

Science Benchmark: 06:03

The solar system consists of planets, moons, and other smaller objects including asteroids and comets that orbit the sun. Planets in the solar system differ in terms of their distance from the sun, number of moons, size, composition, and ability to sustain life. Every object exerts gravitational force on every other object depending on the mass of the objects and the distance between them. The sun's gravitational pull holds Earth and other planets in orbit. Earth's gravitational force holds the moon in orbit.

Standard 03:

Students will understand the relationship and attributes of objects in the solar system.

STUDENT BACKGROUND INFORMATION

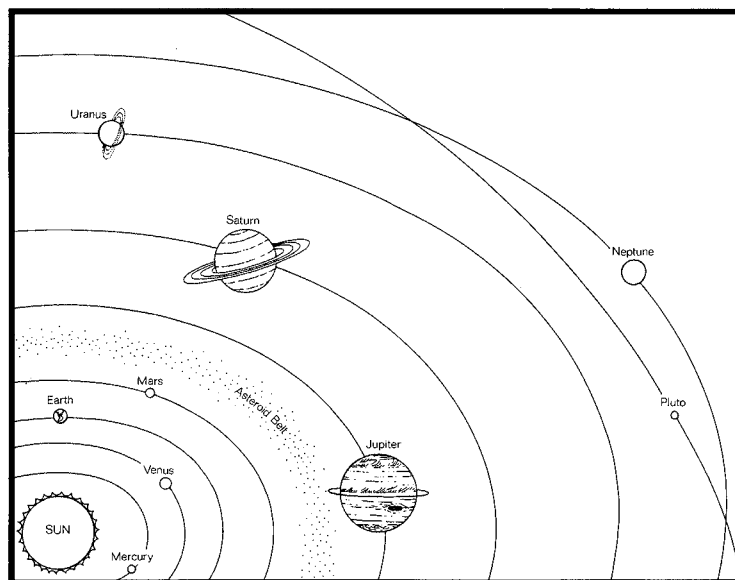
Earth Is Not the Center of the Universe



Have you ever looked up at the night sky and wondered about all the pinpoint lights? People through the ages have wondered about these points too. With the use of telescopes, artificial satellites, binoculars, and even observations with the naked eye, men and women have discovered many different **celestial objects**, *all of the different objects in space that make up our universe.*

Even though all these celestial objects are very far away, astronomers have discovered that some celestial objects are closer to us than others. **Stars** *are celestial objects that consist of gases which generate light and heat.*

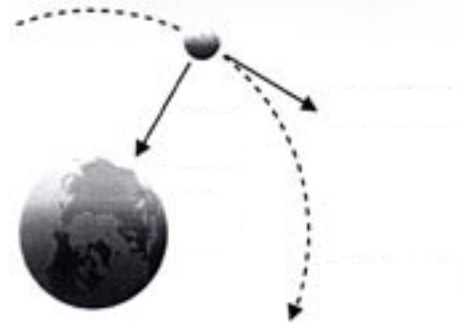
They are very far away from us. (Plan to learn about stars in our next unit.) The celestial objects in this unit are those that are within our **solar system**, *the system made up of the nine unique planets and many smaller objects that orbit the sun.* Our solar system consists of nine planets and their moons, asteroids, comets, and a **sun**, *the star that is the basis of our solar system and sustains life on Earth as the source of heat and light.*



The Solar System

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Most of the celestial objects that are part of our solar system are constantly circling our sun. These circling paths are called orbits. All celestial objects have some amount of **gravity**, *the attraction of one mass to another mass*. **Gravitational force** is a measurement of the pull of gravity. Large masses have a stronger gravitational force than small ones. If a small object is trapped by the gravity of a larger object, it must move fast enough not to be “captured” by the gravity of the larger object. If it slowed down enough, it would fall into the larger object. For example, the moon moves around Earth in an orbit. If the moon moved more slowly, Earth’s gravity would pull it into Earth. If the moon moved more rapidly, it would escape into space. Since the sun is the largest mass in our solar system, it creates the gravitational force needed to hold Earth and other planets in orbit around the sun.



A **planet** is a celestial body that revolves around a star, does not give off its own light, and is larger than asteroids or comets. The planets of our solar system, in order from the sun, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Mercury, Venus, Earth, and Mars, the inner planets, are made up of rocky, solid matter. The outer planets, Jupiter, Saturn, Uranus, Neptune, are made up of gasses. The farthest out planet, Pluto is made up of rocky, solid matter. The chart below shows the **distance**, *a measure of the amount of space between objects, of planets from the sun*. Can you figure out how far some planets are from other planets?

Name of the Planet	Distance from the Sun:	
	Miles	Kilometers
Mercury	36,000,000	58,000,000
Venus	67,000,000	108,000,000
Earth	93,000,000	150,000,000
Mars	141,000,000	228,000,000
Jupiter	484,000,000	778,000,000
Saturn	888,000,000	1,429,000,000
Uranus	1,786,000,000	2,875,000,000
Neptune	2,799,000,000	4,504,000,000
Pluto	3,666,000,000	5,900,000,000

Below are data that can be used to compare the planets:

Mercury:

- It is the nearest planet to our sun.
- Our moon and Mercury's surface look similar.
- It has no atmosphere.
- It has no moons.
- Mercury revolves around the sun with the same side always facing the sun.
- It has the greatest range of temperature-
662° F (day) to -274° F (night) = 936°

Venus:

- It is the second planet from the sun.
- It spins slowly backwards as it orbits the sun.
- Its atmosphere is mostly made up of carbon dioxide.
- The atmosphere traps heat making Venus the hottest planet (860° F).
- Its surface is mostly craters, mountains, and volcanic lava flows.
- It has no moons.

Earth:

- It is the third planet from the sun.
- It is covered by 70% water and 30% land.
- It has one moon.
- It has the conditions necessary for life as we know it.
- It has volcanoes and earthquakes.

Mars:

- It is the fourth planet from the sun.
- Iron oxides (rust) cause its surface to have a red glow.
- It has polar ice caps made of frozen carbon dioxide and water.
- It has two small moons.
- It has a thin atmosphere.
- Huge dust storms sometimes cover the surface.

Jupiter:

- It is the fifth planet from the sun.
- Its atmosphere is made mostly of hydrogen, helium, methane, and ammonia.
- Its Great Red Spot is a storm, which has lasted for millions of years.
- It has a ring system.
- It has four large and twenty-four small moons.
- It is the largest planet in our solar system.

**Planet's size
shown in comparative
scale to Earth**



Saturn:

- It is the sixth planet from the sun.
- It is the second largest planet.
- It has an atmosphere of hydrogen, helium, methane and ammonia.
- It has at least thirty moons.
- The largest moon, Titan, is larger than Mercury.
- If it were set upon Earth's oceans, it would float.
- It has a ring system.

**Uranus:**

- It is the seventh planet from the sun.
- It is the third largest planet in our solar system.
- It has a ring system.
- Its axis points toward the sun
- It has 21 moons.
- It has an atmosphere of hydrogen, helium, methane and ammonia.
- Methane causes Uranus to appear blue in color.

**Neptune:**

- It is the eighth planet from the sun.
- It has a Great Dark Spot that is a huge storm system as large as Earth.
- It has high altitude winds.
- Its atmosphere is made of hydrogen, helium, methane and ammonia.
- Methane causes Neptune to appear blue in color.
- It has eight moons.
- Its moon, Triton, has an atmosphere.
- It has a ring system.

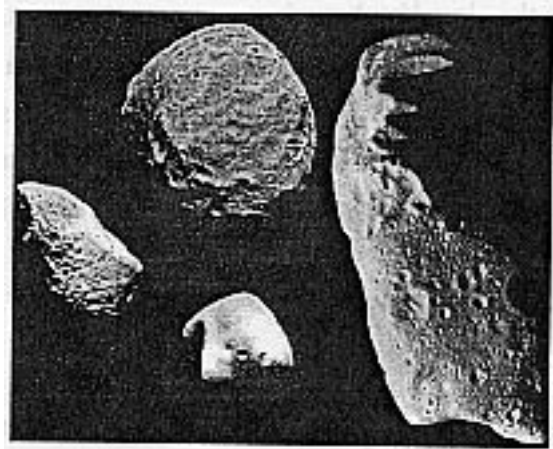
**Pluto:**

- It is the ninth planet from the sun.
- Its atmosphere is nitrogen, carbon monoxide and methane.
- Its moon, Charon, is half the size of Pluto.
- It is the outermost known planet.
- Its oval orbit sometimes puts it closer to the sun than Neptune.



It can be difficult to understand how big and how small the planets are. We have some ideas of how large Earth is because we live and travel on it. We get a sense of how vast it is as we travel to distant cities around the country and the world. It may take many hours or even many days to reach a destination depending on the type of transportation we use. Our knowledge of Earth will help us understand the sizes of the planets. The sizes of the planets on the previous pages are drawn to **scale**, *comparisons of objects to a standard*, showing how big and how small the planets are compared to Earth.

Asteroids are *irregular pieces of rock that move through space*. Their **mass**, *the amount of matter in something*, can be as small as tiny particles or as large as 1000 km in diameter. Most of the asteroids of our solar system are found in the asteroid belt between Mars and Jupiter. Most asteroids in this belt revolve around the sun. Other asteroids are scattered throughout our solar system.

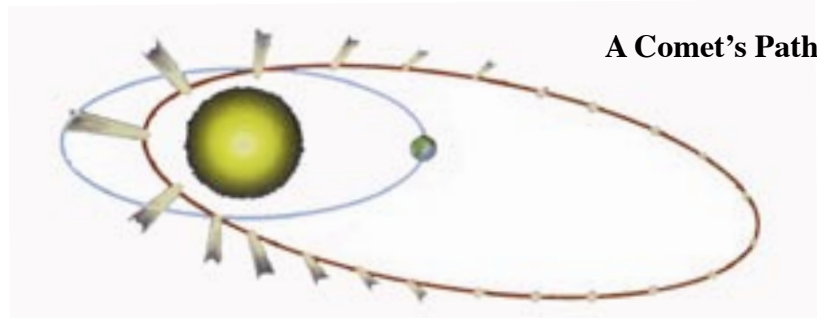


Asteroids

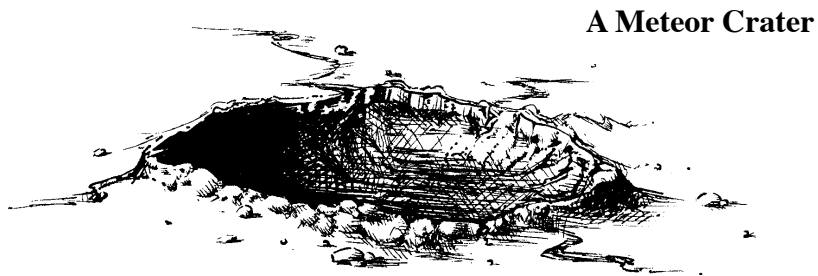
Comets are *composed of dust, ice and gasses which orbit the sun in a large, oval course*. They are often described as “dirty snowballs.” As comets approach the sun, the ice vaporizes, releasing dust and gasses that follow behind, creating tails. The tail may reflect enough of the sun’s light to be visible without a telescope. The tails always stretch away from the sun hundreds of millions of kilometers. Each time they orbit the sun, comets get smaller and smaller. After orbiting the sun many times, the comets will eventually disappear.

Comets are usually named after the people who first discover them. In 1705, Edmund Halley predicted that a comet everyone had seen many years before, would reappear in 1758. When his prediction came true, the comet was named after him. Halley's Comet passes by Earth every 76 years. It was last seen in 1986. When will people be able to see it again?

A new comet was discovered on July 23, 1995, by two young amateur astronomers. Hale-Bopp Comet was visible in the sky for many months. Its brightness peaked in March and April of 1997.



Oftentimes, when you are looking out at space on a clear night, you may suddenly see a streak of light flash across the sky. You have just seen a **meteor**, *a small particle of matter that is seen when it falls into Earth's atmosphere*. Sometimes we call them shooting stars. Meteors form from small rocks and dust clouds floating in space. Sometimes meteors will cross Earth's path. When they hit Earth's atmosphere, friction makes them burn up and produce a streak of light. Sometimes the rock chunk is so large that it won't burn completely, so it strikes Earth. These are called meteorites. Some meteorites can create large holes on Earth's surface, but most meteors are very small. When a group of small meteors enter Earth's atmosphere, we enjoy a special light show for an hour or so.



Satellites *are natural or man-made objects that revolve around a larger object in space.* The moon is considered a natural satellite because it revolves around Earth. Scientists use rockets to place man-made satellites in space to orbit Earth. Man-made satellites are lifted high into space, above the atmosphere. They can gather scientific data about Earth that can't be obtained from Earth's surface. They take photographs of large areas of Earth and huge weather systems. The satellites measure Earth's atmosphere and the military uses satellites to photograph buildings and troop movement all over the world.

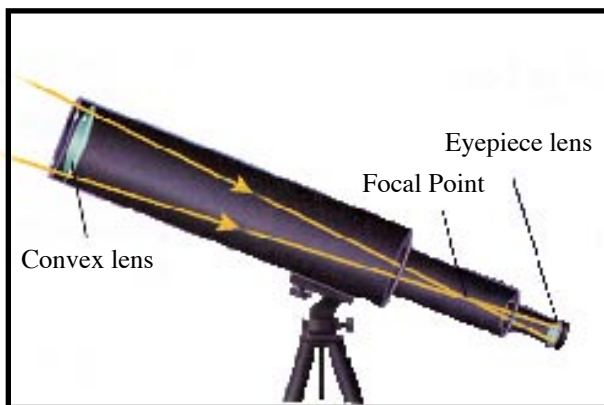
Man-made satellites also help with communications by relaying telephone calls and e-mail messages anywhere in the world. We can hear radio and see television programs that keep us current on world events. Satellites have brought people in the world closer together.

We have launched satellites that orbit Mars and Venus taking pictures of them. These pictures are used to learn more about the surface of Mars and Venus and to determine if there has ever been life on these planets. So far, there is no evidence of life ever existing on them. Man-made satellites are now carrying telescopes into space.

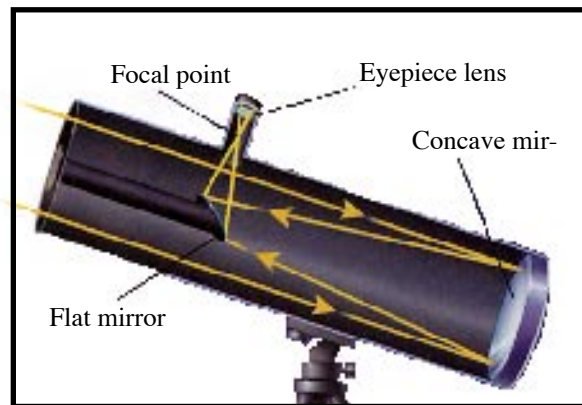


Galileo was one of the first scientists to observe objects in the sky using a **telescope**, *an instrument that magnifies or makes distant objects appear larger*. His observation led to the understanding that we do not live in an Earth-centered universe. Galileo's telescope had a curved lens at each end. He observed the moon's mountains, valleys, and craters. He was also able to observe nearby planets and their moons. In 1668, Sir Isaac Newton improved on Galileo's telescope. Newton's telescope used mirrors and only one lens to sharpen the images. However, even though the telescope had been improved, many early observations were not very detailed.

do not live in an Earth-centered



A Telescope with Lenses



A Telescope with a Lens and Mirrors

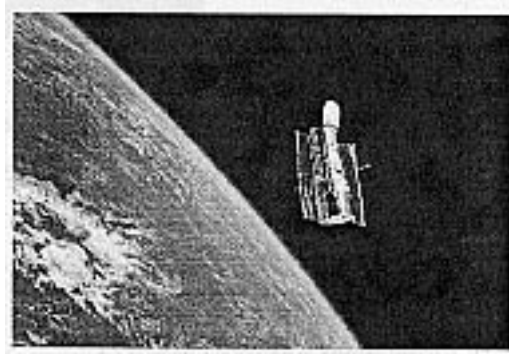
Since the time of Sir Isaac Newton, telescopes have improved. Modern observers see objects more clearly and at greater distances. Telescopes are often housed in observatories. Observatories are placed on top of mountains where the air is thin and fewer city lights exist. Air makes objects in space look blurry, and surrounding lights take away the brightness of objects being observed.

As technology has improved and aided in space exploration, NASA has launched satellites that contain telescopes. Images observed from space are seven times clearer than the strongest telescopes on Earth.

One such satellite-telescope, the Hubble Space Telescope, was launched in 1990. If the Hubble Telescope needs adjustment or repair, we send astronauts in a space shuttle to resolve the problem.

Observatory

jects



Hubble Telescope in Orbit Around Earth

Another type of space exploration takes place here on Earth. Scientists have found that celestial objects give off energy in the form of radio waves. Radio Telescopes use that technology to create different pictures of the universe. They can show energy-producing objects that do not give off light. Huge dish-shaped structures have been made to collect radio sounds generated from space. By listening to radio waves, scientists are making new maps of the universe and listening for signals from space that might indicate the existence of life elsewhere.



Radio Telescope

One way scientists have been able to learn more about space is by working in a space shuttle. A space shuttle takes off like a rocket with large fuel tanks supplying the energy. After launch, the tanks eject and the shuttle flies like an airplane in space. While in space, scientific experiments are performed by the astronauts. Most astronauts have scientific training but others are needed to fly the shuttle or make repairs.

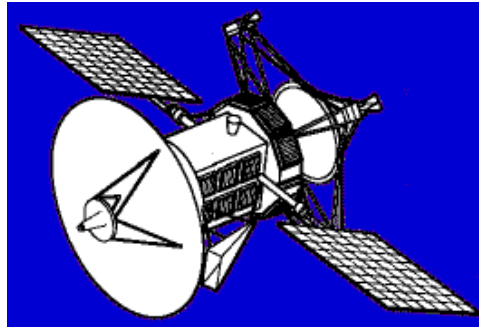
The space shuttle does not stay in space more than a short period. For long-term experiments, a space station is used. In 1973, the United States launched the Sky Lab Space Station where astronauts lived and worked for 84 days. The former Soviet Union space station, Mir, supported astronauts for 438 days. One of the interesting findings is that people can live in space and be weightless for long periods of time without harmful side effects.

One of NASA's most exciting projects is the International Space station (ISS). The station is being built in space with resources from sixteen nations. Each nation is building a section. The parts are lifted into space by American and Russian rockets. The parts are assembled in space and the station should be completed by 2006. The ISS is designed as a permanent laboratory for long-term research projects. When this space station is finished, scientists from all over the world will be able to live and work in space. While only seven scientists can live on the ISS at a time, future space stations will be built to house thousands of people to continue this research. Someday, you might live on a space station and conduct experiments that will benefit the whole world!



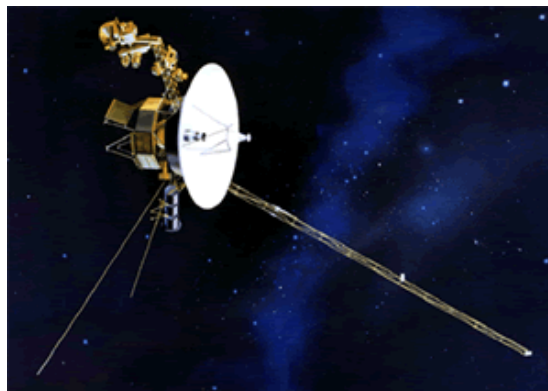
International Space Station

We have talked about objects on Earth and objects that orbit Earth that are used to gather information about our solar system. Another way to collect information requires the use of space probes that are sent to celestial objects we want to know more about. Space probes carry cameras, radio transmitters and receivers, and other instruments. Scientists use radios to communicate with space probes. Programmers tell probes what to do as they pass selected celestial objects. If a probe were passing Venus, the programmers could command it to take pictures or the temperature of the atmosphere.



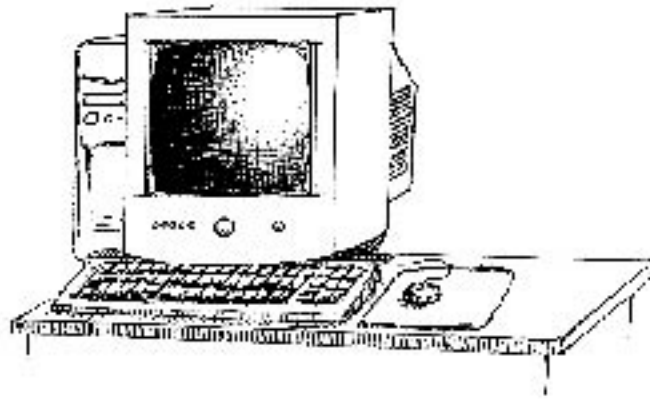
Magellan Space Probe

The probe, Galileo, launched in 1989, reached Jupiter in 1995. It returned some of the most exciting photographs of Jupiter and its moons ever seen. Some probes such as Pioneer 10, Voyager 1, and Voyager 2, have been launched to fly past the outer planets and venture into outer space. These probes have traveled past the asteroid belt and have taken pictures of Jupiter, Saturn, Uranus and Neptune. As the probes travel toward the edge of our solar system, they continue to transmit data to Earth for a few years. By the year 2000, the space probe, Pioneer 10, had traveled more than 11 billion km. On board is a metal plate with an engraving of a man, a woman, and Earth's position in the Milky Way Galaxy.



Voyager Space Probe

Computers have made a huge difference in our ability to organize, compute and analyze information received from space. You may think the only computers astronauts and scientists use are those that are on their desks. All the satellites and probes that we previously talked about have computers placed in them. The scientists use the computers on their desks to communicate with the satellites and probes. Commands are given to satellites to position telescopes. Commands are given to probes to tell them where to journey and how to position cameras for taking pictures. The computers on Earth decode these pictures and interpret their findings for scientists. When samples of gasses or material are taken by a probe, their computers analyze and interpret the gasses or materials of celestial objects and send the information back to Earth. Computers are also helpful in predicting the motion of planets, the phases of the moon, and tracking the course of comets and asteroids.



Technology, and space exploration have made it possible for astronomers and scientists to gather more accurate information about our solar system than we can ever imagine. We can answer questions people have asked for centuries. However, many more questions have been generated because of the information gathered. When you grow up, you may be the scientist who finds answers to these questions.

Science Language Students Need to Understand and Use

1. **asteroids:** irregular pieces of rock that move through space
2. **celestial objects:** all of the different objects in space that make up our universe
3. **comets:** celestial objects made up of dust, ice, and gases that orbit the sun in a large, elliptical course
4. **distance:** a measure of the amount of space between objects
5. **gravitational force:** the measurement of the pull of gravity
6. **gravity:** the attraction of one mass to another
7. **mass:** the amount of matter in something
8. **meteor:** one of the small particles of matter in the solar system that is visible when it falls into Earth's atmosphere
9. **planet:** a celestial object, larger than asteroids or comets, that revolves around a star without giving off its own light.
10. **satellite:** a natural or man made object that revolves around larger objects in space
11. **scale:** objects compared to a standard for accurate size perception
12. **solar system:** the system made up of the nine unique planets, and many smaller objects that orbit the sun
13. **stars:** celestial objects that consist of gases which generate light and heat
14. **sun:** the star that is the basis of the solar system and sustains life on Earth as the source of heat and light
15. **telescope:** an instrument that magnifies, or makes distant objects appear larger