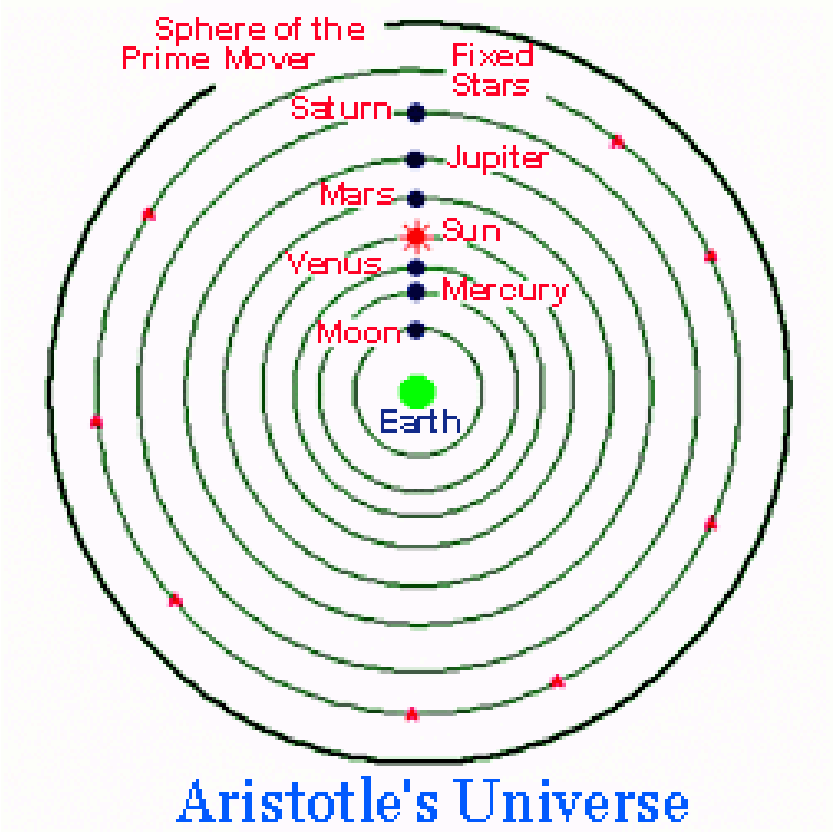
The Scientific Revolution

ca 1540-1690

Essential Questions

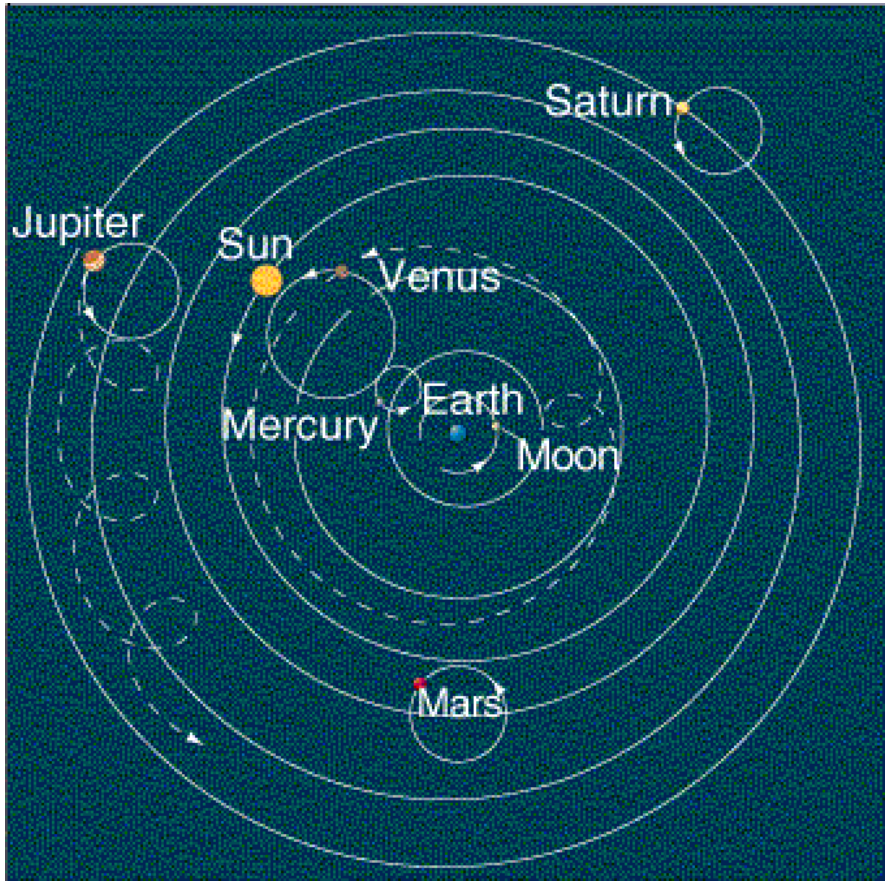
1. *How is the Scientific Revolution a change in both science and thought?*
2. *What are the causes and consequences of the Scientific Revolution?*
3. *Who is impacted by the Scientific Revolution? How are those people/groups impacted?*

The **Aristotelian** View of the Universe



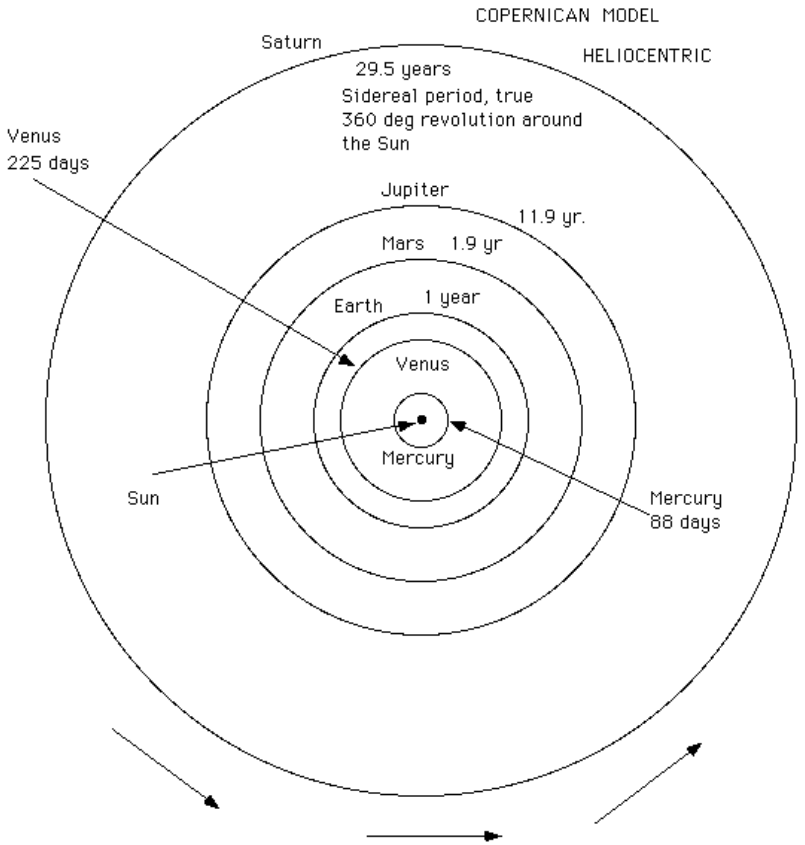
- Aristotle put forth this view of the universe in the 4th century B.C.
- This is commonly known as the GEOCENTRIC view where a motionless Earth is at the center of the universe while the moon, sun, planets, and stars revolve around the Earth.
- Notice also that it was believed that the orbits were circular.
- Ancient astronomers also believed the Earth was composed of “heavy” elements while the celestial bodies were composed of completely different substances and thus were weightless, allowing them to orbit the Earth.

Ptolemaic View of the Universe



- The astronomer and mathematician, Ptolemy (2nd century A.D.) had worked out complicated rules to explain the minor irregularities in the movement of the planets in an attempt to mathematically prove the GEOCENTRIC universe.
- While Ptolemy was wrong, a positive consequence of his work was that it allowed stargazers and astrologers to track the planets with greater precision.

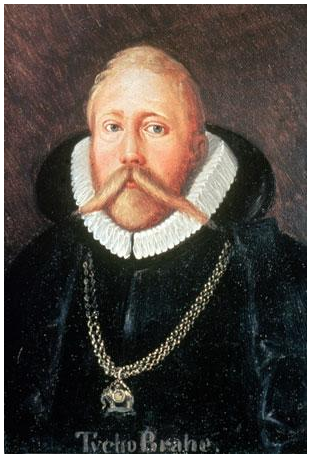
The **Copernican** Hypothesis

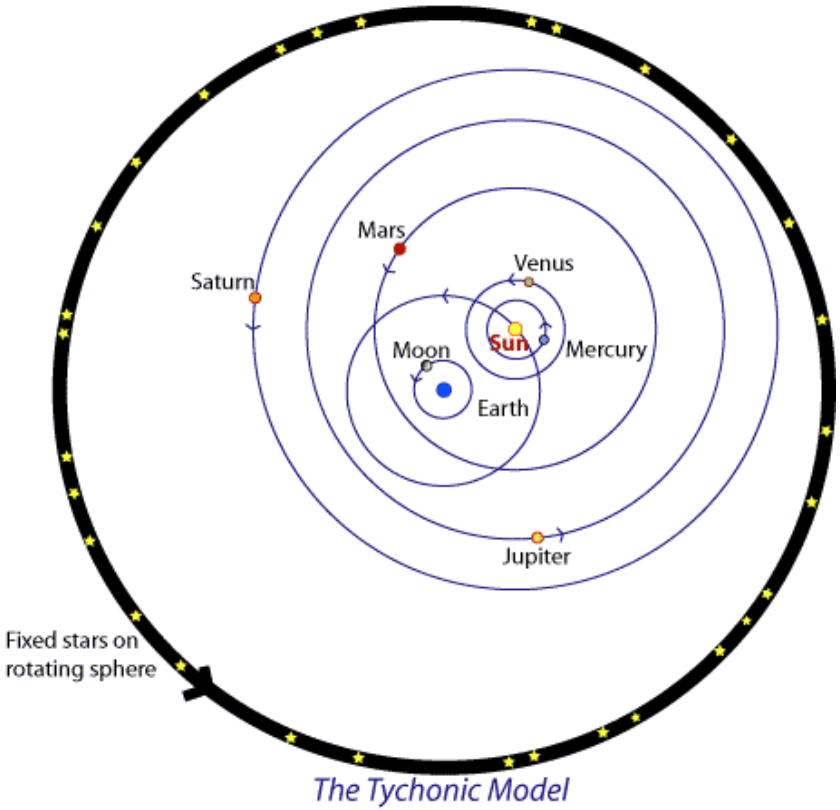


Nicolaus Copernicus: (1473-1543 A.D.), Polish. In the last year of his life published "De Revolutionibus Orbium Celestium".

- In the 16th century, the Polish monk, mathematician, and astronomer Copernicus (1473-1543) challenged the geocentric theory.
- His famous work On the Revolutions of the Heavenly Spheres, held the sun to be the center of the solar system aka, the HELIOCENTRIC theory.
- His ideas are attacked by religious authorities; Luther called him "the fool who wants to turn the whole art of astronomy upside down."

Tycho Brahe (1546-1601)



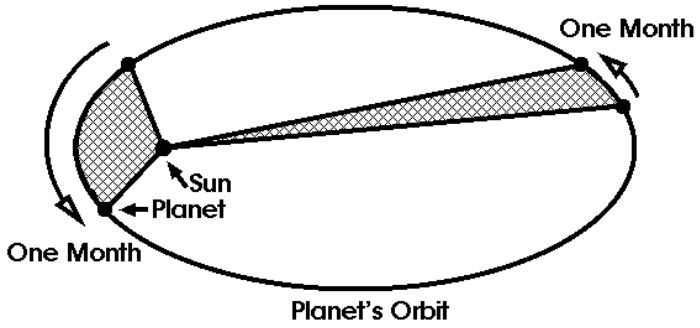


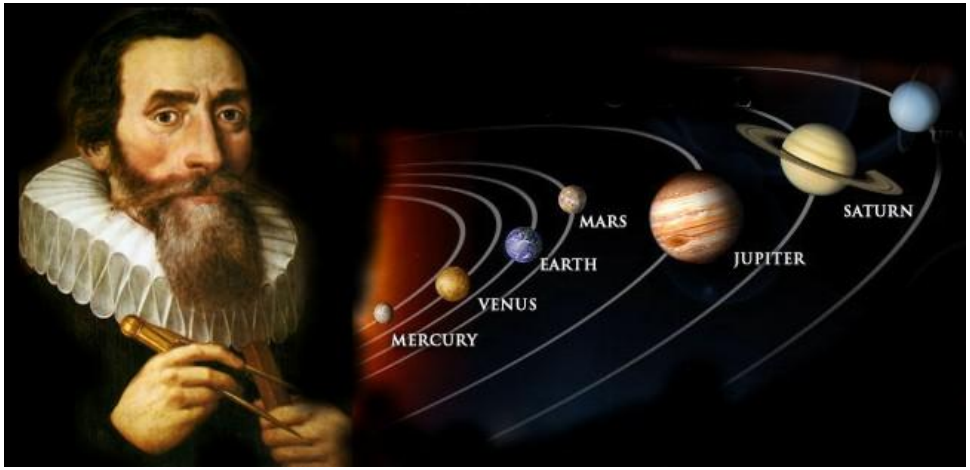
The Tychonic Model

- A Danish nobleman who received money from the king of Denmark to build an advanced observatory where he studied the stars and planets; collecting over twenty years of data.
- He had a very limited understanding of mathematics, but hypothesized a universe that was part Ptolemaic and part Copernican (figure to the left).

Johannes Kepler (1571-1630)

- Brilliant young assistant of Brahe
- Formulated THREE laws of planetary motion:
  - Orbits of the planets are ELIPTICAL rather thai circular
  - Planets do NOT move at a uniform speed in their orbits
  - The time a planet takes to make its orbit is precisely related to its distance from the sui
- Kepler's contributions are HUGE; he had mathematically proved the relations of a sun-centered solar system, aka HELIOCENTRIC

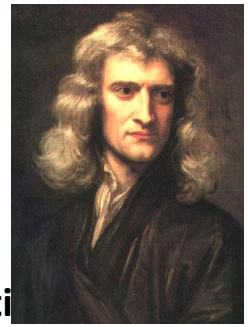




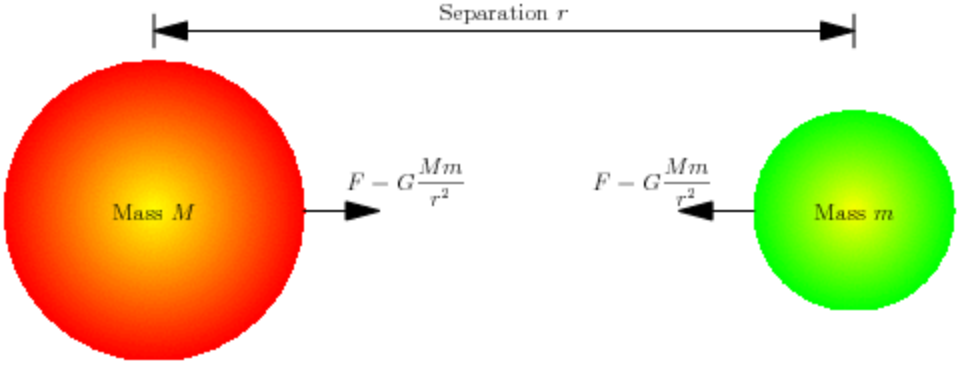
Galileo (1564-1642)

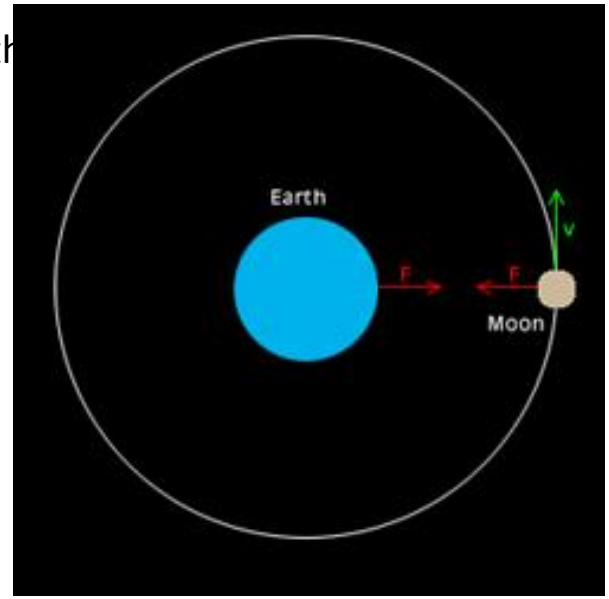
- Using a telescope which he refined, he viewed the moon with all of it's irregularities and stated that the moon is NOT a luminous object but is actually made of earth-like substances.
- Galileo's greatest achievement was the elaboration and consolidation of the **experimental method**; rather than speculate about what might or should happen, he conducted controlled experiments to find out what actually did happen.
- Using experiments, Galileo formulated the **law of inertia** stating that rest is NOT the natural state of objects.
  - Galileo in 1591, according to the story, dropped a 10-pound and a 1-pound weight simultaneously from the top of the Leaning Tower of Pisa.
  - Galileo showed that despite all previous speculation on the subject two bodies of different weights, when allowance was made for differences in air resistance due to differences of size or shape, struck the ground at the same time.
- Galileo was put on trial and condemned by the Catholic Church because his discoveries contradicted scripture.
- He was finally absolved by Pope John Paul II in 1992.

The **Newton**ian Synthesis

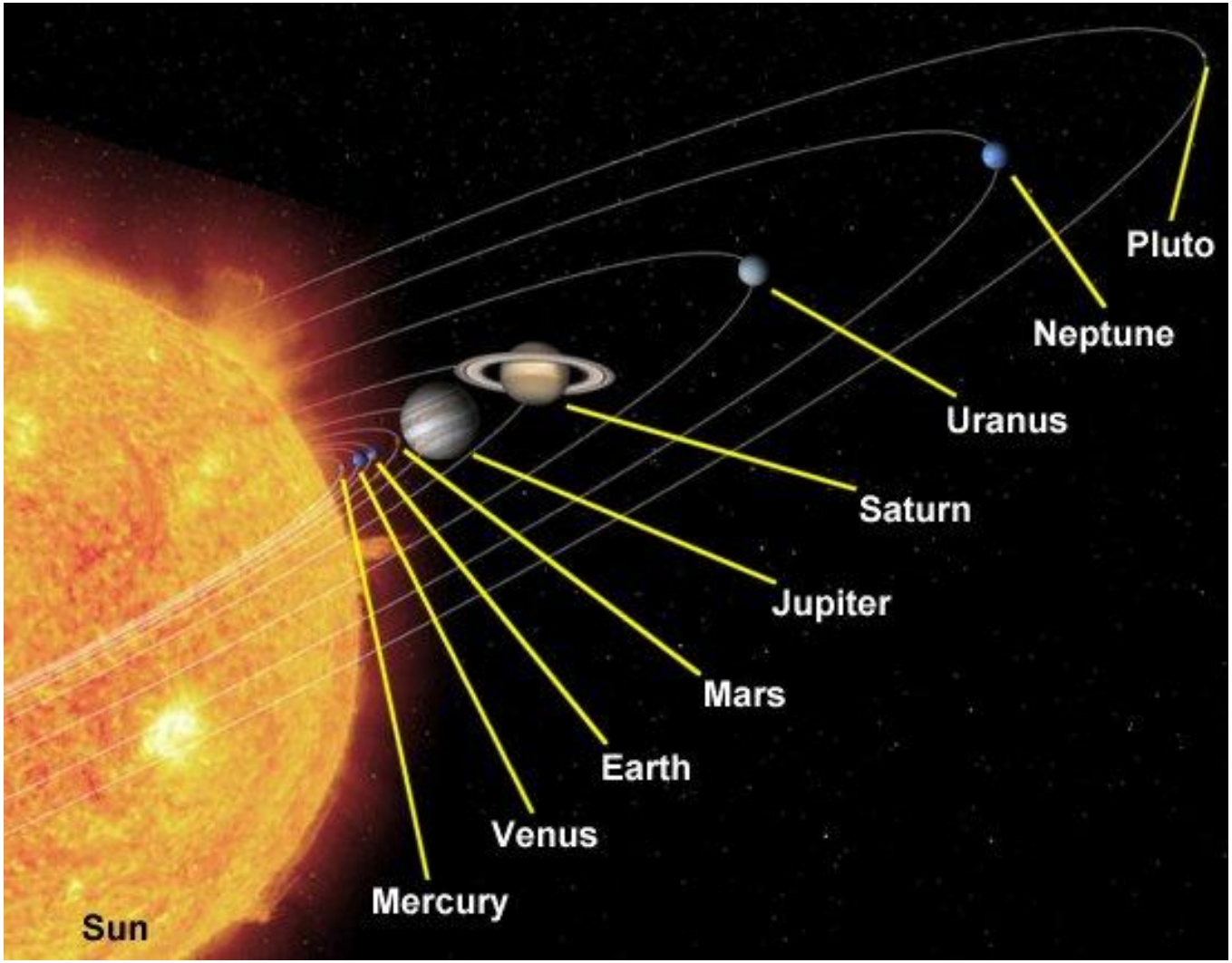


- "If I have seen further [than others], it is by standing on the shoulders of Giants." (Newton) 1642-1727
- Published *Principia* in 1687 which postulated the **law of universal gravitati** synthesized the astronomy of Copernicus, as corrected by Kepler's laws, with the physics of Galileo.
- According to this law, every body in the universe attracts every other body in the universe in a precise mathematical relationship, whereby the force of attraction is proportional to the quantity of matter of the objects and inversely proportional to the square of th distance between them.



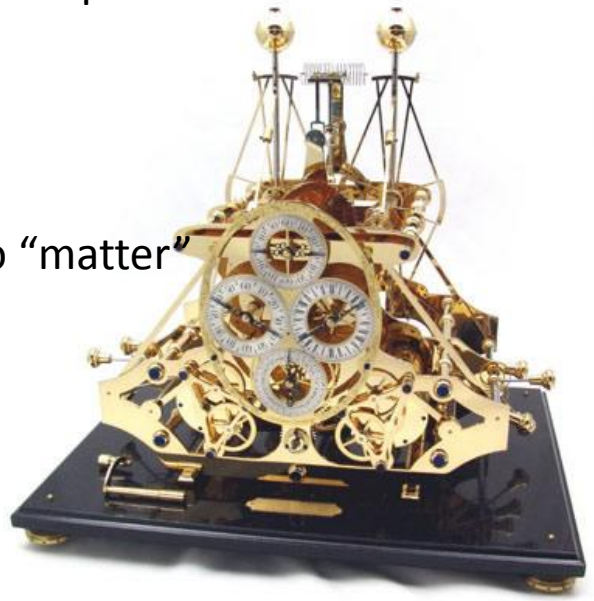


Model of our Solar System



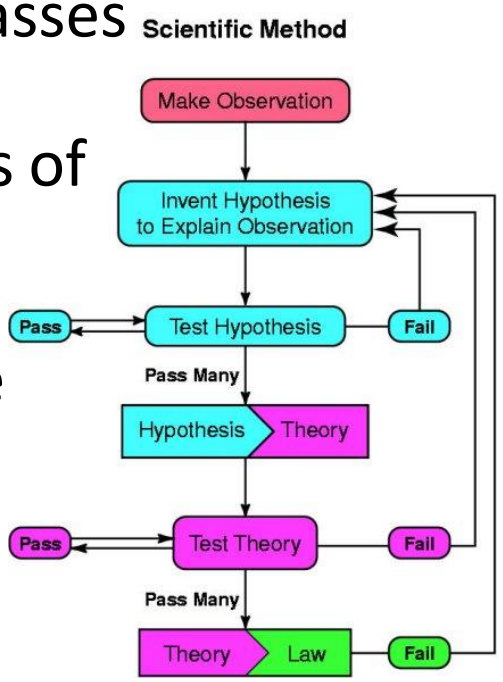
Causes of the Scientific Revolution

- Science emerged as a minor but distinct branch of philosophy in leading universities (14th & 15th centuries).
  - This provided scholars a place to do their thinking, research, and writing.
- The Renaissance stimulated scientific progress.
- Navigational problems of long sea voyages in the 'Age of Exploration' were a cause as well.
- Gresham College in London is established and attempts to link theoretical science with applied science.
- Inductive Reasoning, aka **empiricism** (Bacon)
- Deductive Reasoning, (Decartes)
  - **Cartesian Dualism** = reducing all substance to "matter" and "mind"
- The Modern Scientific Method
- Religion



Consequences of the Scientific Revolution

- Creation of an **international scientific community**; scholars could engage in discourse about theories and ideas, thus expanding knowledge.
- The **modern scientific method**.
- Few economic consequences for the masses initially outside of navigation.
- Few practical and applied consequences of the science to improve the lives of the masses.
- The greatest impact was on how people thought and believed.



Questions to assess your understanding:

- Whose ideas were the basis for Europeans' view of the universe?
- How was science classified before 1500?
- Which astronomers contributed to the destruction of the geocentric view of the universe?
- Who postulated the heliocentric view of the universe?
- What does empiricism emphasize?
- Who created the modern scientific method?
- Who put forth the three laws of planetary motion?
- Who formulated the law of universal gravitation?
- What was Galileo's greatest achievement?
- Who wrote *On the Revolutions of the Heavenly Spheres*? What is its significance?
- Who wrote *Principia*? What is its significance?
- Who postulated the theory of inertia? What did it state?
- What is the significance of Gresham College to the discipline of science?
- Who is regarded as Europe's leading astronomer with his vast amounts of detailed observations?
- What are the significant causes of the scientific revolution?
- What are the significant effects of the scientific revolution?

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