

**The Star Gazers:** Name: \_\_\_\_\_ Prd: \_\_\_\_ Score: \_\_\_\_\_ /15

**The Scientific Giants of Ptolemy, Copernicus, Galileo, & Kepler**

**Directions:** Highlight the answer in the text on the left *before* answering the questions on the right.

Scientists today know much of how the solar system works. But in the 16<sup>th</sup> century, most people did *not* know. Their ideas about the solar system came from an ancient Greek astronomer by the name of **Ptolemy**. Ptolemy lived about 2,200 years ago, in what was called Roman Egypt. He was also a mathematician, geographer as well as an astrologer.

He believed that Earth was the center of the universe; later, this was called the **geocentric theory** ~ "geo-" meaning Earth & "centric" meaning situated at or near the center. He believed that the sun, stars & planets *all* traveled *around* the Earth.

Ptolemy's ideas were *generally accepted* for more than 1,500 years *after* his death. As time went on, some members of the Catholic clergy began explaining them in *religious* terms. God had designed the universe with the Earth in the middle, they claimed. They thought this showed the importance of humans to God. *If* the Earth was the center of the universe, then it was easy enough to claim that humans played a principal role in God's design.

In the 16<sup>th</sup> century, a Polish man named Nicolaus **Copernicus** → also wondered about the universe. Like Ptolemy, Copernicus had a special interest in astronomy. From his youth, he had studied the movement of the stars. He did so with his naked eyes since the telescope *had not yet* been invented. He had also been influenced by the writings of some ancient Greek philosophers. They had argued that the sun was the center of the universe. Later, that would be referred to as the **heliocentric theory** ~ "helio-" meaning sun & again, "centric" meaning center of.

Before long, Copernicus concluded that Ptolemy was *wrong*. And, he began to say so! Some friends warned him about speaking out against the Church.



**Ptolemy's talents** included:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_
- 4) \_\_\_\_\_

Ptolemy's map of the world ↓



**Why** would the Catholic church **prefer to believe** in the **geocentric theory** rather than the **heliocentric theory**?

---



---

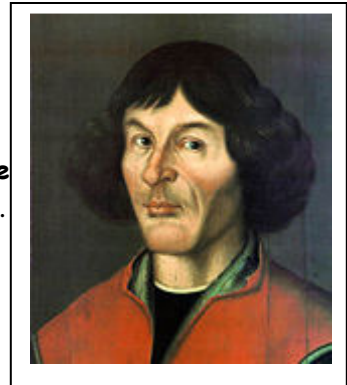


---



---

**BONUS:** The **\*telescope** was **invented c.** \_\_\_\_\_.  
(Look on pg. 3...) (year)



**Making analogies:**

Greek : **Helios** :: Roman : \_\_\_\_\_

To disagree with the Church's teachings could be very dangerous they warned. One who disagreed with their teachings *could be* branded a **heretic**... & possibly *sentenced to death for such* **blasphemy!**

Copernicus, however, refused to back away from his own observations. He was a devout Roman Catholic & an official of the cathedral in his own town. He had never denied that God had created the universe. All he was saying was that the Earth was *NOT* the center of the universe. And he wanted to prove that Ptolemy was not correct.

Copernicus summed up his ideas in his book, On the Revolutions of the Heavenly Bodies. In it, he argued that the Earth was a spinning ball in space. He tried to show, by mathematics & logic, that the Earth & the planets traveled around the sun. But in the 16<sup>th</sup> century, that was not a popular idea...*nor an accepted one!*

He wrote the book in Latin over a period of many years. As he finished sections, he would show them to friends. When the book was complete, some of those friends had it printed in Germany. One of them made sure that Copernicus received a copy just before he died.

Copernicus' ideas were not widely accepted during his lifetime. **Martin Luther**, for example, thought Copernicus was a fool! It was years before most scholars paid any serious attention to what Copernicus had said. By the end of the 1500s, however, some astronomers were examining Copernicus' ideas intensely.

Around the same time as this, Catholic clergy began to notice Copernicus' theory...& it disturbed them deeply! This theory contradicted the Catholic idea of God's design of the universe. In 1616, more than 72 years after Copernicus' death, the Roman Catholic Church declared Copernican theory **heresy!** It also forbade Catholics to even read his book!!

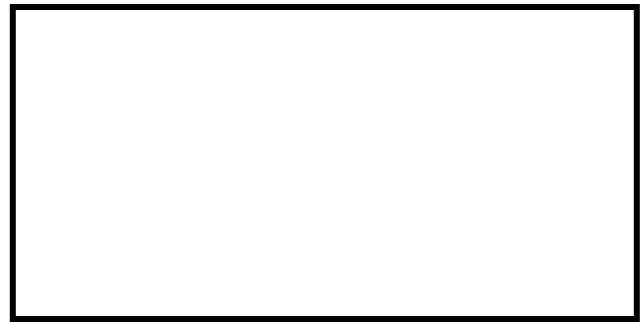
Another word for **blasphemy** is \_\_\_\_.

- |                 |              |
|-----------------|--------------|
| a. sacrilege    | c. godliness |
| b. faithfulness | d. holiness  |

Making inferences: Copernicus' intention was to \_\_\_\_.

- |   |  |
|---|--|
| a. prove he was a devout Roman Catholic       | c. prove the Earth was <i>not</i> the center of the universe |
| b. become an official of his town's cathedral | d. be branded a heretic                                      |

Draw Copernicus' idea of the universe:



BONUS: Who was the **German printer & inventor** of the **printing press** in about 1440 AD?

---

Applying past knowledge: Martin Luther is credited with **nauling** the \_\_\_\_ (#) \_\_\_\_\_ **to the door** of the Catholic Church **questioning** the Church's practice of **selling** \_\_\_\_\_.



Nevertheless, some scholars still studied Copernicus' ideas. One of them was a young German student named Johannes **Kepler** →. He revised Copernicus' ideas to make them more precise. Copernicus, for example, had said that the Earth traveled around the sun in a circle. However, Kepler, felt that the Earth moved around the sun in an oval path called an **ellipse**.

Another follower of Copernicus was an Italian, **Galileo Galilei** ↘. Galileo, as he was to be called, asked the question, "What causes the movement of the planets?" He was able to answer this with the help of a new invention in 1611\*. He ground some glass lenses & fit two together in a long tube. In this way, he made what he called a spy glass. It was the world's first telescope.

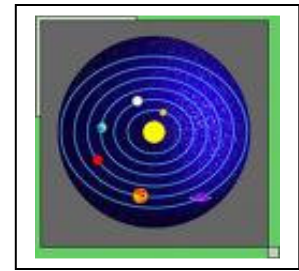
By looking through his telescope, Galileo made many new observations. He discovered that the **Milky Way** → was made up of 1000s of stars. As a result of his observations, he concluded that Copernicus had been right after all! The Earth *did* travel around the sun!

Galileo published his own work on astronomy, the Dialogue on the Two Great Systems of the World in 1632. Here he tried to prove that Copernicus had been right. To do this, he described his discovery of 4 moons circling the planet Jupiter. This *went against* the idea that everything in the heavens rotated about the Earth.

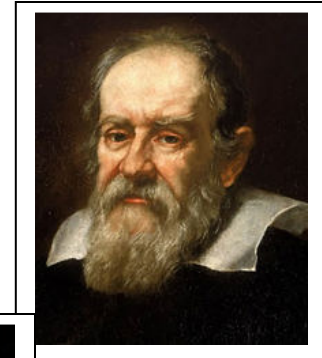
Galileo's Dialogue was published at a time when Pope Urban VIII was under great pressure. The pope reacted to the book as though it were a personal attack on him. Galileo was called to Rome to stand trial as a **heretic**!

In June of 1633, Galileo was found guilty of heresy & *sentenced to death!* Galileo was forced to kneel & **recant** what he had said in his book. Then, he was kept prisoner in his own house until his death in 1642...*9 long years in captivity.*

The Catholic Church could ban books & deny ideas back then, but scientists continued to study the workings of the universe in private.



Another word for "oval path" is \_\_\_\_\_.



**T or F:** (← circle 1):  
Because of the telescope, Copernicus was *finally* able to prove Galileo's theory was *correct*.

Applying past knowledge: The Egyptian pharaoh who was often referred to as the "heretic" king was \_\_\_\_.

- |                |              |
|----------------|--------------|
| a. Cleopatra   | c. Ramses II |
| b. Tutankhamen | d. Akhenaton |

To "**recant**" means to \_\_\_\_\_

**Why** would scientists be *forced into studying* the workings of the universe *in private*? \_\_\_\_\_

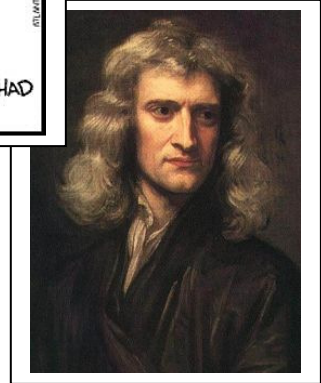
Many of these scientists accepted the beliefs of Copernicus & Galileo. But some wanted *more* proof. *If* the Earth moved around the sun, what caused the movement? *Why* didn't the Earth wander from its orbit & drift in space? What explained the fact that objects on Earth fall to the ground? What explained the movement of the ocean tides?

These & similar questions had bothered both Kepler & Galileo. Each had given partial answers to some of the questions, but neither had been able to end all doubt. That was finally achieved by an English mathematician named Isaac **Newton**. Newton → proved to the satisfaction of most European scientists that *Copernicus had been correct all along!*

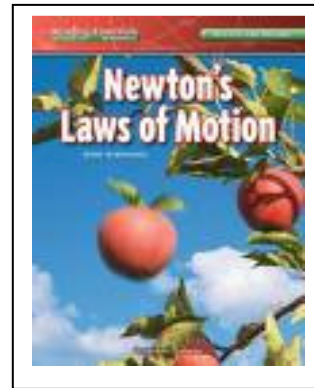
In 1687, Newton published a book, Mathematical Principles of Natural Philosophy. In it, he explained the force that caused the earth's movement ~ the force we now know as **gravity**. According to Newton, every planet has its own gravitational force.

Newton called his idea the **law of universal gravitation**. The law applied not only to planets, but to every particle of matter in the universe. Newton's law helped explain the movement of the planets in their orbits. It explained why objects fall to the ground. It even explained the movement of the tides.

Newton's law of universal gravitation became the foundation for other scientific discoveries. It also began a period now called the **Age of Reason**. In this period, people started placing *greater* faith in human thoughts & ideas. In a sense, then, this law helped change Western thinking. Newton, himself, believes that he could not have succeeded without the work of earlier scientists. **"If I have seen farther,"** he said, **"it is by standing on the shoulders of giants."**



The force that *causes* the Earth's movement as well as the tides, is the force of \_\_\_\_\_.



Drawing conclusions: What do you think Newton meant by his quote, "If I have seen farther, it is by standing on the shoulders of giants"? What "giants" is he referring to? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2 pts)