Unit 4  The Solar System

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Unit 4 covers the following framework standards: ES 10 and PS 11. Content was adapted the following:

Chapter 7  The History of the Solar System

Section 7.1  The Formation of the Solar System

Terms:
- Solar Nebula
- Planetesimals

After the big bang, matter in the universe separated into galaxies. Gas and dust spread throughout space. Where the solar system is now, there was only cold, dark gas and dust. How did the solar system form, then? The story starts with a familiar force – gravity.

About five billion years ago, a giant cloud of gas and dust collapses to form our solar system. A large cloud of gas and dust is called a solar nebula, or simply a nebula. Slowly, gravity began to pull the solar nebula together. As the solar nebula shrank, it spun faster and faster. The solar nebula flattened, forming a rotating disk. Gravity pulled most of the gas into the center of the disk, where the gas eventually became hot and dense enough for nuclear fusion to begin. The sun was born.

Planetesimals began to form in the outer part of the disk. Planetesimals are made of rock, dust and ice. These formed the building blocks of the planets. When enough planetesimals collided and grew larger by sticking together, planets were formed.

The inner planets formed first. Since the early solar system under extremely hot temperatures, a lot of ice-forming materials simply vaporized. Most gases escaped the gravity of the planets that were forming into his region. As a result, the inner planets, Mercury, Venus, Erath, and Mars are relatively small and rocker.
The outer planets, however, are much farther from the sun and are therefor much cooler. As the planets in this region grew, their gravity increased and they were able to capture much of the hydrogen and helium gas in the surrounding space. As a result, the planets Jupiter, Saturn, Uranus, and Neptune became very large. Most comets formed near Jupiter and Saturn. They were later flung out to the outer solar system. Beyond the gas giants, a huge disk of ice and other substances formed. Pluto also formed in this region.

Summary:

- About five billion years ago, a giant cloud of gas and dust collapsed to form our solar system.
- A solar nebula is a large cloud of gas and dust in space. A solar nebula was the beginning of our solar system.
- Gravity pulled the solar nebula together. The sun was born.
- Gas and dust gathered together in the outer parts of the disk to form planetesimals (asteroid-like objects). Over time, these became the planets.
Section 7.2 Observing the Solar System

Terms:
- Geocentric
- Heliocentric
- Ellipse

Earth at the Center
When the ancient Greeks watched the stars move across the sky, they noticed that the patterns of the stars didn’t change. Although the stars seemed to move, they stayed in the same position relative to one another. These patterns of stars, called constellations, kept the same shapes from night to night and from year to year.

Greek Observations As the Greeks observed the sky, they noticed something surprising. Several points of light seemed to wander slowly among the stars. The Greeks called these objects planets from the Greek word meaning “wanderers”. The Greeks made careful observations from the motions of the planets that they could see. You know these planets from the names the ancient romans later gave them: MVMJS. Most early Greek astronomers believed the universe to be perfect with Earth at the center. The Greeks thought that earth was inside a rotating dome called the celestial sphere. Since geo is the Greek word for “Earth”, an Earth-centered model is known as a geocentric system. In a geocentric system, Earth is at the center of revolving planets and stars.

Ptolemy’s model About A.D. 140 the Greek astronomer Ptolemy further developed the geocentric model. Like the earlier Greeks, Ptolemy thought that Earth is at the center of a system of planets and stars. In Ptolemy’s model, however, the planets move on small circles that move on bigger circles.

Even though Ptolemy’s geocentric model was incorrect, it explained the motions observed in the sky fairly accurately. As a result, the geocentric model of the universe was widely accepted for nearly 1,500 years after Ptolemy.

Sun at the Center Not everybody believed in the geocentric system. An ancient Greek scientist developed another explanation for the motion of the planets. This sun-centered model is called a heliocentric system. Helios is Greek for “sun”. In a heliocentric system, Earth and the other planets revolve around the sun. This model was not well received in ancient times, however, because people could not accept that Earth is not at the center of the universe.
The Copernican Revolution  In 1543, the Polish astronomer Nicolas Copernicus further developed the heliocentric model. Copernicus was able to work out the arrangement of the known planets and how they move around the sun. Copernicus’s theory would eventually revolutionize the science of astronomy. But at first, many people were unwilling to accept his theory. They needed more evidence to be convinced.

In the 1500s and early 1600s most people still believed in the geocentric model. However, evidence collected by the Italian scientist Galileo Galilei gradually convinced others that the heliocentric model was correct.

Galileo's Evidence  Galileo used the newly invented telescope to make discoveries that supported the heliocentric model. For example, in 1610, Galileo used a telescope to discover four moons revolving around Jupiter (now known as the Galilean Moons). The motion of these moons proved that not everything in sky revolves around the Earth.

Galileo’s observations of Venus also supported the heliocentric system. Galileo knew that Venus is always seen near the sun. He discovered that Venus goes through a series of phases similar to those of Earth’s moon. But Venus would not have a full set of phases if it circled around Earth. Therefore, Galileo reasoned, the geocentric model must be incorrect.

Tycho Brahe’s Observation  Copernicus correctly placed the sun at the center of the planets. But he incorrectly assumed that the planets traveled in orbits that are perfect circles. Copernicus had based his ideas on observations made by the ancient Greeks. In the late 1500s, the Danish astronomer Tycho Brahe and his assistants made much more accurate observations. For more than twenty years, they carefully observed and recorded the positions of the planets. Surprisingly, these observations were made without using a telescope. Telescopes had not yet been invented.

Kepler’s Calculations  Tycho Brahe died in 1601. His assistant, Johannes Kepler, went to work analyzing the observations. Kepler began by
trying to figure out the shape of Mars’s orbit. At first, he assumed the orbit was circular. But his calculations did not fit the observations. Kepler eventually found that Mars’s orbit was a slightly flattened circle, or ellipse. An **ellipse** is an oval shape, which may be elongated or nearly circular.

After years of detailed calculations, Kepler reached a remarkable conclusion about the motion of the planets. Kepler found that the orbit of each planet is an ellipse. Kepler had used the evidence gathered by Tycho Brahe to disprove the long-held belief that the planets move in perfect circles.

**Modern Discoveries**

Today, people talk about the “solar system” rather than the “earth system”. This shows that people accept the idea that Earth and other planets revolved around the sun. Since Galileo’s time, our knowledge of the solar system has increased dramatically. Galileo knew the same planets that the Ancient Greeks had known—Mercury, Venus, Earth, Mars, Jupiter and Saturn. Since Galileo’s time, astronomers have discovered two more planets—Uranus and Neptune, as well as Pluto, which is no longer considered to be a planet. Astronomers have also identified many other objects in the solar system such as comets, asteroids, and meteors. Today we know that solar system consists of the sun, the planets and their moons, and several kinds of smaller objects that revolve around the sun.

Galileo used a telescope to observe the solar system from Earth’s surface. Astronomers today still use telescopes located on Earth, but they have also placed telescopes in space to gain a better view of the universe beyond Earth. Scientists have also sent astronauts to the moon and launched numerous space probes to explore far reaches of the solar system. Our understanding of the solar system continues to grow every day.

**Summary:**

- The Greek astronomer Ptolemy developed a complex geocentric model of the universe. Ptolemy’s model seemed to explain motions in the sky. Most people believed in Ptolemy’s model until the 1500s.
- In a heliocentric system, Earth and the other planets revolve around the sun. Copernicus was able to work out the arrangement of the known planets and how they move around the sun. Galileo used the newly invented telescope to make discoveries that supported the heliocentric model. Kepler found that the orbit of each planet is an ellipse.
- Today we know that the solar system consists of the sun, the planets and their moons, and several smaller objects that revolve around the sun.