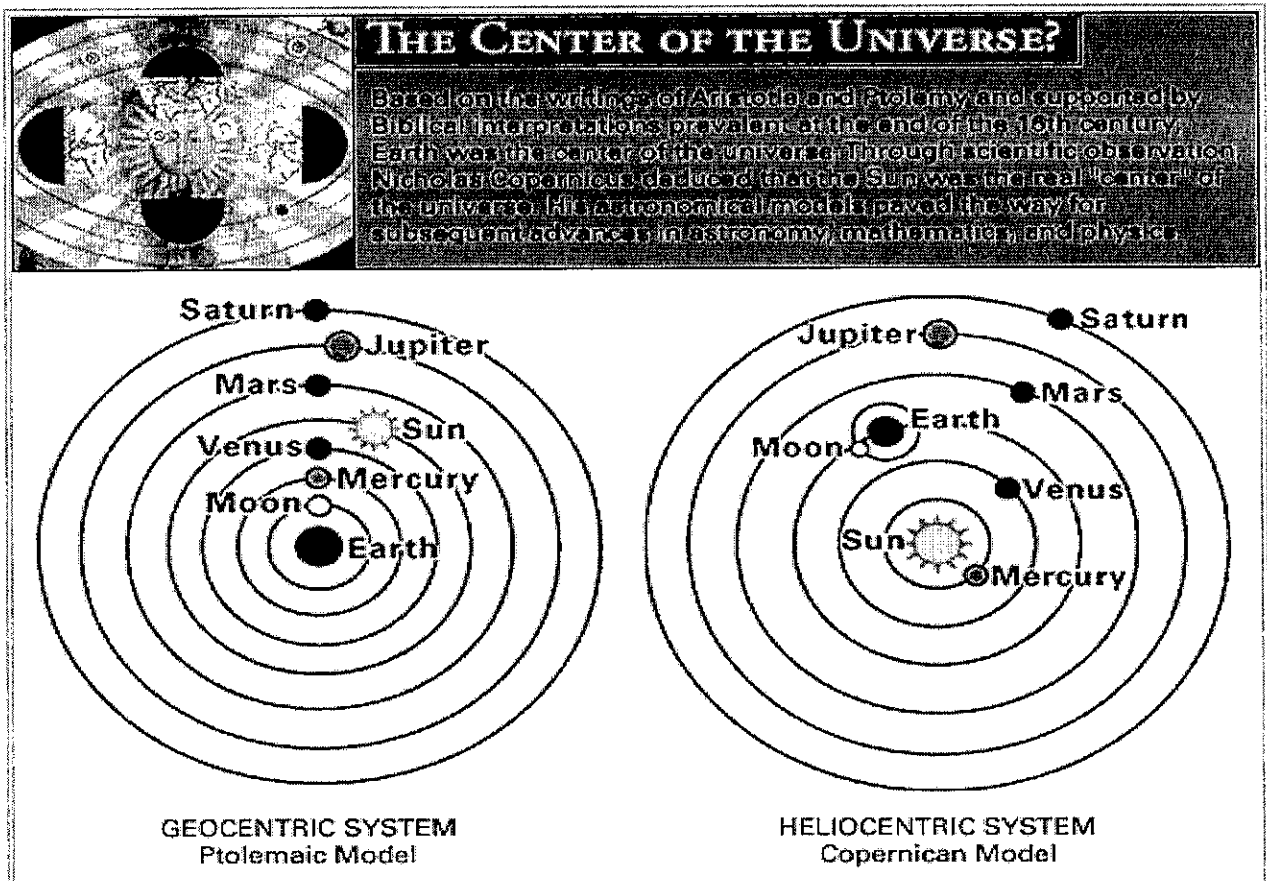


Galileo

Copernicus

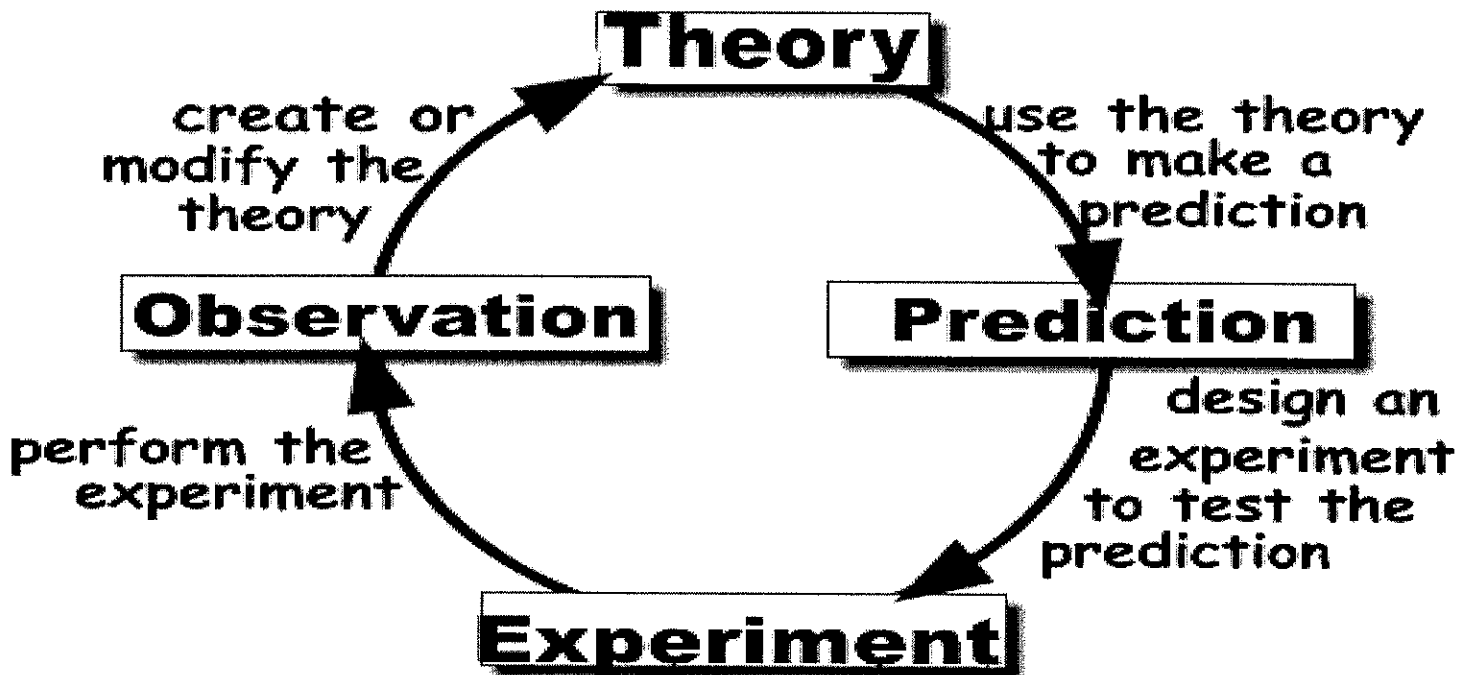
Prior to the Scientific Revolution, the common theory of the model of the universe was based on the idea that Earth was the center of the universe and that the sun, moon, and planets orbited around Earth in a circular motion while the Earth remained in the same position. This, the Geocentric Theory, was supported and taught by the Roman Catholic Church and was accepted by most thinkers and scientist of the time. However, this theory did not satisfy Nicholas Copernicus, an astronomer. The Church taught that God deliberately placed the earth at the center of the universe. Thus, Earth was a special place on which the great drama of human life unfolded.

After much observation, Copernicus reasoned that Earth was not the center of the universe. Copernicus developed the Heliocentric Theory based on his findings. This theory went against the teachings of the Roman Catholic Church. God, it was thought, existed beyond the sphere of the stars and gave his instructions to angels, who were responsible for the motions of the planets. Copernicus could have faced ridicule, persecution and even excommunication for releasing his findings. Copernicus kept his findings to himself until he approached the end of his life to avoid the consequences of speaking out against the Church.



The Scientific Method

The revolution in thinking that occurred during the Scientific Revolution eventually developed into a new approach to science called the scientific method. The scientific method is a logical procedure for gathering information and testing



Brahe and Kepler

Tycho Brahe was a Danish astronomer. Brahe carefully recorded the movement of the planets for many years and produced mountains of accurate data based on his observations. However, it was left to his followers to make mathematical sense of them.

One of Brahe's assistants, **Johannes Kepler**, continued his work. 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 previously thought. Kepler proved that Copernicus' basic ideas were true. They demonstrated mathematically that the planets revolve around the sun

Isaac Newton

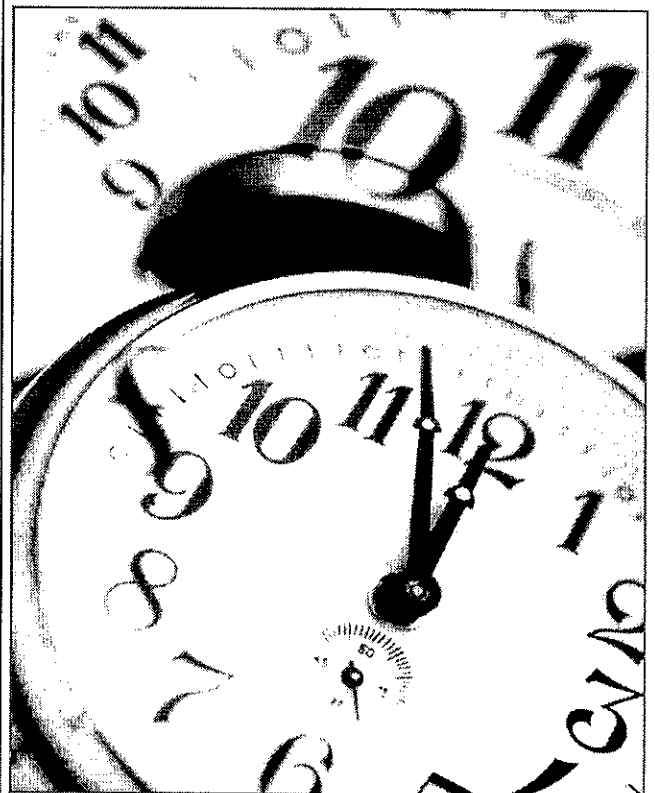


Isaac Newton was a British scientist who studied at the University of Cambridge. Newton was certain that all physical objects (planets, the pendulum, and all matter on Earth and in space) were affected equally by the same forces. This theory disproved the ideas of Aristotle that one set of physical laws governed Earth and another governed the rest of the universe. This is Newton's law of **universal gravitation**. Newton named this force gravity.

Legends has it that Isaac Newton discovered gravity while sitting under an apple tree as he was struck by a falling apple.

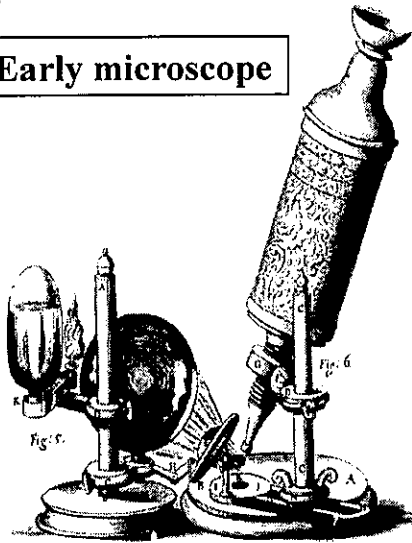


Newton published his works in and ideas in a book called *Mathematical Principals of Natural Philosophy*. His description of the universe was based on a giant clock. Its parts worked together perfectly in ways that could be explained mathematically. Newton believed that God was the creator of this orderly universe and was the clockmaker who had set it (the universe) in motion.



Results of the Scientific Revolution

Early microscope



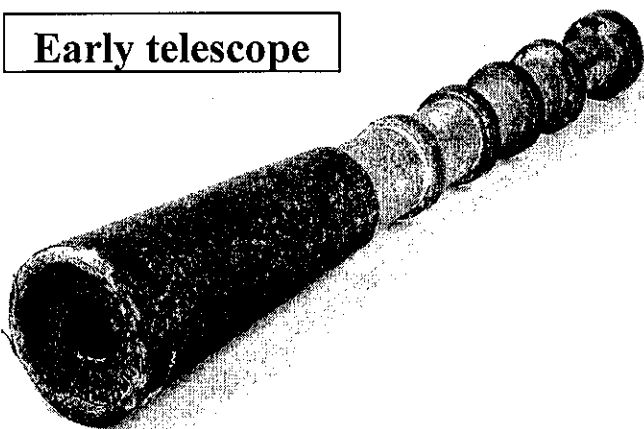
The discoveries and ideas of the Scientific Revolution changed society forever. As astronomers explored the secrets of the universe, other scientists began to study the secrets of nature on Earth.

One result of the Scientific Revolution was the development of new scientific tools. Scientists invented new instruments to make precise observations and collect accurate data.

The Scientific Revolution also impacted the field of medicine. Physicians began to further investigate the human anatomy using the same scientific methods as scientists. It was during this time period that the secrets of the human heart were revealed. In addition, the first vaccine, for smallpox, was developed.

The influence of the Scientific Revolution soon spread beyond the world of science. Other views of the world, specifically about government and society also became uncertain. In many ways, the Scientific Revolution paved the way for the Enlightenment, a period in which thinkers attempted to apply reason to all aspects of society.

Early telescope



Early thermometer