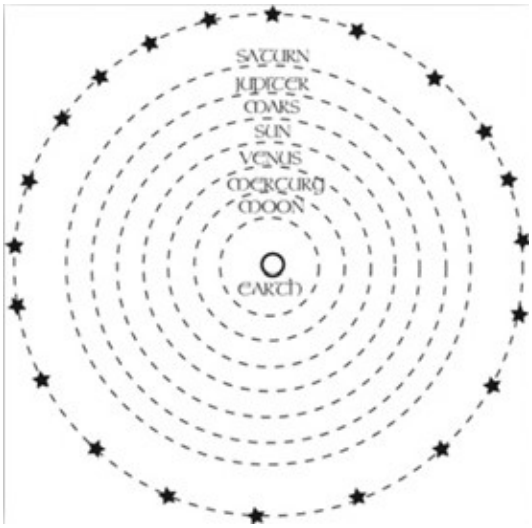
Reflect

Have you ever looked up at the night sky and wondered what was out there? You may see stars, moons, or even planets. But can you define each of these objects? What is the difference between a moon and a planet? How are they different from asteroids, meteoroids, comets, and the other kinds of objects in the solar system?

Discover Science: Geocentric versus Heliocentric

For many centuries, most people assumed the Sun and other stars **orbited**—or moved around—our planet, Earth. This is called the **geocentric model** of the solar system. (**Geo-** means "Earth," so **geocentric** means "Earth-centered.") It is easy to see why so many people thought this. As we look at the sky during the day, the Sun appears to move in an arc over our heads. Throughout the year, the other stars also appear to change their positions in the night sky.

Today, however, scientists have rejected the geocentric model in favor of the **heliocentric model**. The heliocentric model places the Sun at the center of the solar system. (**Helio-** means "Sun," so **heliocentric** means "Sun-centered.") The invention of the telescope around the year 1600 gave scientists a much more accurate view of space from Earth. Using measurements made while looking through telescopes, scientists such as Galileo Galilei demonstrated the truth of the heliocentric model. The Sun is the center of the solar system.



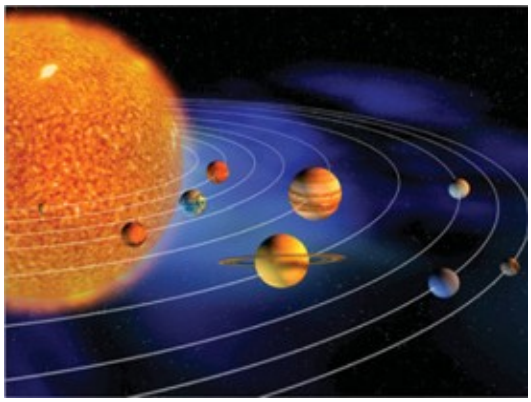
The geocentric model (above) places Earth at the center of the solar system. Today, all scientists accept the heliocentric model (below), which places the Sun at the center.

What is the Sun?

Earth's Sun may seem different to us, but it is a star like all the other stars located outside the solar system. A **star** is an extremely hot, dense mass of gases. As these gases burn, the star gives off visible light, as well as other charged particles. Most of the energy that reaches our planet—including light and heat—comes from the Sun.

The Sun is actually medium-sized compared to other stars. Still, it is the most massive object in the solar system. The Sun has enough mass that its gravitational pull holds the planets and other objects in the solar system in orbit. As all of the other objects in the solar system orbit the Sun, the Sun *rotates*, or spins, about its **axis**.

axis:
an imaginary line through the center of a sphere



What Do You Think?

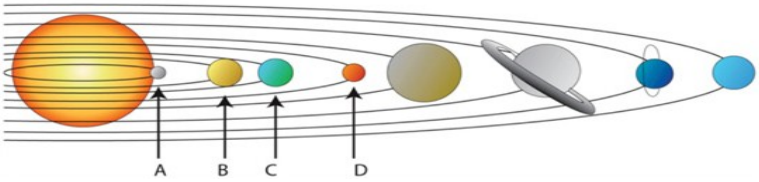
Take another look at the diagram of the heliocentric model. In this diagram, the Sun is larger than the planets that orbit it. But, in real life, the Sun is even **larger** compared to the planets. In fact, the Sun's diameter is more than 100 times greater than Earth's. Find a spherical object such as an orange and measure its diameter. (You can do this by cutting it in half.) If the orange represents Earth, what size object could represent the Sun?

Planets

The solar system is made up of eight planets. The four planets closest to the Sun are Mercury, Venus, Earth, and Mars. They are known as the **inner planets**. The inner planets are mostly solid. They are made of minerals similar to those on Earth. For this reason, the inner planets are also known as the "rocky" or "terrestrial" planets.

The four planets farthest from the Sun are Jupiter, Saturn, Uranus, and Neptune. They are known as the **outer planets**. The outer planets are all larger than the inner planets. They are mostly gas, though their inner cores contain solid matter surrounded by liquids.

Because they are so far from the Sun, the outer planets are much colder than the inner planets. On Mercury and Venus, average temperatures are well over 100°C. In contrast, Jupiter's average temperature is closer to –15010°C and Neptune's average temperature is closer to –200°C!

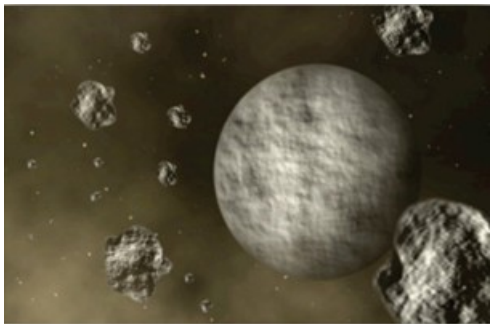


In this diagram of the solar system, planets A, B, C, and D are the four inner planets. Notice how much smaller they are than the four other planets. Also notice the shapes of their orbits. Each planet follows an elliptical path around the Sun. (This diagram is not drawn to scale. In reality, the outer planets are even larger compared to the inner planets.)

All of the planets both rotate and revolve. Like the Sun, each planet spins about an imaginary axis. However, planets complete their rotations in different amounts of time. Earth rotates once every 24 hours: one day. In contrast, Jupiter takes only 10 hours to complete one rotation. Mercury takes over 1,400 hours!

Each planet also **revolves** around, or orbits, the Sun. Planets that are farther from the Sun take longer to complete one revolution. Neptune takes more than 100 times longer than Earth to orbit the Sun!

The orbital paths of the planets are not perfect circles. The planets' orbits are **elliptical**, or oval-shaped. This means the planets are sometimes closer to and sometimes farther from the Sun during their orbits.



Pluto is a dwarf planet because it has not cleared its orbit of smaller objects.

Look Out!

Earth has only one moon (called the Moon). Some planets, including Jupiter and Saturn, have dozens of moons.

Astronomers once identified nine planets in the solar system. In addition to Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, astronomers considered tiny Pluto to be a planet. However, in 2006 the International Astronomical Union (IAU) officially defined **planet** as follows: A planet is a celestial object that meets all three of these criteria:

1. The object is in orbit around the Sun.
2. The object has a nearly spherical shape.
3. The object has cleared the neighborhood around its orbit of smaller objects.

Pluto does not meet the third part of this definition. Because Pluto is so small, its gravity is not strong enough to clear smaller objects from its orbit. Since 2006, astronomers have considered Pluto a **dwarf planet**. Astronomers have located several other dwarf planets in the solar system, including Eris, which is nearly as large as Pluto. There may be dozens more dwarf planets awaiting discovery!

Moons

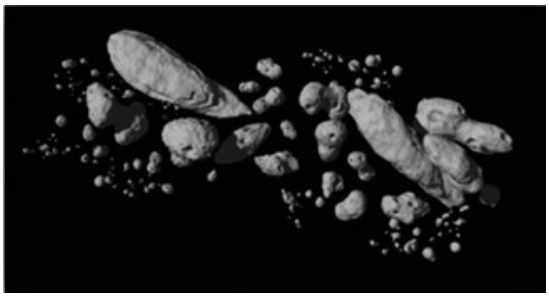
The planets in the solar system orbit the Sun. At the same time, many planets are orbited by moons. Moons are smaller than planets. They are held in place by the gravitational pull of the planet they orbit.

Jupiter, the largest planet in the solar system, also has some of the largest moons in the solar system. Jupiter's largest moons are called Ganymede, Io, Callisto, and Europa. These are known as the Galilean moons because they were discovered by the Italian scientist Galileo Galilei. The telescope was invented during Galileo's lifetime, and he made many discoveries looking through his. Astronomers since Galileo have used improved telescopes and satellites to gather information about the physical properties and motions of each of these moons. Some have large volcanoes. Others have major areas of frozen water. Some of the moons have layers similar to Earth's layers: an inner core, a thick mantle, and a thin, outer crust.

Other Celestial Objects

The solar system contains other objects besides planets, moons, and the Sun. There are also asteroids, meteoroids, meteorites, meteors, and comets.

Asteroids are rocky objects that orbit the Sun. However, asteroids are too small to be called planets, dwarf planets, or even moons. Even though they are small, they can still crash into other celestial objects and manmade objects such as space ships and satellites.



Most of the asteroids in the solar system are located in the asteroid belt.

Look Out!

If these objects crash into other objects, significant damage can be caused. Most asteroids are located in the **asteroid belt**, a wide area between the orbits of Mars and Jupiter. The asteroid belt separates the inner planets from the outer planets.

A **meteoroid** is another type of rocky object moving in space between the planets. Meteoroids are smaller than asteroids. Most meteoroids that enter Earth's atmosphere are about the size of a pebble. They produce tremendous friction and heat as they speed through the air toward the ground. When we can see this heat in the sky as a glowing path, it is called a **meteor**. Most meteors burn up in Earth's atmosphere before they reach the ground. A **meteorite** is a piece of a meteoroid (or an asteroid) that survives its passage through the atmosphere and strikes Earth's surface.

We sometimes see meteors streaking through the night sky.

A **comet** is a small mass of dust and ice that orbits the Sun. Like the planets, comets have elliptical orbits. However, the orbits of most comets are longer than those of the planets. This means that comets can get quite close to the Sun in some parts of their orbits. When comets are close to the Sun, they are affected by solar radiation and solar wind. This gives comets a visible coma and tail. The *coma* is a cloud of dust and gas around the comet. The *tail* is a trail of dust and gas that stretches behind the comet as it travels through space. In other parts of their orbits, comets may travel into the deepest reaches of the solar system.

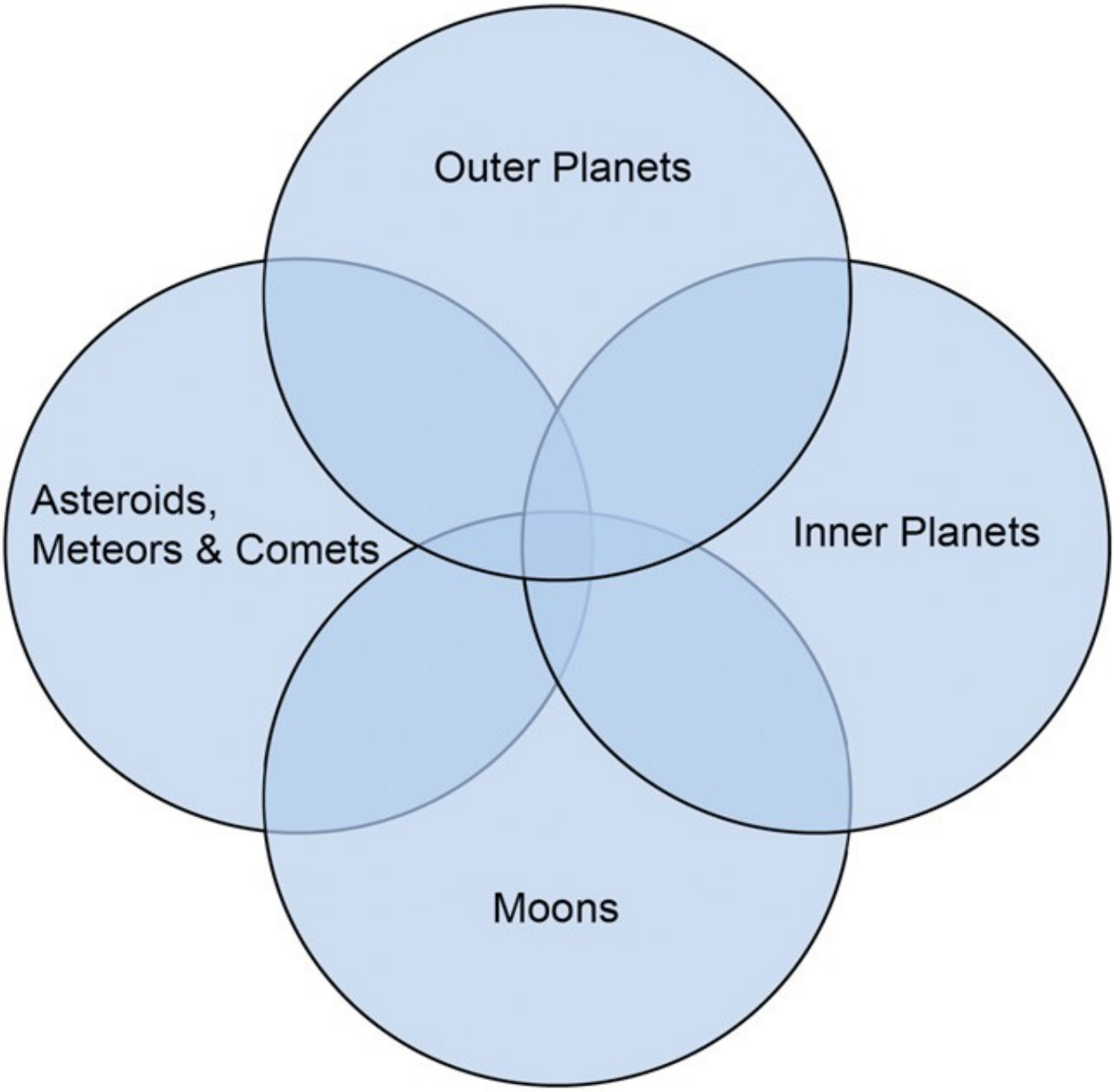
Many comets, including Hale Bopp, take thousands of years to orbit the Sun.

What do you know?

The solar system is made up of the Sun, planets, moons, and many smaller objects. Read the characteristics and names of celestial objects in the box below. Decide whether each characteristic or name describes an outer planet, an inner planet, a moon, or an asteroid, meteor, or comet. Write each characteristic or name in the correct section of the Venn diagram on the next page.

Characteristics and Names of Celestial Objects		
• Orbits the Sun	• Neptune	• Venus
• Mars	• Mercury	• Callisto
• Orbits a planet	• Ganymede	• Earth
• Io	• Smaller than planets	• Saturn
• Uranus	• Europa	• Jupiter

Look Out!


Outer Planets
Asteroids,
Meteors & Comets
Inner Planets
Moons

Connecting With Your Child

Mapping the Solar System
Work with your child to create a map of the solar system. You can create a relatively simple, two-dimensional map on a piece of paper, or you can use foam balls, string, and other craft supplies to create a three- dimensional map. Your map should include the following celestial objects (or groups of objects), properly labeled:

- The Sun
- The four inner planets and their elliptical orbits
- The four outer planets and their elliptical orbits
- The asteroid belt between the orbits of Mars and Jupiter
- A dwarf planet such as Pluto and its elliptical orbit
- A comet and its elongated orbit

With your child, conduct research to determine the relative size and average distance from the Sun of each object in your map, and try to create an appropriate scaled model that reflects these values.

You may need to approximate most of these values; otherwise your map will likely become impractically large. (For example, rather than scale the Sun's radius to be 109 times greater than Earth's, simply show the Sun to be much larger than Earth, Earth to be larger than the Moon, etc.) The website of the National Aeronautics and Space Administration (NASA) contains useful data for comparing and contrasting the various objects in the solar system.

Here are some questions to discuss with your child:
- How much larger is the Sun than the other objects in the solar system?
- How does Earth compare in size to the other objects in the solar system?
- Where in each celestial object's orbit is the object closest to the Sun? Where is each object farthest from the Sun?