The Scientific Revolution

Learning Target

• Explain how new discoveries in astronomy changed the way people viewed the universe.

• Understand the new scientific method and how it developed.

• Analyze the contributions that Newton and other scientists made to the Scientific Revolution.
How did discoveries in science lead to a new way of thinking for Europeans?

- In the mid-1500s, a profound shift in scientific thinking brought the final break with Europe’s medieval past.

- At the heart of this Scientific Revolution was the assumption that mathematical laws governed nature and the universe.

- People, therefore, could know, manage, and shape the physical world.
Until the mid-1500s, Europeans accepted Ptolemy and Aristotle, who believed the Earth was the center of the universe.

This view had become Church doctrine.

- In 1543, Polish astronomer Nicolaus Copernicus challenged this view.
- Copernicus proposed a heliocentric or sun-centered model.
- The Earth was just one of a number of planets revolving around the sun.
Ptolemy and his idea of the Earth as center of the Solar System
Copernicus’ s draft on how the Sun is the center of the Universe
Changing View of the Universe

Copernicus’ s revolutionary theory was rejected.

• If the classic scholars were questioned, then all knowledge might be called into question.
  • But careful observations by Tycho Brahe supported Copernicus.

• Johannes Kepler used Brahe’s data to calculate the orbits of the planets.

• Kepler found that the planets don’t move in perfect circles as earlier believed.
Tycho Brahe
Tycho Brahe using Measurements
Changing View of the Universe

• Astronomers changed the way Europeans viewed the physical world by proving that the Earth moved around the sun.

• New views of how the world works:
  – Copernicus theory on heliocentric universe.
  – Tycho Brahe proves Copernicus theory
  – Johannes Kepler proves the ellipse movements

• Galileo Galilei builds a telescope, discovers moons on other planets / how they move.
  – He went before the Inquisition and recanted under pain of death.
Kepler model of how the Planetary alignment of the Solar System worked

The Christian model
Galileo’s Telescope
1st Aerial Telescope developed by Galileo
Galileo’s Heresies

In Italy Galileo Galilei built a telescope and observed several moons in orbit around Jupiter. He said these movements were the same as those of the planets around the sun. This contradicted Church doctrine that the Earth was the center of the universe.

**Galileo was forced to recant his theories before the Inquisition.**

**The problem with people not wanting to think or have their view of the world challenged**
Galileo's 60ft. Telescope
A New Scientific Method

Despite opposition from the Church, a new approach to science emerged during the early 1600s.

Scientists rediscovered Greek philosopher Plato, who saw mathematics as the key to learning about the universe.

Francis Bacon and René Descartes challenged medieval scholarship that sought only to make the world fit into the teachings of the Church.

Scientists developed a new scientific method based on observation, experimentation, and mathematical calculations.
A New Scientific Method

Bacon and Descartes argued that truth is not known at the beginning of the inquiry, but rather at the end.

• Bacon stressed observation and experimentation.
• He wanted science to be useful in people’s lives.
• Descartes: Used the Scientific Method to improve thought.
• Turned away from religion to explain the world and used the SM to rethink why things happen.
• These two led to the beginning of the Enlightenment Period.
Descartes emphasized human reasoning as the best road to understanding.

In his *Discourse on Method* (1637), he discarded all traditional authorities to search for knowledge that was provable.

The only thing he could not question was doubt.

“I think, therefore I am”
The Scientific Method

Over time, a step-by-step **scientific method** was developed. It required the collection of accurate data and the proposal of a logical **hypothesis** to be tested.
Breakthroughs in Medicine

Medicine advances (studying the body) led to anatomy studies for medical purpose not just art. Blood, circulation, heart as a pump - just the start.

There were dramatic advances in medical knowledge in the 1500s and 1600s.

- Andreas Vesalius:
  - Published *On the Structure of the Human Body* in 1543, the first accurate and detailed study of human anatomy.

- Anton van Leeuwenhoek:
  - Perfected the microscope and became the first person to see cells and microorganisms.
Breakthroughs in Medicine

There were dramatic advances in medical knowledge in the 1500s and 1600s.

- **William Harvey:**
  - Described the circulation of blood, showing that the heart was a pump.

- **Ambroise Paré:**
  - Developed new surgical techniques, tools, artificial limbs, and ointments to prevent infection.
Breakthroughs in Chemistry

Chemistry was transformed by the Scientific Revolution.

Medieval alchemists tried to transform ordinary metals into gold.

Robert Boyle: Transformed Chemistry

Explained that all matter is composed of tiny particles that behave in knowable ways

Defined the difference between individual elements and compounds

Explained the effect of temperature and pressure on gases
The Scientific Method

Isaac Newton linked science and mathematics.

Newton theorized that gravity was the force that controls the movements of the planets.

He believed that all motion in the universe can be measured and described mathematically.

He contributed to the development of calculus, a branch of mathematics, to help explain his laws.
The Scientific Method

• Newton ties it all together:
  – Discovers gravity as a force in the universe. Unifies astronomy and physics as one theory of how the universe works.

• The Scientific Method was born, combining observation and experimentation, not religion / thought.