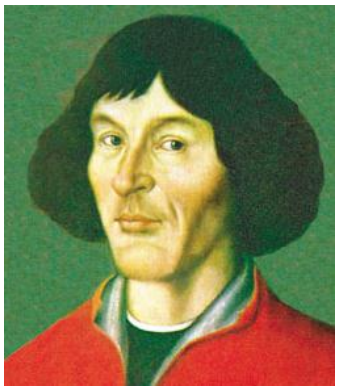
Mr. Sforza / Global 3 **Please Do Not Write On This Handout!**

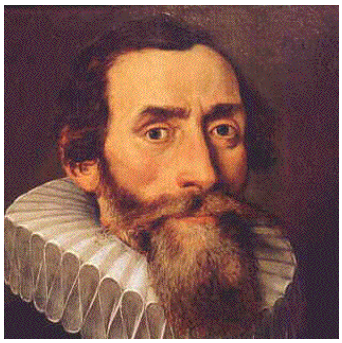
AIM: How did the Scientific Revolution change our view of the world?

DO NOW: Using the projected chart, please answer the questions on your notes sheet.
Q: Is there anything that all three models of the universe have in common? How did the models of Copernicus and Kepler differ from Ptolemy's? How did they differ from each other?

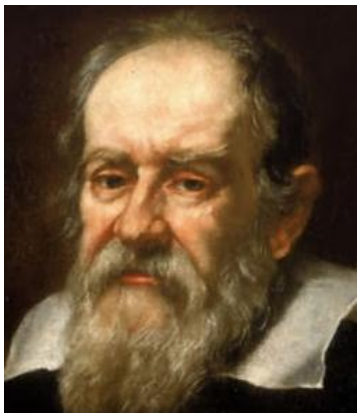
The first major challenge to accepted scientific thinking came in the field of astronomy. The Scientific Revolution started when a small group of scholars began to question the **geocentric theory**, which stated that the earth was at the center of the universe.



Although backed by authority, the geocentric theory did not accurately explain the movements of the sun, moon, and planets. This problem troubled a Polish astronomer named **Nicolaus Copernicus**. 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.



Other scientists built on the foundations Copernicus had laid. A Danish astronomer, Tycho Brahe, carefully recorded the movements of planets for many years. After Brahe's death in 1601, his assistant, a mathematician named **Johannes Kepler**, continued his work. After studying Brahe's data, 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. Kepler's laws demonstrated mathematically that the planets revolve around the sun, showing that Copernicus's basic ideas were true.



In the early 1600s, an Italian astronomer, **Galileo Galilei** learned that a Dutch lens maker had built an instrument that could enlarge far-off objects. Without seeing this device, Galileo successfully built his own telescope, which he used to study the heavens. In 1610 he published the book Starry *Messenger*, in which he announced that Jupiter had four moons, the sun had dark spots, and that the moon had a rough and uneven surface. This shattered Aristotle's theory that the moon and stars were made of a pure and perfect substance. Galileo's observations also clearly supported Copernican theory.

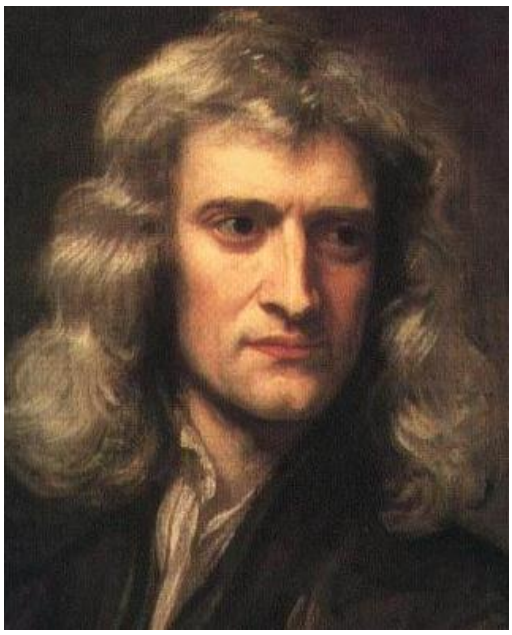
Galileo's findings frightened both Catholic and Protestant leaders because they went against church teaching and authority. In 1616, the Catholic Church warned Galileo not to defend the ideas of Copernicus. Although Galileo remained publicly silent, he continued his studies. Then, in 1632, he published a book that clearly showed he supported the Copernican theory. The pope angrily summoned Galileo to Rome to stand trial. Galileo stood before the court in 1633. Under the threat of torture, he read aloud a signed confession. In it, he agreed that the ideas of Copernicus were false.

The Scientific Method

Interest in science led to a new approach, the **scientific method**. With this method, scientists ask a question based on something they have seen in the physical world. They form a hypothesis, or an attempt to answer the question. Then they test the hypothesis by making experiments or checking other facts. Finally, they change the hypothesis if needed. English writer **Francis Bacon** helped foster this new approach to knowledge by telling scientists they should base their ideas on what they can see and test in the world. This is also called empiricism.

In France, **Rene Descartes** also believed that scientists needed to reject old assumptions and teachings. Rather than using experimentation, however, Descartes relied on mathematics and logic. He believed that everything should be doubted until proved by reason. The only thing he knew for certain was that he existed – because, as he wrote, "I think, therefore I am." From this starting point, he followed a train of strict reasoning to arrive at other basic truths.

Newton Explains the Law of Gravity



The English scientist **Isaac Newton** helped bring together the breakthroughs of Copernicus, Kepler, and Galileo under a single theory of motion. Newton's great discovery was that the same force ruled the motions of the planets, and all matter on earth and in space. According to his law of universal gravitation, every object in the universe attracts every other object. In 1687, Newton published his ideas in one of the most important scientific books ever written, *The Mathematical Principles of Natural Philosophy*.

Document 1

Q: What do you think Newton meant by this quote?

> ***"If I have seen farther than others it is because I have stood on the shoulders of giants."***
> *– Sir Isaac Newton*

The Scientific Revolution Spreads

After astronomers explored the secrets of the universe, other scientists began to study the secrets of nature. Anton von Leeuwenhoek invented a microscope to study creatures too small for the naked eye to see. Evangelica Torricelli developed the first barometer for measuring atmospheric pressure. German physicist Gabriel Fahrenheit made the first thermometer that used mercury in glass.

Doctors also made advances. Andreas Vesalius dissected human corpses and made drawings that showed the different parts of the human body. In the late 1700s, Edward Jenner first used the process called vaccination to prevent disease. By giving a person the germs from a cattle disease called cowpox, he helped that person avoid getting the more serious human disease of smallpox. Scientists made advances in chemistry as well. Robert Boyle challenged the old idea that things were made of only four elements—earth, air, fire, and water. He and other scientists were able to separate oxygen from air.

Sources: Patterns of Interaction; NYC Global History III Resource Guide